CHAPTER - 1

INTRODUCTION

1.1 BACKGROUND

The Satpara dam multipurpose project with an installed capacity of 13.2 MW is proposed, in Northern Areas, 6 km south of Skardu city. It is located 16 km north of Deosai planes and about 3 km downstream of Satpara village. It is a natural lake formed by the glaciers having a surface area of 689 Acres. The dam has a dead storage of 38,500 acre-ft and live storage of 54,122 acre-ft. The project will generate 4.86 MW electricity from with one powerhouse and 13.2 MW with two powerhouses. The project will irrigate about 4,600 acres of land on right side of Satpara nullah and 10,400 acres of land on left side of Skardu city. The land on left side of the nullah is spread up to Hoto village just upstream of Ayub Bridge. To deliver power from the proposed powerhouse new transmission lines and improvement of existing transmission system will be required.

Northern Areas of Pakistan is a land locked area with a population of 1.20 million(Census report 1998). At present more than 50% of the population (This figure is less for rural areas.) has access to electricity in their homes and many of those experience frequent load shedding, blackouts on daily basis through out the year.

Economic growth in the country has severely been affected inadequate supply of power. Present domestic demand is increasing by a rate of 6 % per annum. The power demand of WAPDA system is forecast to increase at an annual average compound growth rate of 5.2 percent and 6.7 percent in case of low growth scenario and normal growth scenario respectively. The total demand forecasted for system in the year 2010 is 24000 MW and 20000 MW for normal and low scenarios respectively. Skardu region has primary source of 5 MW hydropower electricity. The powerhouses are located on Satpara and Kachura nullahs.

The proposed Satpara dam is designed to meet the Baltistan's growing electricity demand in the context of poverty alleviation program and economic development objectives. Besides power generation the Satpara project will help the region in agricultural development by irrigating about 15,000 acres of barren land. Another utility of the project is to fulfill water supply requirements of the Skardu city as the city is expanding very rapidly due to new economic activities.

The Satpara multipurpose dam project will consist of two power stations housing 2.43*2 and 4.5*2 MW Francis turbines with an associated 130 feet high dam and spillway. The project will require permanent land of 1 ha for project facilities and 24 ha newly inundated area adjacent to the Satpara lake and 0.3 ha of temporary land for project's ancillary facilities. The dam will impound a reservoir extending back to wooden bridge on Satpara nullah. The reservoir will have 686 ha surface area and have a live storage of 54,122 acre-ft at maximum operating level, which, will be fully replenished once in a year by the inflows. The reservoir will be contained within the natural steep mountains. The project will be completed within four and a half years.

Adjacent to the powerhouse there will be a switchyard to transmit electricity to 66 kV transmission line to be constructed for the project. A grid station has been proposed by NAPWD near radio station at Skardu. The electricity will be distributed from this grid station to Skardu, Khaplu and other side of the Indus River. The main uses of the project are given below:

- Water supply to Skardu city and its outskirts areas.
- Irrigation supplies to the 15,000 acres of land
- About 13.2 MW of power generation from the dam
- Flood control
- Tourism development of in the area
- Soil conservation
- Erosion control of the banks of the Satpara nullah due to floods.

The project will be designed keeping in view of the following key objectives;

- The energy needs of the region and community;
- Impact of the project operation on undertaking the social, culture and economic;
- Need to protect the natural environment of the area;
- Reducing deforestation of the area;
- To irrigate the barren land of Skardu city.

CHAPTER - 2

IEE REQUIREMENT

2.1 PURPOSE OF THE STUDY

The purpose of Initial Environmental Examination (IEE) studies is to identify the environmental issues expected to arise during construction and operation of the project and prepare mitigation program to manage the environmental affects in a manner to minimize adverse impacts and maximize secondary benefits. IEE seeks to compare the various alternatives, which are available for the project to improve. It is done by incorporating the environmental impacts into the design of the project at planning stage. For water resources projects in general, and river basin development projects in particular, impacts on the environment include:

- Land use and pollution during construction (of a dam/reservoir or irrigation project), including temporary, secondary problems caused by construction teams, transportation, equipment, etc.;
- Impacts on the environment during operation of the project due to alterations in the environment such as change of water flow pattern and subsequent downstream effects, discharge of wastes into the atmosphere, water, and soil, possibly causing environmental and human health hazards as well as those due to related or induced activities;
- Impacts of pollution on the environment and acute hazards to mankind during abnormal operating conditions such as extreme floods or accidents like dam break, or anaerobic water conditions in reservoirs or Hydrogen Sulfide fish kill during and after reservoir filling;
- Environmental degradation due to the consumption or exploitation of renewable and non-renewable natural resources, in particular, land required for the project;
- Secondary environmental impacts due to changes in land use, population density, and the socio-economic structure around a new reservoir or development project

The contents of this IEE report have been designed meet according to the World Bank, Asian Bank and GoP Guidelines. An IEE is required for all dams, reservoirs and hydroelectric power projects with a maximum storage volume greater than 50 million m^3 or surface area greater than 8 km^2 and hydro projects above 50 MW of installed capacity. The EIA is carried out following the ADB and GoP 1997Guidelines (Guidelines for the preparation and review of the environmental reports, policy and procedures for filing review and approval of environmental assessment. The IEE has to be submitted by the executing agency to the provincial environmental protection agency. In case of Northern Areas it should be submitted to the Pakistan Environmental Protection Agency (PEPA) for resettlement and compensation issues mostly in line with the ADB and the World Bank requirements.

The National Environmental Protection Agency 1995 status provides sustainable management of the environment. The procedure for conducting IEE of the projects as well as the consideration to be born in mind by the developer is elaborated in the Environmental Impact Assessment Regulations. According to the GoP Environmental Guidelines, no detailed EIA is required for less than 50 MW installed capacity. Only Initial Environmental Examination can fulfill the requirement of the PEPA. The IEE study has been prepared after fully consultation with the relevant local agencies and potentially affected people.

The Environmental Protection Agency regulations provide basis for:

- Sustainable development of wetlands, riverbanks
- Prevention of pollution
- Environment impact assessment for activities likely to have adverse impacts on these features
- Special measures for protection of flora and fauna in these habitats
- To create awareness among the people /stakeholders and dissemination of information.

CHAPTER - 3

PROJECT DESCRIPTION

3.1 PROJECT LOCATION

Satpara dam is located on Satpara nullah about 6 km south of Skardu city, which is a left tributary of the Indus River and flows from south to north direction. It starts from Deosai planes, flows through Satpara village and Skardu city and finally discharges in to the Indus River. The Satpara basin has two distinct parts; the upper part consisting high altitude hilly terrain, which contribute almost 90% flow and the lower (downstream of Satpara) shares 10% respectively. The nullah has a 275-km² watershed area. The location of the project is shown in Figure 3.1. The dam is located at WAPDA's gauging station site just downstream of existing intake of lake. The elevation at dam site is 2630 m.a.s.l.

3.2 DAM RESERVOIR

The Satpara project would be one of the major power projects in Northern areas of Pakistan in Baltistan region comprises dam with reservoir surface elevation at 2666 m.a.s.l. costing approximately Pak Rs. 2090 million (2002) including irrigation facilities. The water of the reservoir, which would inundate an area of 2.8 Km^2, has a total volume of 114.247-million m^3 storage. The total area of the reservoir would be 2776143 m^2. To optimize the capacity of the dam Shatung nullah in Deosai planes will be diverted through a tunnel, which will carry a discharge of 6 m^3/s. The length of the tunnel is proposed 5 km. Layout plan is shown in Figure 3.2.

The salient features of the project are:

3.2.1 Reservoir

- Full supply level 2666 m.a.s.l.
- Gross storage capacity 92622 Acre-ft.
- Active storage capacity 54122 Acre-ft.
- Surface Area 686 Acre.

3.2.2 Hydropower characteristics

- Installed capacity 13.2 MW.
- Annual energy 81 GWh.

3.2.3 Irrigation development

- Left side of Skardu city up to Hoto village 10,400 acre
- Right side of Skardu city up to Hussainabad village 4,600 acre

Other Social and economic benefits and environmental impacts

- Incremental dry flow 6 m^3/s
- Flood control yes
- Resettlement 8 families

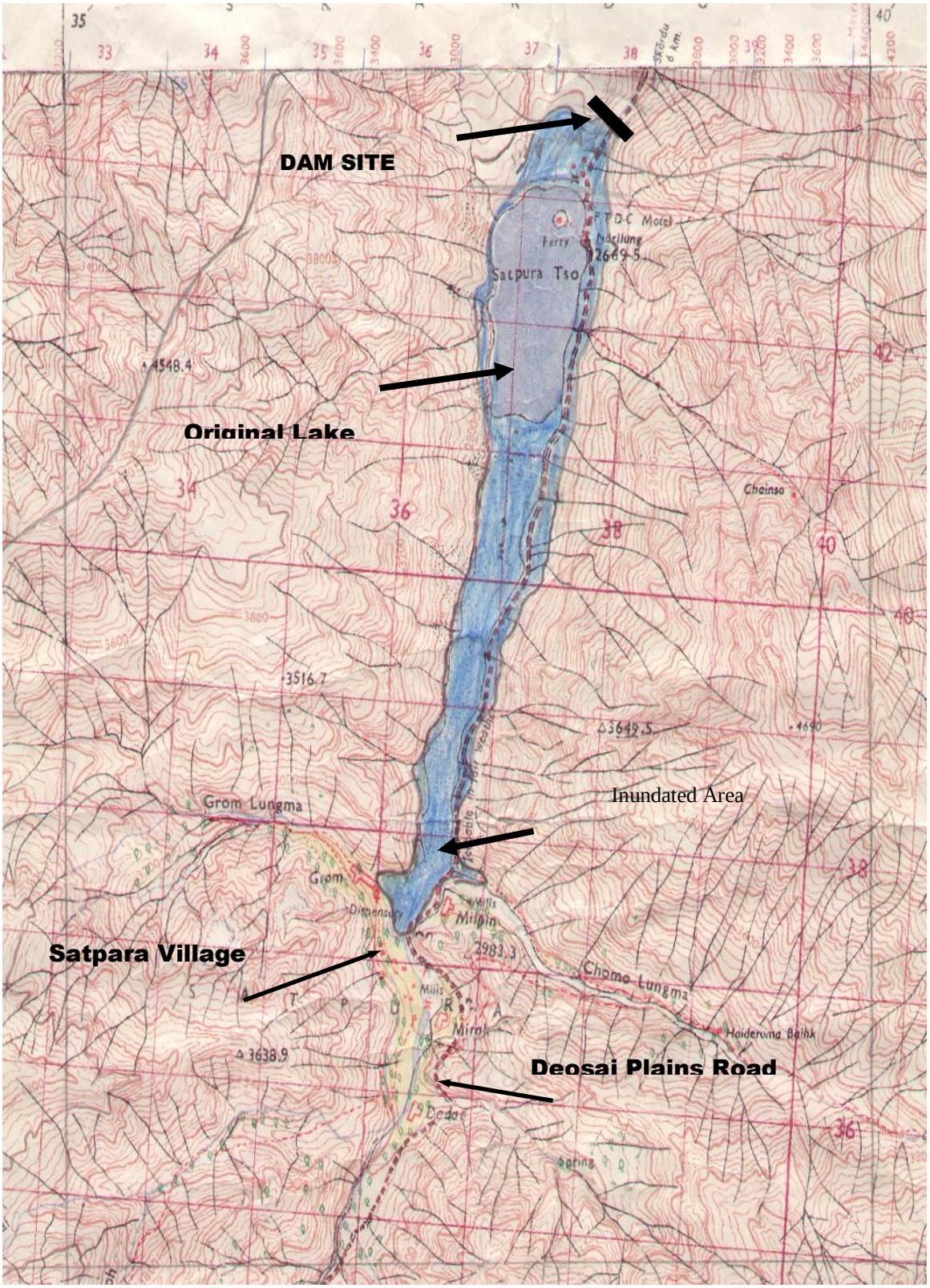


Figure 3.1: Location Map of Satpara Dam Project

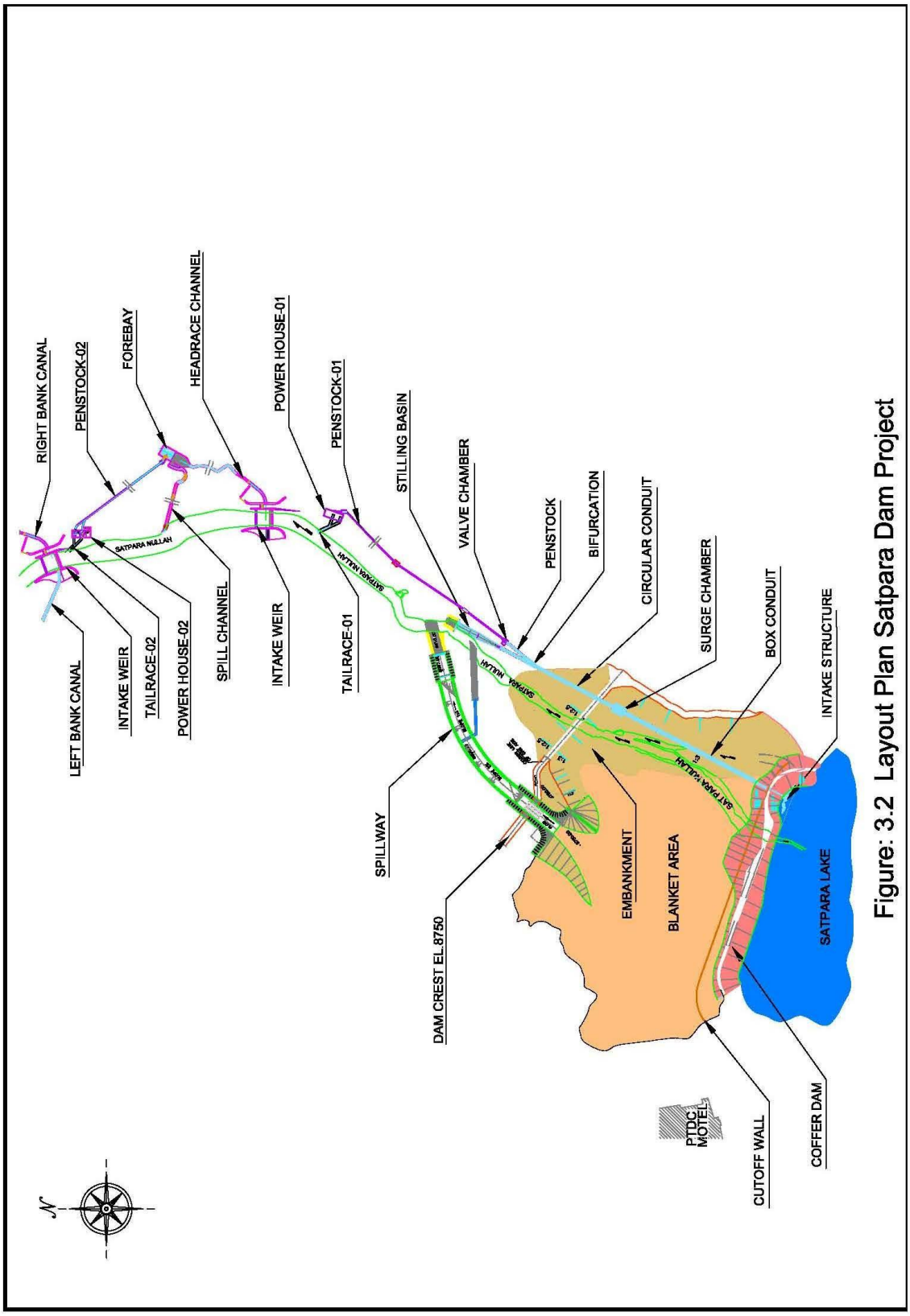


Figure 3.2: Layout Plan of Satpara Dam Project

CHAPTER - 4

ENVIRONMENTAL BASELINE

4.1 PHYSICAL ENVIRONMENT

4.1.1 Topography

The topography of the project area can be classified in to four topographic units by the feature of landforms and geological conditions as follows:

- Rocky Mountains
- Higher terraces
- Lower terraces
- Alluvial fans

In the lower terraces the vegetation cover consists of grass and trees. The local people cultivate these terraces. The total geographic area of the Satpara valley is about 275 km^2.

The Satpara Lake on which the Satpara dam project is located is predominantly high altitude land. The region is characterized by a pattern of high and steep hills, which are generally high towards south, closer to Deosai planes. General elevation of the land gradually increases towards north of Skardu city. Altitude ranges from 2300 to 4300 m.a.s.l. Abundant glacier deposits overlie in the valley. Intense avalanches/weathering has taken place in the area, which has left terraces in valley.

The Satpara nullah has a width ranging from 50 m to 100 m the nullah drops about 500 m within the project area. The nullah is quite noisy due to collision of flow over the boulders and sudden rapid falls. The local people have intensively planted the area right bank of the lake during the recent years, which has created fairly dense vegetation up to the road level. Island in the lake presents a high quality of scenic beauty of interest.

4.1.2 Geology

Satpara valley is a narrow valley, which shows evidence of past glaciations. The nullah has a steep gradient with falls at different locations and its bed contains large size boulders of various sizes, which are brought down by the glaciers and avalanches. Apart from the glacial characteristics, the valley shows talus/scree accumulation and alluvial terraces, which indicates that valley is a modified glacial valley, where glacis-fluvial and collegial activities have taken place.

4.1.3 Soils

The local soils of the area are well drained and even during heavy rainfall the soil does not become saturated and no pounding occurs. The basement of the lake is consisting of rock and aquifers have low hydraulic conductivity.

4.2 WATER RESOURCES

4.2.1 Hydrology

The flows of Satpara nullah will be regulated through Satpara dam. Presently a gated weir just at the inlet of the lake controls the flows. The flows are released from the lake according to the downstream requirements for irrigation and water supply during low flow period, however, during summer time the discharge increases and surplus water is disposed to the Indus River. The average annual flow recorded at Satpara gauging station is 5.602 m^3/s and highest flow recorded as on June 22, 1988 was 38.50 m^3/s.

Irrigation is the most dominant use of the Satpara nullah water, accounting for 74% of all water demand. The flow of Satpara nullah is controlled through temporary weirs, built by local people and Northern Areas Public Works Dept. The water for irrigating is diverted to the fields through number of channels. Small watercourses are constructed by the farmers for their land coming under the command of that water channel. New channel has been constructed on right

bank of Satpara nullah. The water for this will be drawn from the power channel of existing powerhouses. The channel leads water to irrigate the land of Hussainabad village. The proposed project will irrigate about 15,000 acre of land in Skardu area.

4.2.2 Surface water / Ground Water Quality

The seasonal rainfall is low and the groundwater level is very deep close to the relatively impermeable rock. Lower groundwater levels are encountered near Indus River. No borehole to establish the groundwater level has been carried out in the area so far. No groundwater level data is available about the project at the time of assessment.

The chemical and biological tests for the water quality of the Satpara nullah have been got tested at different laboratories by several departments. These departments are Northern Areas Public Works Department (NAPWD), Water, Sanitation Program of AKRSP and WAPDA on different locations. The water quality results of the Satpara and reference values are given in the table.

Table 4.1: Water Sample # 1 Test Results at Khosho Skardu (NIH)

Analytical Parameters	Ref. value Mg/L	Results Mg/L	Analytical Parameters	Ref value Mg/L	Results Mg/L
Calcium	200	40	Chloride	200	14.95
Chlorine	0.3	Nil	Nitrate	10	0.425
Magnesium	200	4.80	Sulphate	200	45.35
Sodium	500	15	Nitrite	0.1	Nil
Hardness	150	120	Bicarbonate	500	91.53
Potassium	100	3.0	Iron	0.3	-
Ozone	0.5	-	Fluoride	1.5	-
Total Dissolved Solid	1000	168	Suspended solid	Nil	++
PH	6.5-8.5		Colour	Unobjectionable	Normal
Turbidity	5.0 NTU	7.86	Odour	Unobjectionable	Normal
Conductivity	1334 uS/cm	224	Taste	Unobjectionable	-

NTU= Nephlometric Turbidity Unit

Source: Results obtained from Mr. Nazir AEE NAPWD Skardu

Table 4.2 Water Samples #2 Test Results (WASEP)

Selected Water Quality Standards							
Parameters	**Satpara lake**	**U/s of PH-1**	**U/s of PH-2**	**D/s of HP-1**	**D/s of HP-1**	**WHO g/lines**	**WHO Standards**
PH	6.5	6.8	7.2	7	6.8	7.5	6.5-8.5
Turbidity (NTU)	8	8	12	9	8	5	5-25
Total Dissolved Solid	111	114	42	117	115	200	500-1500
(TDS)	56	68	4	68	65	80	
Suspended Solid	46	50	60	58	58	100	75-200
Total Alkalinity	88	92	72	100	92	75	30
Total Hardness mg/l	28.8	60.5	24	33.6	32	50	45
K (mg/l)	3.9	3.9	3	3.9	2.9	0.05	
Mn mg/l	0.03	0.03	0	0.04	0	0.35	200-400
Nitrate (NO_3) mg/l	20	40	0.01	40	20	70	
Cl (Chloride) mg/l	60	65	6	58	68	100	
Sulphate SO4 mg/	0	0	0	3.4	1.9	0	
Greese traces mg/l	0.03	0.06	0.1	0.04	0.1	0.3	
Iron (Fe) mg/l	-	-	-	-	-	-	
EC							

NTU= Nephlometric Turbidity Unit
Source: Results obtained from Mr. Nazir AEE NAPWD Skardu

Table 4-3 Chemical and Bacteriological analysis of water samples of Satpara nullah and Lake

Sample code	Date Sampled	Loca-tion	Temp ^0C	Q. m^3/s	DO Mg/l	CO_3 mg/l	Mg mg/l	NH_3	NO_3	COD Mg/l	T Coli-form	E. Coli MPN/100ml
SPD-01	18/5/02	U/s lake	9 ^oC	14.2	9.9	48	0.2	0.2	0	4	17	17
SPD-02	18/5/02	U/s lake	12 ^oC	-	10.0	70	Nil	0.1	0	90	2	Nil
SPD-03	18/5/02	D/s dam	9 ^oC	S5.8	10.4	74	Nil	Nil	0	52	2	2
SPD-04	18/5/02	D/s dam	10 ^oC	-	10.0	70	0.3	Nil	0	20	4	4

Analyzed by Institute of Environmental Engineering and research, Uet, Lahore.

Sample code	Date Sampled	Loca-tion	Temp ^0C Water	Do. %l	DO Mg/l	Alk mg/l	Mg mg/l	NH_3-N	Na	COD Mg/l	Ca	PO4
SPD-05	03/09/02	u/s bridge	9 ^oC	73.2	11.6	56	4.8	0.2	4	20	24	1.2
SPD-06	03/09/02	lake	14.5^oC	85.4	10.3	56	9.6	0.1	4	4.0	24	0.7
SPD-07	03/09/02	D/s lake	14.5 ^oC	86.4	10.3	56	5.8	0.05	4	32	24	0.1
SPD-08	03/09/02	Powerhouse	14.5^oC	92.2	10.3	52	5.8	0.05	4.5	5.0	23.6	0.8

Solubility of Do in water in equilibrium with dry air at 760mmoh Hg and containing 20.9 % oxygen

Analyzed by Institute of Environmental Engineering and research, UET, Lahore.

Table 4-4 Chemical analysis of water samples of Satpara nullah and Lake

Sample code	Date Sampled	Location	Temp ^{0}C	Q. m^3/s	Ca++ Meq/L	CO_3 Meq/l	Mg Meq/l	Na	HCO_3	SO_4 Meq/l	DS EVP PPM	PH
SPD-01	18/5/02	U/s lake	9 ^{o}C	14.2	0.9	0	0.1	0.24	0.8	0.25	73	7.78
SPD-02	18/5/02	U/s lake	12 ^{o}C	-	1.1	0	0.4l	0.50	1.40	0.40	119	7.77il
SPD-03	18/5/02	D/s dam	9 ^{o}C	5.8	1.2	0	0.4l	0.40l	1.40	0.30	121	7.78
SPD-04	18/5/02	D/s dam	10 ^{o}C	-	1.1	0	0.6	0.40	1.60	0.20	125	7.79

Analyzed by Scarp Monitoring Organization, WAPDA, Lahore

Sample code	Date Sampled	Location	Temp ^{0}C	K	Ca++ Meq/L	CL	Mg Meq/l	Na	HCO_3	SO_4 Meq/l	DS EVP PPM	PH
SPD-01	03/09/02	u/s bridge	9 ^{o}C	.04	1.3	.800	0.40	.71	1.10	.50	140	7.07
SPD-02	03/09/02	lake	12 ^{o}C	.04	0.2	0.20	1.30	.18	1.10	.40	97	8.14
SPD-03	03/09/02	D/s lake	9 ^{o}C	.04	1.2	0.20	0.3	.18	1.10	.40	97	8.15
SPD-04	03/09/02	Powerhouse	10 ^{o}C	.04	1.3	0.50	0.3	.42	1.10	.40	116	7.7

Analyzed by Scarp Monitoring Organization, WAPDA, Lahore.

Table 4.5: Chemical Analysis of Water Samples of Satpara Nullah and Lake

Analytical Parameters	Ref. value Mg/L	Results Mg/L	Analytical Parameters	Ref value Mg/L	Results Mg/L
Calcium	200	40	Chloride	200	14.95
Chlorine	0.3	Nil	Nitrate	10	0.425
Magnesium	200	4.80	Sulphate	200	45.35
Sodium	500	15	Nitrite	0.1	Nil
Hardness	150	120	Bicarbonate	500	91.53
Potassium	100	3.0	Iron	0.3	-
Ozone	0.5	-	Fluoride	1.5	-
Total Dissolved Solid	1000	168	Suspended solid	Nil	++
PH	6.5-8.5		Colour	Unobjectionable	Normal
Turbidity	5.0 NTU	7.86	Odour	Unobjectionable	Normal
Conductivity	1334 uS/cm	224	Taste	Unobjectionable	-

NTU= Nephlometric Turbidity Unit

Source: Results obtained from Mr. Nazir AEE NAPWD Skardu

Table 4.6: Laboratory findings of bacteriological test of water

Sample No-1 Spring water		Sample No-2 Tap water	
Analytical Parameters	Results mg/L	Analytical Parameters	Results mg/L
Total Viable count	$5x10^3$ per/ml	Total Viable count	$1.9x10^3$ per/ml
Coliform count	$2.4x10^3$per/ml	Coliform count	$3.8x10^3$per/ml
MPN for coliforms	240^+ /100 ml	MPN for coliform	240^+ /100 ml
MPN for feacal coliforms	Negative	MPN for feacal coliform	Positive /100ml

NTU= Nephlometric Turbidity Unit MPN= Most Probable Number

Source: Results obtained from Mr. Nazir AEE NAPWD Skardu

The water sample was taken at Khosho site for laboratory analysis. According to the test performed by the National Institute of Health Islamabad the sample was found unsatisfactory due to high viable count and coliform contamination. This may be due to presence of residences at the intake site which discharges its sewage indirectly or directly in to the Satpara nullah from the field and other sources. Hardness, organoleptic, TDS, and potable water quality and all other remaining parameters appear to be within the permissible limits and found acceptable for drinking purposes.

Similarly WAPDA staff took the water samples from upstream and downstream of Satpara Lake. The sample taken from upstream of the

lake shows high number of E coliform. The reason of this high coliform may be human feces. The people in project area do not have proper sewerage system. Another reason is the astray animals that come to the lake area for grassing.

4.2.3 Present Water Quality Status

Consultation with Northern Areas Public Works Department (NAPWD) official and WASEP department of Aga Khan Rural Support Program indicated that no routine monitoring or research program exists from which baseline water quality data for Satpara nullah may be obtained. However, NIH Islamabad and Water & Sanitation Extension Program (WASEP) of Aga Khan Rural Support Programme got tested the water of Satpara nullah at two different occasions. The samples were sent to National Institute of Health Islamabad by NAPWD. The tests show that the chemical quality of the water sample appears to be good. No survey was carried out to determine the aquatic ecology in the Satpara Lake and nullah. No chlorophyll tests carried to know the biomass in the nullah. The nullah flows with high velocity resulting the biomass move quickly downward and cannot grow. But the algal biomass can be observed in the Satpara Lake, which shows influx of nutrients (P and N) into the Lake from the upper villages and other sources. This indicates a tendency towards eutrophication and is likely to have been caused by anthropogenic inputs of nutrients. It is not known that in which season the inflow and outflow of nutrients are entering in to the Lake. A regular chemical and biological analysis will determine the source and high concentration time. No hyacinth plant was observed during the field visit.

4.3 CLIMATE

The project area remains under the influence of severe cold during winter season. The rainfall is scarce and monsoon cannot cross the high Himalayan mountains and stays far reach of the area. Situated in the western most arm of Himalayan range, Satpara is found within semi arid and rugged mountain landscape (mountain desert). This whole region lies in a

"rain shadow" area, with average annual precipitation less than 200 mm, but rising with the elevation to create a moist environment at the extensive high altitude range lands. Because of altitude the area has marked seasonal climate comparable to that of temperate zone. The mean annual rainfall in the highlands of Skardu region varies from 150 mm to 225 mm. The maximum temperature during summer is around 35°C while mercury drops to –15°C in winter. The lowest temperature recorded in the Skardu city is –29°C in 1995. The mean minimum monthly temperature is –2°C in Skardu. The climate at the Satpara area is similar to Skardu. Average temperature and precipitation record for a period of 25 years is shown below:

Table 4.7: Mean Monthly Temperatures and Precipitation

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Temp (°C)	-2	1.3	6.8	11.6	15.5	20.8	24	24	19.6	12.2	5.5	-0.8
Prec (mm)	15	20	21	36	32	7	9	10	8	7	3	13

4.3.1 Wind

The wind in the Skardu valley blows from North side to South side. The local meteorology is characterized by high frequency of wind during winter season. Prevailing southern winds occur about 40% of the year. The Shigar river valley and Indus River are the sources of wind blowing in the Skardu. The maximum wind velocity recorded at Kachura site is 219 miles/hour in the month of September 1970 and minimum velocity 2 miles/hour in November 1970. SWH WAPDA has established the climatological station in 1970 just upstream of Ayub suspension bridge on Indus River. The data is related to year 1970 only. The wind in the area is the major source of erosion and dust. Given the recorded conditions, wind erosion of exposed ground is likely to be significant source of airborne dust. Dust generated by the wind has little affect on the normal life of the Skardu city.

4.4 BIOLOGICAL ENVIRONMENT

4.4.1 Flora

The total area of Northern Areas is 7.04 million hectares, out of which the forest area is 4%, agricultural land 14%, glaciers 59% and area

under Baltistan is 2.592 million hectares. The Deosai Plateau is a rolling area at elevations mostly above 4,000 meters. It has a cold climate and remains covered with snow for three quarters of the year. It is located at the junction of four major mountain ranges, the Karakoram, Ladakh, Zanskar and Himalayas. The known flora includes 342 species in 36 families and 142 genera. The area was declared as national park in 1995, and a management plan for the area is currently being prepared. There is an active program underway to study brown bears on the plateau and protect them. The reasons for the high level of biodiversity on the Deosai Plateau are multiple, which include topography, location at the junction of 4 major mountain ranges and the adaptations of its plants and animals. Some species, such as the burrowing vole (Hyperatcrius) serve as keystone species, allowing numerous other species to make use of underground burrow systems for shelter and foraging activities, thus maximizing species numbers and diversity in an otherwise austere region.

The Deosai Plateau is an uninhabited mountain wilderness surrounded by deep valleys and snowy peaks in the far north of Pakistan. In this rugged terrain the plateau stands apart as an expanse of open area with grass, flowers, streams and lakes. LaPersonne (1928) vividly described the area when he wrote: "It was a relief being able to see such an expanse of open country after months of confined valleys and dreadful gorges, to see the sun set without intervening mountains or the gold orb of the moon rise over the rim of the world."

Humans have subjected these regions to extensive exploitation during the past 50-100 years, with population growth, pastoral grazing, hunting, tourism and development having led to a great reduction of biodiversity. However on the Deosai, most of these activities have had very little impact, and as a result, the flora and fauna of the Deosai are largely intact.

The plateau is located about 25 km south of Skardu in the Northern Areas of Pakistan in Baltistan. It is bounded on the south by the Deosai Mountains, on the west by the Astor Valley, and on the north by a series of high ridges south of the Indus River. A jeepable road passes across the plateau from Ali Malik Mar Pass (4,084 m), Chakor Pass (4,266 m) just above Sheosar Lake, and down to the village of Chilam (3,350 m). The Deosai Plateau occupies an area approximately 35 km from east to west and 20 km from north to south, and ranges in elevation from 3,400 m to 4,300 m, with occasional peaks over 5,000 m.

The Deosai Plateau is an area of high plains with sloping southeast. There are three main rivers draining the Deosai. The Astor River originates from the western slopes of Burzil Pass. It also drains Chilam Nullah and the Deosai Mountains surrounding the Parashing Valley north of Astor, and roughly forms the western boundary of the plateau.

The Shigar River is the major river of the interior Deosai Plateau. It is also known as the Bara Deosai. It originates from the Shigar Mountains, and drains most of the area of the northern, northeastern and northwestern Deosai. In the upper reaches it is divided into many smaller branches. The Shatung River is the main branch, and drains the eastern uplands and flows westward to join the Shigar upstream of the wooden suspension bridge across the Shigar River, which is a major landmark on the Deosai. Another major tributary of the Shigar River is the Kala Pani River, which drains the northern and western uplands, including the Sheosar Lake area, and joins the main river below the wooden suspension bridge. These rivers drain a region of open rolling hills, spring-fed nullahs and mountain peaks and lakes that form the upland regions of the Deosai. This whole region is often called Bara Deosai, which means "big Deosai".

The Gultari River is on the southern and southeastern side of the Deosai. The river originates on the northern slopes of Burzil Pass, and flows eastward. Below the village of Gultari the river joins the

main Shigar River. It flows on to the north and east, joining the Suru River from Zanskar, and finally joins the Indus upstream of Kargil. This lower area of the Deosai in the region of the Gultari River is called the Shota Deosai ("small Deosai").

The Shota Deosai, as defined by Khan and Zakaria (1995), is restricted to an area south and west of the main Deosai Plateau. It begins near the village of Chilam, and runs eastward as a narrow valley to Gultari. This area of valleys and lower plains ranges in elevation from 3,300 - 4,000 m, and is more populated and ecologically degraded than the upper reaches of the Deosai Plateau proper.

The area receives abundant snowfall during the winter, and rain during the brief summer season. The moisture percolates through the course soil, and emerges in springs along nullahs and in open grassy valleys. In areas where springs emerge, deep rich grasslands and numerous flowers abound. The high elevation and strong winds combine to prevent trees from growing on the higher areas of the plateau (Bara Deosai).

The forest area under Baltistan is 0.0058 million ha. The natural forest area is 0.036% while the forest type is dry type. The land within and surrounding of the project area are largely composed of intensive settlement. The vegetation in Skardu and Satpara valleys generally consists of agro-ecosystem with wheat, maize, apricot, and cherry etc. Special attention has been focused on the plants in the reservoir area, which will be submerged due to increased water level, particularly endangered species. Several species are found in the site, none of them is recorded as endangered species globally or locally. Along the right bank of Satpara lake vegetation consists of cylix, apricot and mulberry trees. The banks of Satpara nullah are free of vegetation right from the intake area to the powerhouse site. There are small irrigation fields on the right bank of lake where wheat is grown as observed during field visit. High peaks are on all sides of

lake, which are covered by snow during winter, and avalanches frequently come down to lake. The vegetation in the project area is given in the table below.

Table 4.8 Vegetation in the project area	
Woody (trees and shrubs)	Popular, Willow, Rubina, Apricot, Almond, Peach, Walnut, Pine trees, Mulberry, Selix spp. Betula utilis
Crops	Alfalfa, Maize, wheat

4.4.2 Aquatic flora and fauna

Data regarding flora and fauna in the Satpara Lake and nullah is not available. So far no such studies have been carried out. However, during field visit it was reported by the staff of Fisheries Department that two types of trout fish are found in the lake and phytoplankton exists. The phytoplankton consists of blue green algae. The significance of phytoplankton to the fisheries in terms of food for zooplankton and juvenile fishes. Algae has been observed in the lake Satpara during field trip which is an indicative of eutrophic conditions due to nutrients input from irrigation and human population areas on right bank of lake.

4.4.3 Fisheries

The area has extensive water potential for the development of inland fisheries. There are eight major rivers and 121 streams that drain water in Indus River besides lakes over an area of 570 hectares including Satpara (48 hectares). Clean water is ideal for trout while the muddy water breads local fish species. The Satpara Lake has two types of trout fish, which are given in the table below. Fisheries department has been introducing trout fish in the lake for the last several years. Every year approximately 10000 juvenile fishes are introduced in the lake. The rooted vegetation on either bank of the stream is sparse and at a distance adding little to the biomass of the stream in the form of falling leaves and litter. Due to fast running nature of the stream filamentous algae and other macrophytes are not found except in some back water where pool-like situation exists. The fish fauna found in Skardu district is given below:

Table 4.9: Types of Trout Fish in the Satpara Lake

Brown Trout	Salmo truta fario
Rainbow Trout	Salmo gairdneri
Kamloop	Salmo gairdneri Kamloop

No site-specific data for indigenous or native species are available. Satpara nullah is a perennial stream fed by rainfall and snowmelt. The stream length up to Indus River is 34.5 km and the catchment area up to intake site is 275 km^2. The quality of water is good as anthropogenic pollution at present is bare minimum. The use of fertilizer and pesticides is also limited. The water is fast running and big boulders; cobbles, gravels and pebbles constitute the bed of stream. Very few pools and puddles are located along its course.

4.4.4 Historical Background of Trout Fish in Northern Areas

The trout fish was introduced in Northern Areas in 1908. The breading season of fish starts from 15 March and lasts in 15 October. During this period fishing is not allowed. Trout fish growth has increased in Northern Areas for the last 6 years. The lake was supplied brown rainbow from Australia in 1908 and from America in 1985. From 1985 another exotic fish Kamloop imported from USA and Australia and bred successfully in Northern Areas. There is no commercial fishing in the Skardu area. The fishes caught are for the personal consumption. Residents of project area and Skardu were interviewed for ascertaining the quantity of fish consumed. The survey showed that very few people consume fish as a part of their diet. These fishes are tolerant to extreme cold conditions in the lake. Phytoplankton, snails, fruit, plants etc are the feeders of trout fish.

4.4.5 Fauna

The Deosai Plateau is an uninhabited mountain wilderness surrounded by deep valleys and snowy peaks in the far north

Pakistan. In this rugged terrain the plateau stands apart as an expansive open area of grass, flowers, streams and lakes. LaPersonne (1928) vividly described the area when he wrote: “It was a relief being able to see such an expanse of open country after months of confined valleys and dreadful gorges, to see the sun set without intervening mountains or the gold orb of the moon rise over the rim of the world”.

Satpara lake/nullah and Shatung nullah are rich in aquatic fauna. Several kinds of fish exist in the waters of project area. Some fish types are in high altitude waters i.e. Triplophysa stoliczkae High Altitude Loach. This high altitude fish was originally described from Lake Tsho Mararai at 4,728 m elevation in western Tibet. Its distribution extends from Central Asia in the Oxus and Tarim river systems both of which occur at high elevations. In the Indus River system it has only been recorded from headwaters areas at elevations from 4,179 m to 4,905 m. The upper Gultari River is the only documentable site for the occurrence of this species in Pakistan. Nineteen specimens of this species were collected in the Gultari River at an altitude of 3,680 m from a site located 10 km upstream from where Sufaid Nullah joins the Gultari.

4.4.6 Reptiles & Amphibians

The number of reptiles and amphibians in the Deosai plateau is very limited because of the high elevation. At Deosai the specimens were collected near the edge of Sheosar Lake, and in tall grass around small pools of water. Near Babusar Pass it occurred in the same kinds of wet habitats under rocks at the edge of stream channels. Therefore, we predict that this frog may be widely distributed on the Deosai Plateau in wet, grassy habitats up to highest elevations at which such habitats are found (± 5,000 m). According to Auffenberg (pers. comm.) this frog can occur as high as 5,643 m in some areas where there are pockets of open ground in the permanent snowline.

Little is known about its natural history. A specimen from Babusar had a wasp in its mouth when collected. The tadpoles may take two years to develop into adults (Auffenberg, pers, comm.), and can be observed in deeper still pools of water in grassy areas where springs emerge. Tadpoles are found in both still and flowing water. Adult frogs are very slow moving, and are not usually observed moving about until after the sun has warmed the surface of the ground.

It appears to be restricted to alpine habitats. Dubois (1978) found it in high mountain torrents between 2,680-3,900 m in India. In addition to finding refuge from cold in water (streams and pools) and under rocks, this frog was observed emerging from the burrows of Hyperacrius (burrowing voles) and from rock crevices. The burrows of Hyperacrius also are known to shelter Sicista (birch mice) and Alticola (rock voles) and numerous insects, and may play a major role in the survival and distribution of these frogs on the Deosai.

4.4.7 Birds

The actual number of birds occurring on the Deosai Plateau is confusing because many migratory species pass through the area, and there is also a significant amount of altitudinal migration. Khan and Zakaria (1995) report that over 100 bird species have been observed on the Deosai Plateau. Matthews (1941) studied birds in the area between 15 July and 20 August, 1941. From his overall list of 58 birds, he documented 23 occurring on the proper Deosai Plateau. Khan et al. (1996) reported that they have observed 108 species of birds over a three year period, 81 of which were confirmed breeding, 23 were passing through the area as migrants, and 4 were vagrants. In our list of the 41 birds that are likely to be observed in the overall area of the Deosai Plateau we have followed published records, and the range maps and discussion in Roberts (1992). Our list is not a complete record. The lack of reliable published data on the birds of the region is too limited to allow such an analysis of the avifauna of the Deosai. Some of the more easily observed or ecologically significant species recorded on the Deosai Plateau are listed below. We have followed the nomenclature in Roberts (1992).

Order AcclpItriformes	
Family Accipitridae	
Haliaeetus leucoryphus	Palla's or Ring-tailed Fish Eagle
Gypaetus barbatus	Lammergeier or Bearded Vulture
Gyps himalayensis	
Accipiter nisus melaschistos	Eurasian Sparrow Hawk
Aquila chrysaetos	Golden Eagle
Order Falconiformes	
Family Falconidae	
Falco tinnunculus	Eurasian Kestrel
Order Galliformes	
Family Phasianidae	
Tetraogallus himalayensis	Grey Himalayan Snowcock
Order Charadriiformes	
Family Charadriidae	
Charadrius mongolus	Lasser Sand Plover or Mongolian
Family Scolopacidae	
Actitis hypoleucos	Common Sandpiper
Tringa totanus	Common Redshank
Family Laridae	
Larus burnnicephalus	Brown-headed or Tibeten Gull
Laws brunnicephalus	Tibetan Common Tern
Family Sternidae	
Sterna hirundo tibetana	
Order Columbiformes	
Family Columbidae	
Columba rupestris	Turkistan Hill Pigeon
Columba leuconota	Snow Pigeon
Order Cuculiformes	
Family Cuculidae	
Cucules canorus	Eurasian Cuckoo

Order Caprimulgiformes

Family Caprimulgidae

"Caprimulgus europaeus

Order Apodiformes

Family Apodidae

Apus apus pekinensis

Order Coraciiformes

Family Upupidae

Upupa epops Hoopoe

Order Passeriformes

Family Alaudidae

**Alauda gulgula* Lesser Skylark Ereinophila alpestris longirostris Long-billed Horned lark Family Hirundinidae Delichon dasypus cashmeriensis Family Motacillidae

**Anthus roseatus*

**Anthus trivialis*

**Motacilla citreola* Family Cinclidae Cinclus cinclus Family

**Prunella rubeculoides* Family Turdidae

**Luscinia svecica Phoenicurus ochruros phoenicuroides Phoenicurus erythrogaster* Family Sylviidae 'Phylloscopus affinis

**Phylloscopus sindianus* Family Tichodromadidae *Tichodroma muraria* Family Corvidae *Pyrrhocorax pyrrhocorax Pyrrhocorax graculus Con/us corax tibetanus*

4.4.8 Aquatic Birds

Satpara hydropower project was visited and surveyed for aquatic birds. Several species of aquatic birds were recorded. None of the species was endangered globally or locally. According to the available data with Forest Department of Northern Areas Skardu, waterfowls, eagles and ducks are found abundantly. However, many of the birds roost on the trees, especially on the Satpara Island located at the middle of the lake. There are presently enough trees for them to do this. Fortunately the area has been planted abundantly.

4.4.9 Mammals

Information on the mammals of the Deosai Plateau is very limited, Roberts (1977) available is the only source of reliable information. Since few investigators have collected or studied mammals on the Deosai, even Roberts has little information on the mammals of the plateau. About 18 mammals living on the Deosai Plateau have been reported according to research of local IUCN officials, ranging in size from the tiny Tibet red-toothed shrew (Sorex fhfbefanus) weighing less than 7 grams to the Himalayan brown bear (Ursus arctos) weighing approximately 150 kilograms. Both species are relatively rare, and it is uncommon to encounter either. On the other hand, the long-tailed marmot (Marmota caudata) is extremely common on the Deosai, and at times a dozen or more individuals can be observed across the rolling terrain. The marmot is the mammalian symbol of the area, sitting at the entrance to its extensive burrow system, vocalizing loudly. Few places in Pakistan have large concentrations of marmots. However, in terms of total biomass, the most dominant mammalian species on the Deosai Plateau is the small burrowing vole (Hyperacrius fertilis). Even though most individuals of this species weigh less than 20 grams, they live in huge colonies that cover large areas where the soils are deep and not too compacted. It is possible to find large areas of excavated soil and small burrow openings throughout the area of both the Bara and Shota Deosai, and when the total number of individuals is multiplied by the average mass of 20 grams, the total biomass of this species on the Deosai is extraordinary.

The activities of marmots and burrowing mice are important to the ecology of the Deosai in many ways. They excavate the soil, keeping it porous and loamy. They disperse plant materials. They serve as the major source of food for carnivores such as brown bears, foxes, predatory birds, and even the snow leopard. In addition, their deep burrows serve as shelters and nesting places for a number of insects, reptiles, amphibians and even other mammals.

Birds have been used as indicator group of fauna. Previous studies have been carried out by IUCN and individuals on the fauna of Deosai planes. The island within the Satpara lake is best shelter and safer place for the aquatic birds. A list of the small mammals known to occur on the Deosai is given in Table 4.10, along with their numbers, localities and respective elevation of capture site. The distribution of the small mammals more or less coincides with the boundaries of the Deosai Plateau.

Table 4.10: Relative Numbers of Small Mammals on Deosai Plateau

	Bara Deosai				Shota Deosai				
	Shatun (4,050	**Shatun** (3,880	**Kala** (3,970m)	**Sheosar** (4,150m)	**Burzil** (4,200m	**Sufaid** (3,650m)	**Parashin** (3,333m)	**Chilam** (3,350m)	**Total**
Sorex	0	2	2	2	0	2	0	1	9
Crociduia	0	0	0	0	0	0	0	1	1
C. suaveolens	0	0	0	0	0	0	1	0	1
Mustefa	1	1	0	0	0	0	0	0	2
Ochotona royfei	1	0	0	0	0	1	2	0	4
Hypwacms	21	15	28	16	9	4	9	8	110
Alttcola	26	0	7	1	0	2	15	0	51
Siesta concolor	0	0	5	4	0	1	0	0	10
Apodemus	0	0	0	0	0	0	18	4	22
Rattus	0	0	0	0	0	0	0	2	2
Maimofa	8	8	10	10	0	0	0	0	36
E. fimbriatus	0	0	0	0	0	0	1	0	1
PipislrgHus sp	0	0	0	1	0	0	0	0	1
Total	57	26	52	34	9	10	46	16	250

Source: IUCN Skardu Baltistan

Deosai plane has been declared as protected area for brown bears (Ursus circles') and their better management in the Deosai National Park (DNP). The Deosai plain is a plateau 20 km wide and 30 km long, situated about 30 km south of Skardu and 80 km east of the Nanga Parbat Range in Pakistan. The elevation ranges from 3500 to 4500 m above sea level and falls in the alpine ecological zone. Activities prohibited in the Deosai plane include:

Killing, trapping and hunting of different species like birds, bear, marmots, snow cock, partridges etc.

Destruction of any animal habitat (Deosai plane is habitat for brown bear, marmot).

Collecting of live animals or parts of animals dead or alive for any purpose.

The Northern Areas Forest Department Skardu has provided the following data about wildlife, which is responsible for safeguarding the forest and wildlife. The wildlife found in Skardu and its surrounding district is Asiatic Ibex (Capra ibex sibirica), snow leopard (Panthera uncia) wolf (Canis lupus), red fox (Vulpus vulpus), marmot (Marmota caudata) and mouse hare (Ochotona sp). Musk deer (Moschus moshiferus) is known to be found in the area but has been highly priced hunted for its musk. Common birds include chukor partridge (Alectoris chukor), jungle crow (Corvus machrohyncos char) and Himalayan snowcock or ram chakor (Tetraogallus himalayensis). Asiatic Ibex is probably the most abundant caprinae in Pakistan, in terms of relative numbers (Schaller 1977). Distribution of Ibex is restricted to relatively dry mountains of Northern Pakistan, which include the inner Himalayas, Hindukush and Karakoram. Population numbers for Northern areas (District Gilgit, Diamer and Baltistan) were estimated to be between 9000 to 10,000 Ibex in 1993 (Hess et al. 1977).

Satpara is a scattered settlement with meager population. Considering its wildlife resources to be protected and preserved, shooting, trapping of wild animals is banned except with a special permit. Killing and capturing of animals and birds is also restricted and specified in the permit. Snow leopard and Ibex are declared, as endangered and other species of mammals are scarce. But trophy hunting is allowed which is beneficial to the local community as the 70% of the funds go to the local community, which is used for the development of the local area.

Local inhabitants were interviewed about sighting of game animals. Their observation was that Ibex descends down to village Satpara

Bala during winter. Game watcher posted to monitor the wildlife in Satpara valley stated that poaching and illegal hunting is not common. However, the decline in wildlife has been witnessed over number of years.

4.4.10 Forestry

Forestry is important for fuel and timber, in addition to control of the soil erosion and reduction of silt load in lakes and rivers. Survey in Satpara valley showed that utilization of wood as a fuel, fro construction purpose and for grazing has a great importance for each household. To encourage and involve people to grow more forest, a Forestry Development Program has been initiated with the assistance of AKRSP and local community organization with the help of NORAD. A new program of planting trees over private land by the people of the project area has been started with the help of Forest Department. The forest areas including uncultivated wasteland are State Forests owned by the government. Wood is used for timber, fire and fuel throughout the year. Firewood is used during winter season. Agriculture University of Norway is striving hard to save the resource. Satpara is rich in natural forest although it has been extensively exploited. In the valley more forest plots are planted to reduce the pressure on existing forest.

4.4.11 Vegetation in the Project Area

The area falls under three major vegetation types (Schweinfurth, 1957). The lower northeastern part of the Indus River to about 2500 m elevation is described as sub-tropical semi desert. Dry, steep slopes with outcrop of rocks dominate the area. People practice single cropping agriculture and sub-tropic horticulture based on irrigation channels leading the glacial water from higher up the valley. The area above the sub-tropical semi-desert is classified as Steppe of Artimisia, dominated by shrubs such as Artomisia maritima. Euroratia ceratoides and Kochia. The average annual rainfall in the area is less than 150 mm, lacking a defined rainy season. The average rainfall

may approach 400-500 mm, depending on location. Most of the precipitation is received as snow during winters.

High snow-covered mountain peaks surrounded by the valley and slides into moraine slopes from the valley sides. Vegetation varies from drier eastern facing slopes to the moister northwestern slopes. Natural blue pine forest covers the north western facing moraine slopes. The forested moraines are led by deep gulches and glaci fluvial gravel farms sparsely vegetated by pine trees, willow (subx sp) and shrubs. Grassy slopes and juniper (Junipur macropda) cover areas where the forest has been cut down. About the pine, patches of birch (Belula utilis) delineate the upper forest line at about 3800 m.a.s.l. Steep slopes with artenisia (Artemiri maritima) characterise the southeastern facing parts of the valley up to 3600 m.a.s.l. Patches of blue pine and Juniper are found around the lower part at about 3300 m.a.s.l. Average rainfall is 400-500 mm depending on location and precipitation is received primarily as snow during winter. The altitude limit cultivation to single cropping favoring alpine species such as barley.

The class high alpine scrub and meadows cover all area above 3800 m and contained different habitats such as Scree slopes, boulder areas, meadows, etc. The upper part of the valley Charimond and Mangalistrong was recorded under this class. The grazing areas above Sari and Birtay and Ruskin (Steppe of Artemisia on Moraine) slopes appear to be heavily grazed.

4.4.12 Cultivated Plants

In and around the villages various trees are grown for fruit, shade, timber and firewood. In northern parts of the state where there is great scarcity of timber and fuel wood, these plantations are very jealously guarded. Poplar (Populus nigra) trees, which are grown for timber are very often protected from browsing damage by tying thorny branches around them. More commonly grown plants are black poplar (Populus nigra), apricot (Prunus armenica), walnut (Juglans regia), mulberry

(Morus spp), grape (Vitis vinifera), apple (Pyrus malus), pear (Pyrus communis), pomegranate (Punica granatum), sour cherry (Prunus cerasifera), sweet cherry (Prunus avium), peach (Prunus persica), Amlock (Diospyros lotus), fig (Ficus carica), almond (Prunus amygdalus) Maple (Plantanus orientalis), willow (Salix spp).

4.4.13 Pastures

The natural pastures are found above tree limit from about 3811 meters elevations. Only herbaceous plants grow and the density of ground cover depends on available moisture and soil depth. The most common grasses/ plants are Astragalus spp; Plygonum ssp; saxifrag spp; Oxyfropis spp; Corydalis spp; and potentilla spp. These Pastures are used from April to October.

Beside these natural pastures large blanks areas within the forest is also used as pastures during different months depending on their altitude. Common grasses and plants are Salix spp, Juniperus spp, Rosa spp, Berberis vulgaris spp, Lonicer spp, Prunus jacquemontii, Betula utilis, Rhamnu minuta, Heracleum thomsoni, Ribes villosum Ephedra gerardiana. And Viburnum continifolium.

The inhabitants keep large herds of goats and sheep to supplement their food supplies in the form of milk and meat as well as for providing wool, which is used in various local crafts. During the winter months when practically the whole of the tract remains under the cover of the snow, flocks are fed on oak leaves for which purpose the oak trees are lopped. The intensity of lopping is heavy and quite frequently the entire new growth is removed. During the mild summer months these flocks are grazed in the alpine pastures where they often herd in the upper forest limit.

The oak branches lopped for the leaf fodder are utilized as fuelwood in the villages. In areas adjacent to Oak forests, firewood is obtained from the nearby oak forests, which are cut ruthlessly for this purpose. In certain areas deodar is also lopped for fuelwood due to the absence of oak. In upper reaches there is acute shortage of fuel wood

and the people burn bushes like artimisia spp, and Ephera spp. A survey carried out in the project area shows that average house hold consumption is around 20-25 mounds in winter and around 10-15 maunds in summer. This requirement is higher in upper parts of the valley while comparatively lower in lower parts.

4.7 SOCIO- ECONOMIC ENVIRONMENT

Northern Areas are divided into five districts. These districts work under the decentralized system of government responsible for the general administration. The districts are further divided in to tehsils and Sub-tehsils. Local councils run these tehsils and formulate policies, resolving issues and providing leadership at grass root level. They play most important role in the local government. Socio economic indicators show that Skardu is backward with low quality of life. The means of communication are available by air as well as by road throughout the year. Life style is gradually improving after the construction of Karakoram-Gilgit – Skardu road.

4.7.1 Population

The increase in population of Northern Areas has been more than double since the first population census in 1951 compared to second census in 1981 as it increased from 0.25 million to 0.57 million showing 126.4 percent increase. According to population census 1998 the population of the Northern Areas was 0.87 million as against 0.57 million in 1981 showing annual growth rate of 2.5%. The overall urban proportion for Northern Areas has increased from 8.34 percent in 1981 to 14.05 percent in 1998. The density of population has increased from 8 persons per sq. km in 1981 to 12 person per sq. km in 1998. If the population continues to grow at its present rate it is likely to be double in 26 years unless some effective measures are taken to reduce birth rate. In rural areas population concentration is mostly along rivers and streams. Majority of the villages are spread out on the both sides of rivers / streams.

The study of population as well as its growth and distribution is highly important to forecast load of the areas, which based on these

parameters. With the objective in view the detailed analysis of the information, contained in 1981 and 1998 census (brief) of Northern Areas was made. Data collected from the offices of Deputy Commissioners/Assistant Commissioners was also considered. The population of Northern Area is unevenly distributed among its districts. The district Gilgit has the maximum population i.e. 27.96% while Ghanche, the minimum i.e. 10.15%. Urban and rural annual growth rates are the highest in Diamir district (urban 6.29% and rural 2.8%) between 1981 to 98 where as the same are the lowest in Skardu district (urban 4.85% and rural 1.82%). Similarly the over all growth rate (urban + rural) is the highest in Ghizar district i.e. 3.03% in Diamer 3.02% in Gilgit 2.66% in Skardu 2.12% and 1.11% in Ghanche between 1981 to 1998 census.

Literacy ratio in the project area population is low, being 6.0% to 38.0%. Only limited number of households has access to water supply. The size of landholdings per family varies from 23 to 6 acres, 5 acres being self-sustainable.

4.7.2 Settlements Households

Project area is spread over two settlements namely Skardu valley and Satpara consisting of several villages. These villages are located along the Satpara nullah upstream of lake.

4.7.3 Family Structure

Field enquiries show that majority of households are inhabited by single families. According to 1998 population census average size of household of the Northern Areas comes to 7.9 persons as compared to 7.1 to 1981. Variation in the average household size exists among the districts. It is the highest in Diamer district i.e. 8.2 persons per household and the lowest in Ghanche district i.e. 6.7 persons per household. Population statistics subdivision wise showing growth rates and persons per household are given in socioeconomic section. The average family size in Satpara valley is 10 members per household.

4.7.4 Ethnicity

The project area is inhabited by people from two different ethnic/ linguistic compositions and has distinct socio-cultural traditions, language and way of life. The upper part of the Satpara nullah is dominated by Shina speaking people. The lower part of the valley is inhabited by Balti speaking people. The whole valley is influenced by 100% Muslims.

4.7.5 Landuse

According to rough survey about 10500 hectares of land is lying barren in the shape of big planes and mountain passes. The planes are nearby Indus River. The big mountain plane is Deosai spreading over 70 km long and 20 km broad at the height of 3600 m.a.s.l.

4.7.6 Agriculture

Most of the agricultural activities in the Skardu and Satpara Valley are carried out on the terraces prepared in the vicinity. The land is much fragmented as such per capita land holding is 1.5 kanals (0.089 ha). About 14700 hectares of land is under cultivation of different crops.

About 90% of the population depends upon farming. Agricultural production cannot cope the food requirement for whole of the year, therefore the farmer research side earning through labours and trade especially during winter season. Agriculture is the dominant domestic economic activity and is essential to the rural populations who have to depend upon the production of their land holding when alternative income sources are insufficient. In view of peculiar climatic and topographic conditions of the area only single crop is practiced and in some areas buck wheat/kangani is cultivated as fodder crop after wheat harvesting.

Irrigation intervals reported for maize are 15 to 20 days depending on the rise in temperature and grain filling time. A serrated sickle does

harvesting and threshing is done either by hand or trampling of grain by oxen.

4.7.7 Horticulture

A variety of crop pattern is practiced in the farming system. The main crops grown in the project area are wheat, maize and barley. A special importance is given to the cultivation of fruits. Fruits are grown for household consumption as well as for market sale in the dry form. Fruits include apricot, cherry and mulberry. Eucalyptus is grown on the sides of roads. There may be some variation in the farm size or in the status of minor crops in the overall cropping practices but the general combination of crops, livestock and other farm related activities are more or less the same. Majority of the trees are grown on the field boundaries and banks of watercourses. The Agriculture Department and Aga Khan Rural Support Programme (AKRSP) are making efforts to improve crops and fruits production through various schemes of seed production and multiplication, development of horticulture and plant protection operations. Schemes for land reclamation and construction of irrigation channels are also underway to bring more area under plough.

The agricultural department of Skardu has recently provided about 10000 plants to the to the people for plantation purpose.

4.7.8 Occupation and Income

In the Satpara valley majority of population is engaged with agriculture profession about 5 % are employed in other fields (mainly in the field of education department and NGOs) 5% engaged in hotelling and about 10% in labours.

Annual average income per household in Satpara Valley is given in Table-4.11, the lowest 9% have 20000 to 30000 annually, and the maximum 30 % have 5000. The average income per household is Rs. 16500 per annum.

Table 4.11: Annual income of population of Satpara valley

% of Population	Annual Income (Rs.)
17	> 30000
9	20000-30000
11	15000-20000
9	10000-15000
24	5000-10000
30	Upto 5000
Total 100 %	

4.7.9 Migration

Field survey shows that a big percentage of permanent migration of population is taking place from down country and rural areas to Skardu urban areas mainly of business related persons. Skardu town is the district headquarter where all administration setup based. Jobs and business opportunities are available. Due to limited employment opportunities, transport and marketing problems of high value crops, people have to look for jobs or business in and outside their villages to earn their livings. Various forms of migration have been reported in Satpara village. Firstly there is a periodic migration when people go on appointment or transfer to other part of the states and visit their families. Secondly a number of students are studying in other parts of the country and come to their villages on vacations or special occasions. Thirdly there is a seasonal migration, which takes place during winter from the area of high altitude due to extreme cold. People along their cattle move to the lower part where pasture fields can be found. As summer approaches these people return to their houses in the upper part with their cattle.

The NAPWD is already facing problems in providing drinking water, sanitation and electricity facilities due to rapid population growth but the seasonal migration are causing further threat to these facilities. The household income is estimated/derived from various farming activities and the other sources of income such as wages, salaries, pension, shop keeping, trade and small-scale industries. Average household income varies from area to area. The average income of

Satpara inhabitants, based on the sample survey of the valley is presented in the above table. It appears that the available land cannot provide enough income to the farmers. The topographical conditions and small-holding restrict farmer's income from crop sector. Since in most of the rural areas there is high level of agricultural activity as such people have high livestock holdings. This is the reason that income level integrates small public works programs, which will be implemented with the collaboration of private sector. The only powerful mean to improve this aspect is that local government will identify, formulate and execute the development schemes in close association with local community and non-governmental organization in a transparent way.

The rural schemes includes farm to market roads/tracks, soil conservation, repair and resurfacing of small rural roads. These schemes are expected to contribute to agriculture and rural development, easier access to market to increase employment opportunities, better access to health, education and social amenities by increasing their source of income. It has been observed that social sector is not receiving the attention it deserves. To improve the social indicators the Social Action Program was also launched, beside on the realization that long term growth differs from area to area. It is high in urban areas and low in far off mountainous areas.

4.7.10 Education

The over all literacy rate in the entire Northern Areas was about 30% according to the census of 1981. The literacy ratio in urban areas is 36.8 percent compared to 12.6 percent in rural areas, which is even poorer when compared to the state where it is 47.1 percent (59.0 percent male and 35.4 percent female).

During the survey it was observed that the number of schools is increasing and people are very keen to get their children educated. Some non-government organizations are striving hard to develop education facilities in the Northern Areas. The government of

Northern Areas and local community based organization are taking great interest to develop education facilities in the project area. Primary education has been the top priority within education sector as is evident from the fact that half of the budget allocation had been earmarked for the promotion of primary education.

4.7.11 Health

Health facilities are not well developed within the Project area. Lack of adequate facilities has affected the incidence of malnutrition, illness, mortality and fertility. The local government within the project area provides health care facilities. The health facilities are scarce and the life expectancy in the valley is short. Infant mortality rate is high. One government dispensary is located in the Satpara village, which has no qualified doctor only a dispenser is serving and treating the patients. Serious patients and maternity cases are taken to the Skardu hospital, which is located about 15 km from Skardu city. Some old experienced women in this field make deliveries at home. However, now a days government is employing ladies health workers for this purpose. These workers actually belong to local area and after being trained will be deputed in the villages to look after the children and maternity cases.

Respiratory diseases are the major health problems in the project area. Silicoses has not been diagnosed for the last several years, (Dr. Abrar and Dr. Ammachat, Pers. Comm.). Nevertheless, the consulted experts said that dust causes serious problems for the inhabitants. Almost everyone suffers and particularly close to the “sand dunes” areas.

The prevailing diseases in the project area are asthma and bronchitis, probably caused by the prevailing adverse in door atmosphere due to the poor ventilation and extensive use of Kerosene and wood for heating and cooking. Chronic lung diseases were regarded as the extensive “traditional ways of dying”, from January to March being the period having the heaviest toll. Diagnosed eye diseases are also

commonly connected with in-door climate. During load shedding the use of generators to provide electricity to government houses and hotels create air pollution that may also be the risky to the common health.

Increased vegetation cover in Skardu Town due to afforestation along the Indus river during the past decades has considerably reduced the sand storms related problems, and health professional believe this has had a positive health impacts.

Other common diseases like typhoid, worm infestation, hepatitis A & B, seasonal diarrhea, gastrointestinal fever, cold, and tuberculosis/asthma are common. The children and women particularly are the more vulnerable to these diseases.

4.7.12 Existing Power Stations

There are two-hydel power stations constructed by NAPWD on the right bank of the Satpara nullah along the Satpara road. The capacity of these powerhouses is 960 KW. The generation of these powerhouses goes to the Skardu city as well as adjoining areas. However, cooking and heating is not allowed from these hydel power stations.

4.7.13 Natural Mineral Resources & Archeology

So far no initiatives have been taken to explore the archeological resources of the area by the Governments. Although the population of the area has been in the valley for since long people are not aware of any archeological features site in and around the valley. No natural mineral resources or mining related activities are reported in the area. A fort namely Kharpochu is resting on the mount in the Skardu city.

4.8 WOMEN IN THE PROJECT AREA

In Northern Areas of Pakistan women take all responsibilities at home. These responsibilities including taking care of household activities, bringing up of children, agriculture (sowing, watering, weeding), livestock, poultry and

collection of wood for cooking etc. Female population also carries out drying of apricot and mulberry; however, men also participate in leveling of land and sowing of crop. Now women are taking interest in all the fields specially education and health.

4.9 TOURISM

Tourism is the backbone of the Northern area's economy. Hundreds of people are engaged with this profession. The whole of the Northern Areas is known as the paradise for mountaineers, climbers, trekkers, hikers, painters and photographers. The area is well known in Pakistan for its scenic beauty and high mountains. The three mighty mountain ranges i.e. the North West Himalayas, the Karakoram and the Hindukush are the unique places of the world. These are not only representing the geographical phenomenon but also a part of the history and civilization in the past. Through these passes Buddhism reached China and other far eastern countries, which has become the part of many cultures.

Hunza, Naltar, Phandar, Yaseen, Deosai plain, Astore and Skardu are the valleys of immense beauty in the Northern Areas. Skardu has a historic fort known as castle of queen Mindoq and two lovely lakes, Kachura and Satpara, which are at a distance of 29 km and 8.04 km from Skardu respectively. In Diamer district there is Rama Lake, covered with snow, is a place of worth seeing. Shigar valley 32.18 km from Skardu is the gateway to the mountain peaks of the Karakoram.

The cultural patterns in these areas are as interesting as its topography. The people with their typical costumes, folk dances and sports provide some interesting area of study. The tourist season remain in full swing from April to October. During the mountaineering season the Government collects million of rupees from trekking groups. The increasing numbers in mountaineering and trekking expeditions has created pollution problem too. The Government started receiving US$ 200 per expedition party to overcome this problem since 1989. There is a continuous flow of tourists in the area from other parts of the country, China and abroad and the tourist industry is flourishing. In view of the past trend it is expected that tourist traffic will increase further in future.

Realizing the immense potential of tourism for the Central Karakoram area, one criteria' for World Heritage list nomination has been world-class mountaineering and trekking opportunities. Indeed, innumerous mountaineering and scientific expeditions have visited the area since over 150 years. Trekkers and adventurers have followed their footsteps since the 1980's, when the area was opened for regular tourist flow. Whereas other regions, such as Nepal and India have become popular with trekkers and adventure tourists much earlier and more intensively, The Central Karakoram has retained a reputation of 'last unspoiled wilderness', due to its vast tectonic formations, its remoteness, and difficult access. The Central Karakoram is estimated to provide 70% to 75% of regulated foreign tourism in Pakistan'. Baltistan is estimated to receive ca. 4.000 foreign tourists annually and a considerably larger number of porters, guides and cooks from other parts of the country. It goes without saying that this increasing trend of tourism to the area does leave its marks on the natural environment and the local cultures. To lessen the negative impact on the area, the concept of 'eco-tourism' is propagated in the planning process. Eco-tourism can be simply defined as a form of tourism, which is socially and environmentally sustainable. Another version of this form of tourism, ethno-tourism, may become a viable option once the area becomes better known for its outstanding cultural features, and tourists will be attracted to experience the unique ways of life still found in these remote regions. This has already happened partly in Gilgit region and areas falling into the buffer zone of the park, i.e. Hunza, Nagar. Considerably larger numbers of foreign tourists than the figures given above for trekking and mountaineering, frequent these buffer zone areas for sightseeing and small scale independent trekking. Tourism infrastructure is particularly well developed in these areas and partly; the concept of a cultural zone, already exists here in practice. Nonetheless, the establishment of a cultural zone to attract more tourists into the buffer zones around the park should be a provision in the initial park management plan.

CHAPTER - 5

ASSESSMENT OF CONSTRUCTION PHASE AND OPERATION PHASE IMPACTS

5.1 GENERAL

An accurate impact assessment associated with an initial design and planning exercise lowers the project costs in the long term by avoiding environmental problems thus minimizing costly changes in the later stages of the project. Such a strategy increases public trust in the scheme and reduces the chances of any litigation, proceedings or any other such cost which is caused by suits filed by the affected population.

The nature and effects of the construction related impacts are limited to a 4 to 6 year construction period of the project whereas the operational impacts are expected to last 25-50 years after construction. The main impact of the Satpara multi purpose project will be caused as a result of the changes in the hydrodynamics of the river, changes in water flow, variation in sedimentation levels and their affect on the natural resource base. The main impacts, which are of concern, are those that are likely to arise as a result of a direct or indirect activity, which might be associated with the project. Wherever possible, the magnitude and the probability of occurrence of the impacts have been quantified.

5.2 CHECKLIST OF POSSIBLE NEGATIVE AND POSITIVE IMPACTS

According to ADB guidelines, a checklist (Table 5.1) has been prepared for identification of impact. This checklist provides the significance of different parameters of Environmental Impacts of the project.

It is clear from this checklist that the project is environmentally friendly in the reservoir area but in Deosai plane it can create serious problems during construction of the shatung tunnel, which will divert the discharge of the Shatung nullah to Satpara nullah to enhance the capacity of the power project and storage of the reservoir. On the other hands the project has very positive affect on the Satpara Lake, which can be developed for fisheries

and economy of the area by irrigating more than 21000-acre lands of Skardu. Resettlements is often a major problem and have short term and long terms effects, but in this case only eight houses have to resettle and so its impact is not significant.

Table 5.1: ADB Checklist of Environmental Parameters for Major reservoir/hydropower Projects

ACTIONS AFFECTING ENVIRONMENTAL		IMPACT ON	RECOMMENDED FEASIBLE	IEE (D)			
RESOURCES AND VALUES (A)		ENVIRONMENT (B)	PROTECTION MEASURES (C)	(DI)	Significant Effect		
				No Sig. Effect	D2 Small	D3 Moderate	D4 Major
a	**Environmental Problem Due to Project Location**						
i	Resettlement	Serious social inequities	Carefully planned compensation and resettlement program including assistance & monitoring		X		
ii	Encroachment into precious ecology	Loss of ecological values Loss of these values	Careful planning plus offsetting measures Careful planning plus mitigation measures.			X	
Iii	Encroachment on Historical/cultural values	Shortened reservoir life	Watershed management program	X			
iv	Watershed erosion silt runoff	Economic loss	Careful planning plus mitigation measures				
v	Impairment of navigation	Economic loss	Careful planning plus design modification		X		
vi	Effects on ground water hydrology	Decrease in fish species catch	Fish traps, stream improvement reservoir development for fisheries and monitoring	X			
vii	Migrating valuable fish species			X			
viii	Inundation of mineral resources	Loss of precious resources	Proper location s, protection and planning		X		
ix	Alignment of project structure	Inconveniencies to population; resettlement relocation	Realignment Careful planning/design/O and M/monitoring.	X			
b	**Environmental Problems Related to Design**	Impairment of water quality and land values Affects reservoir water Quality including nutrients for fishery Loss of fish stock	Careful planning/design/ O&M/ monitoring	X			
i	Road erosion		Prepare site to suit optimal reservoir uses		X		
ii	Reservoir site Preparation		Proper screening.				
	Fish screens				X		

ACTIONS AFFECTING ENVIRONMENTAL		IMPACT ON	RECOMMENDED FEASIBLE	IEE (D)			
RESOURCES AND VALUES (A)		ENVIRONMENT (B)	PROTECTION MEASURES (C)	(DI)	Significant Effect		
				No Sig. Effect	D2 Small	D3 Moderate	D4 Major
iii							
(c)	**Environmental Problems Associated with Construction Stage**						
i.	Soil erosion/silt runoff	Impairment of water quality and land values	Proper construction planning plus, mitigation & monitoring		X		
ii.		Hazardous to worker's health/ safety	Proper planning, management and monitoring. -do-				
	Other construction hazards	Hazardous to health of workers and nearby communities	Proper construction planning plus monitoring and mitigation.		X		
	1. Safety of workers	Hazardous to health of workers and nearby communities	- do - - do -		X		
	2. Sanitation at workers camp		Appropriate construction monitoring and management.	X			
	3. Water-oriented	Hazardous to workers and neighbors Loss of scenic values	Minimize adverse effects		X		
	4. Dust/odors/fumes/ noise		Offset by promotion of services aquaculture, provision and fisheries management plan.		X		
iii.	5. Quarrying hazards (blasting and halting)	Without it, construction contractor not likely to observe constraints	Careful design to control problem plus monitoring				
(d)	6. Environmental aesthetics						
i	Construction monitoring	Disturbance to downstream fisheries, navigation & other uses		X			
ii		Loss of fisheries formerly growing inundated fields			X		
iii	Environmental Problems Relating to Project Operations	Erosion of banks and river bottom damaging downstream riverside.			X		
	Downstream flow variations						
	Depreciation of downstream inundation fisheries						

ACTIONS AFFECTING ENVIRONMENTAL		IMPACT ON	RECOMMENDED FEASIBLE	IEE (D)			
RESOURCES AND VALUES (A)		ENVIRONMENT (B)	PROTECTION MEASURES (C)	(DI)	Significant Effect		
				No Sig. Effect	D2 Small	D3 Moderate	D4 Major
	Downstream erosion						
iv.	Lack of reservoir management	Social conflicts and safety in reservoir	Appropriate reservoir management	X			
v.	Eutrophication (aquatic weeds)	Impairment of fishing and power generation	Temporary phenomena can be reduced	X			
vi.	Downstream water quality	Impairment of downstream water quality from flow restrictions	. Careful operations planning to minimize problem and release of compensation flow.		X		
vii	Insect vector disease hazards	Community health hazard	Careful monitoring plus use of appropriate control measures.		X		
viii	Reservoir bank stability	Impairment of reservoir uses and water quality	Careful planning/design	X			
ix	Operations monitoring	Without it operators not likely to comply with constraints.	Appropriate monitoring		X		
e.	**Potential Environmental Enhancement Measures**						
i.	Reservoir fishery enhancement	Considerable extra reservoir fishery potential realized	Appropriate reservoir fishery management plan and monitoring			X	
ii.	Draw down agriculture	Considerable extra agricultural production realized	Appropriate management of draw down agriculture	X			
iii.	Downstream community water supply	Improvement in community living standards	Planning for optimal use of stored water & provide alternate sources.			X	
Iv	Downstream aquaculture	Improvement in community quality of life including the poor	Use of project for establishment or reasons to offset losses.	X X			
v	Forestry/wildlife reserves	Conservation of forests/wildlife	Planning for optimal multipurpose reservoir use and stream development			X	
vi	Recreation	Possibility of developing additional land	Proper utilization and disposal and development plan.			X	
vii	Land development						
f.	**Additional considerations for Hydropower Projects**						
i.	Multipurpose management need	Opportunity to optimize over all project benefits	Integrated multi-purpose reservoir management		X		
ii.	Rural electrification	Improving quality of life for rural poor	Planning to accommodate this need			X	
iii.	Transmission lines	Loss of forest resources	Careful planning/design/O and M and monitoring to minimize and offset problems	X			

ACTIONS AFFECTING ENVIRONMENTAL		IMPACT ON	RECOMMENDED FEASIBLE	IEE (D)			
RESOURCES AND VALUES (A)		ENVIRONMENT (B)	PROTECTION MEASURES (C)	(DI)	Significant Effect		
				No Sig. Effect	D2 Small	D3 Moderate	D4 Major
	1. Encroachment on precious ecology	Impairment of wildlife values	- do -	X			
	2. Impairment of wildlife movement	Loss of scenic beauty	- do -		X		
	3. Impairment of environmental aesthetics	Depreciation of water quality and land values	- do -		X		
g.							
i.	4. Soil erosion from construction and areas		Planning should be consistent with national environmental protection policies	X			
ii.	left exposed		Proper cost benefit analysis on long-term basis.	X			
iii.	**Critical Review criteria** Loss in irreplaceable natural resources		Planning should be consistent with national environmental protection policies.		X		
iv.	Accelerated use of resources for		Proper development control/monitoring	X			
v.	short-term gains		Proper planning accommodating needs of all income groups	X			
	Endangering of species			X			
	Undesirable rural to urban migration						
	Increase in affluent/ proper people gap,						

1. This lists all significant environmental effects know to have occurred in past dams and reservoirs and hydropower development projects in developing countries.
2. This is arranged to permit (i) ready screening out of non-pertinent items (by checking the column "No significant Impacts" and (ii) ready grading of significant environmental effects SEIs) by degree of effect.
3. The checking process of (2) above furnishes the information needed for preparing the IEE.

Source: Environmental Guidelines for Selected Industrial and Power Development Projects Asian Development Bank, 1987.

5.3 CONSTRUCTION STAGE IMPACTS

5.3.1 Water Related Impacts

5.3.1.1 Water Quality

The water quality of Satpara nullah was determined by testing of different samples, in NHA Laboratory, Islamabad and WASEP Skardu. The water quality is fair and may be used for

drinking only after treatment, including disinfecting due to presence of faecal coliform. The major impacts of the flow reduction will be on water quality. This will impact on aquatic life downstream of Shatung weir. Water quality data has been given in Table 5.2, 3 and 4 shows prior to building of dam on Satpara nullah. Physical and chemical parameters are well within the tolerable limits specified by the World Health Organization (WHO) for drinking water, however bacteriological quality of water is not good and high number of faecal coliforms are found in the water. There will be some significant changes in the quality of water of the Satpara nullah during the construction of the project. The impacts on water caused by temporary diversion works at dam site will be significant.

During construction of diversion structure and other intake structure will alter the water quality of Satpara nullah and as a result dissolved and suspended particles may be increased. Water may become turbid for a certain reach of the stream, till the regime stabilizes.

During the pre-construction stage, diversion tunnels will be constructed. Construction of diversion structure and other intake structure will affect the water quality of Satpara nullah and as a result dissolved and suspended particles may be increased. Water may become turbid for a certain reach of the stream, till the regime stabilizes.

As noted earlier, water from the tunnel used in drilling/mining activity or originating from groundwater inflow will be silt laden. This water will be directly discharged in to the Satpara nullah. The silt will have to be cleared/settled before discharging. The water for drinking is taken directly from the nullah for Skardu city. The flow velocity in the nullah is high so it is anticipated that water will contain lot of suspended particles and bed load, which will damage the existing powerhouse turbines and may not be fit for drinking. In this context, the natural surface water

run-off will also get polluted as it may collect fine material from spoil dumping areas close to the construction activity as it trickles down the slopes. All this is expected to increase sediment load in Satpara nullah during construction activity and make it unfit for domestic use. Mitigation measures may require during construction activity to offset this impact.

During the construction of powerhouse, main dam, quality of water downstream of the dam may be affected, because of increased sediment loads contributed by construction activity. The diversion of water and increase in temporary sediment is expected to affect the unprotected drinking water source of Skardu city water supply network. Hussainabad irrigation channel's intake is located below the dam and will also be affected. Some mitigation measures will have to be taken to protect these water sources (or treatment) in order to maintain water quality in these sources.

Additionally water supply network may have to be established for construction labour in site installation camps during this stage.

5.3.1.2 Sediment

There will be no impact on the downstream of the dam as the sediments settle down in the lake. Sediment load released from the lake is negligible and will not any have any adverse effect. However, flash floods and heavy rains simulate a condition similar to discharge of heavy sediment load.

5.3.1.3 Irrigation

The dam of the project is located about 6 km from Skardu city. Any increase in sediment load in the nullah during construction stage will have impact on the water quality. The water should be released to nullah after settling the sediments. All the irrigation channels are located downstream of powerhouse.

Irrigation requirements will not be affected rather improved. No irrigation channel off takes above the project site.

5.3.1.4 Watershed Erosion

During the construction of project's infrastructures, care should be taken to protect and conserve the natural vegetation cover. Several thousands trees are standing in the reservoir area. Removing of these trees will multiply the erosion process rather these trees should be cut from the stem keeping a height of 2 to 3 ft. The excavation and construction activity should also be well planned. As most of the project structures are located downstream of the weir, the watershed area will not be disturbed by the project.

5.3.1.5 Downstream Erosion and Siltation

The rate of erosion will be increased to some extent due to the removal of vegetative cover on slopes during the construction phase. Construction activities like construction of the power channel, road construction, movement of trucks, cleaning of land area for infrastructure, provision of housing for the work force and storage for the machinery, excavation, cutting of trees will all contribute to increased erosion in valley. This may cause health and safety problems for the local population and increase the sediment load in the nullah; and subsequently, may affect the stream ecology.

There is danger of landslides due to the disturbance of the natural slopes, removal of vegetation cover. The material may have to be removed from the slide area. Depending on the site specific conditions and mode of excavation, this may result in the following impacts;

- Loss of vegetation cover may accelerate soil erosion and increase the probability of landslides.
- Hydrographic modification due to changes in the local surface flows to a minute extent.

- Re-routing of streams and channels may accelerate the erosion of the banks and increase sediment load.
- Degradation of aesthetic value of the area.

5.3.1.6 Waste Water Discharges

The quantity of waste will increase due to presence of large number of labour force working during construction phase. This will deteriorate the quality of water downstream of dam. Some mitigation measures will have to be provided to control waste from site installation camps and construction waste entering the water body to off set this impact. Within the site drainage should be installed such that all the surface water flow, including seepage water into the area between diversion structures will be intercepted and passed through a sedimentation basin to be located downstream. The sedimentation tank should work continuously. The sedimentation basin may be comprised of one or two parallel sedimentation tanks. Oil separation will be carried out using skimmers on the surface of the dams. The system should also include provision for dosing with chemical flocculants upstream of the sedimentation basin, in the event that this is required in order to achieve national standards for suspended solids in the final effluent. Effluent from the sedimentation basin will be pumped over the downstream diversion dam and discharged into the nullah.

As the water in the Satpara nullah flows very fast due to steep gradient there will be significant aeration/dilution process, which will help in reducing of nullah from being contaminated.

5.3.1.7 Fisheries and Fish Life

In the above section of the report current status of fish species has been given in the Satpara lake. The survey carried out by the field team identified two macro-habitat types in the nullah and reservoir: fast flowing habitat and slow or stagnant habitat.

The fast flowing zone habitats are the section of the nullah. This section has steep slopes, a predominantly rocky shoreline and contains several rocks in the bed. There are trees on the left bank of the nullah at the weir site. Satpara has a steep gradient of 6.48%. At number places there are falls. No fish was reported downstream of existing intake of the power projects, however, fishes were observed during field visit near dam site. After construction of the hydel project the reservoir will be further developed for fish culture and establishment of new hatcheries in downstream. Northern Areas fisheries department releases every year. During construction period fish fauna may be affected downstream of Shatung nullah and dam site but reservoir itself will not be affected. Following changes are expected during construction due to increase of suspended sediment load.

- Change in availability of a food resources for some species/life stages of phytoplankton.
- Change in availability of spawning habitat for some species invertebrates.
- Change in availability of cover from predators for smaller species like macrophytes.
- Effect on a sensitive life, possibility affecting population age structure of juvenile fish.
- Effects on feeding

Effects on invertebrates prey species:

- change in habitat availability on the basis of water depth, flow velocity and diurnal water level fluctuation

Effects on macrophytes species:

- change in macrophytes cover and species composition on the basis of water depth, transparency, flow velocity

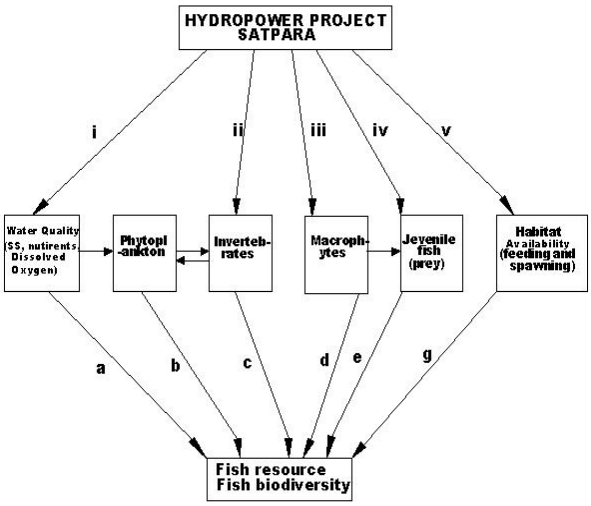
and diurnal water level fluctuations.

Effects on juvenile life stages (including prey species):

- Change in food availability (phytoplankton and invertebrates)
- Change in habitat availability on the basis of water depth, flow velocity, diurnal water level fluctuations and effects on macrophytes
- Change in feeding efficiency due to change in transparency of water column

Effects on feeding and spawning habitat:

- change in availability of habitat on the basis of water depth, flow velocity, water level and fluctuations.



The importance of each of the potential changes outlined above is assessed in Table 5.2 for the reach of Shatung nullah and downstream of Satpara dam during construction.

The major changes that will occur during construction and operation of the project will be increased suspended sediments concentrations downstream during construction and changes in habitat type within the impounded reach. The Shatung reach has slower velocity due to its flat slope, a more sandy and silty

substrate and is characterized by a higher diversity of both plant and animal including fish species.

Table 5.2: Importance of Potential Changes on Fish Resources in Shatung and Satpara Nullah

Parameters	Downstream of Satpara/ Shatung (Construction Phase)	Upstream of Satpara dam and Shatung Nullah	During Operation Phase
(i) Water Quality	Increased suspended solids (up to 15 mg/l above baseline Slight decrease in suspended sediment and increase in transparency (due to decreased How velocity) Slight decrease in dissolved oxygen due to decreased turbulence	Little potential for eutrophication in Shatung nullah and Satpara dam. Slight decrease in dissolved oxygen due decrease in turbulence in Shatung nullah. No change in Satpara.	Decrease in suspended solids and increased transparency due to "settlement pond' effect in Satpara.
(ii) Invertebrates	No change in Satpara. Little change is expected in Shatung Nullah	Change in species composition. Some loss of non-mobile species due to reservoir level fluctuation. Increase in lake margin habitat due to increase in shoreline and daily water level fluctuation.	No change
(iii) Macrophytes	No change	Increase in over all habitats due to increase in surface area of reservoir. Increase in species tolerant to water level fluctuation.	No change

Parameters	Downstream of Satpara/ Shatung (Construction Phase)	Upstream of Satpara dam and Shatung Nullah	During Operation Phase
(iv) Juvenile fish	Reduction in total habitat due to increase in suspended sediment. Decrease in species sensitive to water level fluctuation. loss of shoreline in Shatung nullah but local increases in biodiversity due to creation of habitat in the lake.	No change	No change
(v) Adult fish habitat	Potential minor impacts due to increased suspended solids e.g. reduced hunting efficiency	Change in habitat.	No change

5.3.2 Air Related Impacts

5.3.2.1 Air

During the construction movement of heavy traffic and dumping machinery will also cause pollution by the emission of dangerous gases through the Skardu city. However the impacts will be of short term and low, as the most activities will occur at dam and powerhouse sites.

5.3.2.2 Dust

During construction, generation of dust along off site routes during importation of construction materials and staff travel id of concern, particularly during the dry season periods. Satpara roads near project site can yield large amounts of airborne particulates during dry weather and there is potential for nuisance levels to be high.

Most of the heavy goods vehicles movements associated with construction are within the project area. This includes the about 200 movements per day during construction to transport roxk from the quarry to crushing plant.

Skardu city Health problems arise through many sources. The main source during construction is dust. Generally Pulmonary Tuberculosis and Silicosis may result from the dust generated by stone crushing, blasting and movements of equipment. Fumes and smoke from burning materials and vehicles exhaust can cause respiratory irritation and bronchitis. According to the health department these areas are already exposed to tuberculoses. The present conditions of dust in the project area are calm when there is no vehicular movement and no windy conditions. But the level of dust goes high in the case of wind blowing and traffic movement.

During explosion, transportation of construction material and heavy equipment, dust levels are expected to rise in the project area at the time of blasting and excavation. The large particles of the dust will deposit in the adjoining areas and smaller particles will remain suspend in the air causing air pollution in the surrounding areas. Although the problem will be temporary, special measures should be taken to reduce this impact.

5.3.2.3 Air Emissions

Heavy loading and dumping machinery may cause air pollution during construction by the emission of carbon oxides and other greenhouse gases. This effect will be felt at the dam site, and at the powerhouse site, where the main construction activity is focused. Though the adjoining areas may also be affected due to movement of trucks for haulage and dumping. However this would be a temporary activity.

During construction there will be potential for deterioration in local air quality due to generation of suspended particulates

from the construction of project roads, blasting, excavation and quarrying, vehicle movements, batch plant operations, wind blow and mechanical handling. For the purpose of this assessment, a dust deposition rate of 400 mg/m/day will be used as the nuisance threshold. This value is twice as high as that generally used in residential areas of the United Kingdom, on the basis that the project area is largely barren land and has earthen roads and therefore has higher ambient dust levels.

5.3.2.4 Noise

The existing noise levels in the Satpara valley are high due to colliding of flow with big boulders on the bed of Satpara nullah. This is due to the colliding of flow with big boulders and small falls. Blasting activities and traffic will increase noise level of the Satpara valley. However, this is short-term activity, which will reduce during operation of the project. High sound levels will effect the villagers but have no negative effects as no sensitive receptors like hospital, library etc., exist near the sites.

The World Health Organisation (1980) recommends generalized environmental noise standards aimed at minimizing the potential long-term adverse effects of noise. They conclude that general daytime outdoor noise levels of less than 55 dBLAeq are desirable in order to prevent any significant community annoyance. At night, a lower level is desirable to meet sleep criteria; depending upon local housing conditions and other factors this would be in the order of 45 dBLAeq, corresponding to an internal level of about 35 dBLAeq at the ear of the sleeper. The WBG guidelines do not provide guidelines for noise during construction. The recommended facade noise levels are 75 dBLAeq during the day and 65 dBLAeq at night. These limits make no reference to the duration or size of the construction project. It may be assumed that the type of building project for which these limits were

developed had 'noisy' periods of typically 6 months. Applying the equal-energy principle, 75 dBLAsq for 6 months would equate to 72 dBLAeq for 1 year, 69 dBLAeq for 2 years, 67 dBLAeq for 3 years and 66 dBLAeq for 4 years. • It is anticipated that the "noisy" major construction works at Satpara will be completed within about 4 years, so that a daytime target limit of about 66 dBLAeq would be reasonable.

Table 5.3: Emission from 81.4 GWh Thermal Power Plant using Different Sources Available within Pakistan

Energy Source	Emissions in tonnes per year			
	CO2	SO2	NOX	Particles
Quetta semi bituminous coal	63676	1328	287	379
Furnace oil	60345	436	252	24
Sui Natural gas	55155	1.55	139	5.42

Source: (WAPDA office of chief chemist)

5.3.4 Socio – Economic Impacts

5.3.4.1 General

The Satpara valley is economically cut off from the rest of the country with little population density, scarce agricultural resources, and very limited employment opportunities. It is very important to assess the impact of Satpara power project during both stages, as it would have some long term effects on the socio-cultural and socio-economic set up of the area. Before the construction and operation stages of the project the improvement of existing roads/ bridges (on main Indus and Nullah) is a pre-requisite to allow the movement of heavy machinery and equipment. This alone will have some long-term effects on the socio-economic life of the residents. Other benefits of the project include rural electrification, employment, health, and improvement in living conditions and cultural up- lift of the people.

5.3.4.2 Population, Lifestyle and Culture

During the construction phase of the hydropower project some more than 200 local people will be given job opportunities, which will uplift the living condition and life style of the people of the area. It will also benefit skilled manpower in and outside workers. Heavy machinery will disturb their socio-cultural life. It is anticipated that with the availability of energy new developments like hotels and accommodation facilities will be developed in Satpara Valley and the local people will be exposed to new income generation opportunities. The tourism industry will be improved. People from other cities and countries are expected to visit the project site and participate in the construction activity, which will lead to influence changes cultural transformation and learning from each other.

5.3.4.3 Economic, Employment and Income

The project will have major impact on local economy, employment and income. There are big markets in Skardu city, which is very close to the project site. During field visit about 2 to 3 shops were seen in the Satpara lake area. There is an opportunity of opening up of more shops, which will provide food, garments and other consumable items for the workforce on the project. The requirements of gasoline, fuels, teashops, hotline and commodities will bring more business in the project area; improving its economy. The prices of local produce will be stabilized due to market opportunities developed at source.

Employment opportunities will increase not only in the construction activities of the project but also on development of new shopping areas, hotels, services and in agriculture to meet the increased demand of food grain and commodities. The income level of the local residents is also expected to increase improving their standard of living.

Moreover, as new jobs become available in the area, the out migration of the labour force will reduce enabling the men to stay at home and find work. This in turn will lead to the men supporting their women in farming and other family activities.

It is anticipated that 200 locals will be employed during the peak construction activities. Additional funds will be provided by project sponsor for uplift the resource development of the area in the form of mitigation costs.

5.3.4.4 Human Resource Development

Both labor and semi-skilled workers can benefit by getting employed on the project. The demand for labor will increase as the contractor is expected to employ about 200 semiskilled local labors. There are a number of semiskilled unemployed persons in the project area like driver, mason, electricians who could be employed. This will act as an economic catalyst bringing in additional demand for resources as the standard of living improves in the project area.

5.3.4.5 Resettlement

8 houses in the Satpara lake area will be displaced due to construction of project. The houses are lying on left bank of existing intake and belong to one joint family. In order to minimize Compensate and mitigate effects on the effected families WAPDA will implement the resettlement and community development action plan (CDAP). The action plan will be finalized after consultation with public. Where further revisions are required based upon lending agency comments or ongoing consultation, they will be incorporated into the resettlement action plan through the management process given below:

- The resettlement action plan, which outlines the measures to be, carries out to resettle those affected

families whose property completely occupied by the project or whose property no longer will be viable units. It also outlines the measures to be carried out to compensate these families and persons who lost their assets but who will not require resettlement.

- The community development action plan, which outlines the measures to be carried out to ensure that the affected community as a whole will benefit from the presence of the project. These measures are intended to go above and beyond direction compensation for lost assets and include strengthening of health and education the in the area and provision of water and electricity supplies.

5.3.4.6 Health

The contractor should be responsible for the prevention of unhealthy or unsafe conditions and practices and for the promotion of healthy and safe working practice at the site. The supervising agency should appoint trained persons at site during working hours in first aid. A first aid clinic and facility should be maintained on site to provide basic treatment. During the construction of project, facilities for clean drinking water / medical for labour, staff and local community is essential. This will reduce the incidence of water born diseases in the area. At present all the facilities are available in Skardu district Headquarter Hospital (DHQ), which is 8 km from project site.

Increased vegetation cover is expected further reduce dust problems and some of the connected health, problems, extending this achievement from the Skardu Town to some of the neighboring villages. Achieving this benefit depends on a successful implementation of the irrigation and land development schemes of the project. Irrigation and cultivation of the 1,750 ha rolling sand plain area is a special challenge,

but both local people and professionals of AKRSP and the Agriculture Department regard this as feasible. Some land-use options may be particularly' beneficial with regard to the wind erosion control and health impact (multi-story agro-forestry, systems, e.g. fruit tree/fodder crop). With a successful Satpara Dam project, large tracts of land could be brought under cultivation reducing the sand storms along the Indus River.

5.3.5 Conclusion – Construction Stage

The impacts of this stage are summarized below.

- Control of blasting and other construction procedures to ensure human safety and to maintain acceptable noise and dust levels in the project vicinity, taking into account not only the on-site workers but also off-site workers in the affected valley.
- Control of noise, dust and traffic nuisances along routes traversed by trucks handling materials into or out of the construction site.
- Control waste and spills of fuels and lubricants (from vehicles and other equipments and from stockpiles of disposable containers and parts, and of other wastes and refuse materials.
- Provision of acceptable facilities for housing, water supply and sanitation of construction workers including checking of recruits to exclude communicable disease carriers,
- Where job opportunities are scarce, selection of workers taking into account the needs of the affected communities in the vicinity,
- Management of the worker communities to prevent their transformation into socio economic problems of slums,
- Re-vegetation of barrow pit areas to be consistent with acceptable environmental aesthetics,

- Prevention of excessive erosion by rainfall during construction.
- Human resource will be developed by getting experience on the project.
- Increased business activity and employment opportunities will have positive impacts on the local economy.

5.4 OPERATION STAGE IMPACTS

5.4.1 Water Related Impacts

5.4.1.1 Water Quality

During the operation phase only rest flow will be released in the Satpara nullah for major parts of the year. Most of the solid/liquid waste of population of the project area is carried by Satpara nullah; due to increase in flow by diverting Shatung nullah the condition of flow will be better than the previous and waste digestion/dilution capacity of Satpara nullah, will be enhanced. Mitigation measures may have to be provided to ensure adequate safe drinking water provision for the local population.

Generally the flow of Satpara nullah is used for irrigation for 8 months while for drinking purpose throughout the year. Sufficient water is available for the generation of electricity during the low flow period and no water rights issue may arise.

5.4.1.2 Sediment

In 1987 the hydraulic survey was conducted from old axis to 5900 ft upstream. The lake capacity and surface area was computed at maximum El. 8649.00 feet. At this level the total capacity was 46500 Acre-feet and covered a surface area of about 315 Acres. In order to determine the loss of storage in 15 years the lake capacity and surface area have also been computed at El 8649 feet using the survey data of 2002, from

old axis to 5900 feet upstream. At this level (8649 Ft) the total capacity is 44220 Acre-feet and covers a surface area of about 302 Acres. The gross capacity of lake reduced from 46500 Acre Feet, showing a reduction of 4.9% over the course of 15 years operation.

There will be no impact on the downstream of the dam as the sediments settle down in the lake. Sediment load released from the lake is negligible and will not any have any adverse effect. However, flash floods and heavy rains simulate a condition similar to discharge of heavy sediment load.

5.4.1.3 Irrigation

The project has huge benefits for the Skardu city and bordering areas in terms of irrigation and power. During the operation stage about 21000-acre new barren land will come under the command of Satpara nullah, which will bring green revolution to the area. The stored water will be released according to the requirements of downstream.

5.4.1.4 Watershed Erosion and Sedimentation

The project does not have any direct impact on the watershed or upstream siltation pattern during the operation stage, though there is a possibility that with improved infrastructure (roads) the exploitation of Satpara valley in terms of tourism, illegal felling etc., may increase and affect the watershed erosion and siltation pattern. Adequate protection measures and monitoring is required for protection of watershed.

5.4.1.5 Downstream Erosion and Siltation

The release of sediment free water from the plant tailrace is also expected to result in some downstream erosion of riverbanks and bed. This effect can be considerably reduced by bank and bed protection measures near the tailrace. The speed of the discharging water can also be controlled by an

appropriate design to cause minimum erosion. Downstream siltation will also be modified by reservoir storage, though no significant change is expected.

5.4.1.6 Waste water Discharges

During the operation stage the number of labours will be confined to small number and few permanent employees would be in the powerhouse, hence waste discharge will decrease. Sewage will not be allowed to enter into the stream from the labor camps as the inhabitants are using the water of this stream for domestic and drinking purposes. Similarly waste generated at the operator village will also have to be properly controlled/ treated before it released into any water body otherwise it will have additional impacts.

5.4.1.7 Fisheries and Fish Life

After the completion of the project the discharges will be regulated from Satpara dam according to the downstream requirement of irrigation and power generation. Especially during peak hours there will be high discharge in the nullah in evening time and low during daytime, which will ultimately change the regime of flow. The upstream portion of the stream above the dam will remain undisturbed. There is great possibility of development of fish in the reservoir area during operation phase. The reservoir has potential to produce a higher fisheries yield than the existing conditions in lake. The biological entities have a remarkable power for adaptation to various physical, chemical and biological factors.

Conclusion: 10% of the total flow in the Shatung nullah shall be released to compensate the aquatic life, while there will be no affect on downstream of dam. It is assumed that as a result of the project the fish will increase in the fish. Fish farming in nets or cages should not be allowed due to risk of contamination drinking water and of spreading fish diseases.

5.4.2 Air Related Impacts

5.4.2.1 Air and Dust

Presently in the project area the air quality is good but emissions of greenhouse gases like carbon dioxide are high in winter season due to use of Kerosene oil and wood, subsequently reducing the air quality specially indoor atmosphere. Air related environmental impacts are due to construction and operation of the scheme on the site and its surrounding areas. During construction the air related impacts will occur due to moving of vehicles, blasting and excavation etc, but during the operation stage the area related impacts are positive.

In-door climate expected to be improved due to increased availability of electricity to cooking. However, it is doubtful if the project can provide sufficient electricity on household basis for heating purposes so the impact may be limited. The benefit of providing electricity for cooking and heating of water would still be significant (AKRSP staff) Current use of generators will probably decrease due to the proposed electricity supply scheme.

5.4.2.2 Air Emissions

No increase in emission level is expected during the operation of the project. The emissions will decrease by electrification of villages. The use of kerosene oil for burning and lighting will stop or minimize, hence there will be overall positive impacts on local and global environment. Other positive impacts will be felt during operation on the forest. The situation of cutting down of trees is already alarming and forest area is rapidly squeezing. Deforestation in the area will reduce. The project is hydro powered and does not use any fuel.

5.4.2.3 Noise

The World Health Organisation (1980) recommends generalized environmental noise standards aimed at minimizing the potential long-term adverse effects of noise. They conclude that general daytime outdoor noise levels of less than 55 dBLAeq are desirable in order to prevent any significant community annoyance. At night, a lower level is desirable to meet sleep criteria; depending upon local housing conditions and other factors this would be in the order of 45 dBLAeq, corresponding to an internal level of about 35 dBLAeq at the ear of the sleeper. The WBG guidelines do not provide guidelines for noise during construction. The recommended facade noise levels are 75 dBLAeq during the day and 65 dBLAeq at night. These limits make no reference to the duration or size of the construction project. It may be assumed that the type of building project for which these limits were developed had 'noisy' periods of typically 6 months. Applying the equal-energy principle, 75 dBLAsq for 6 months would equate to 72 dBLAeq for 1 year, 69 dBLAeq for 2 years, 67 dBLAeq for 3 years and 66 dBLAeq for 4 years. • It is anticipated that the "noisy" major construction works at Satpara will be completed within about 4 years, so that a daytime target limit of about 66 dBLAeq would be reasonable.

5.4.3 Comparison with Alternative Energy Sources

Hydropower projects play very important role in sustainable development. These projects produce electricity without encroachment of natural resources, subsequently conserving the nature and valuable resources. There is a global concern regarding the increase in green house gases and in particular on CO2 emissions. The significance of this for the Satpara dam project is that it will avoid atmospheric emissions of CO2, SO2, NOx and particulates by avoiding the needs to construct an equivalent thermal plant of 81.4 GWh. The Satpara hydel Power project will be connected to the Skardu and Ganche districts and hence it will help to reduce dependence on thermal sources of energy, which have

contributed substantially to the CO2 emissions and other green house gases in the atmosphere. Thus the additional benefit of Satpara would be in reducing the green house gases emissions in the atmosphere. The project will save about foreign exchange of US $ 3.75 million annually which incurred on fuel for the same energy of thermal plant.

5.4.4 Socio – Economic Impacts

5.4.4.1 Population, Lifestyle and Culture

The existing road network will enhance social and geographic mobility. Health conditions of the people will be improved by using electricity at homes for domestic purposes. As the upper part of the Satpara valley is very beautiful and game reserve area, the possibility of tourism will open up which will be developed for local and tourist. With electrification and general improvement in economic activity the government establishments will improve upon the infrastructure facilities. Electrification will enhance the introduction of mass media (TV etc) facilities, which could bring socio-cultural changes.

5.4.4.2 Economy, Employment and Income

At present Satpara is an isolated valley, with clusters population inhabited by Shina and Balti speaking population. 100% Muslim population inhabits the area. The hydropower project network will improve transportation and communication linkages, which will facilitate geographic and social mobility of the people. It is expected that during the operation stage working staff both local and foreigners will mostly reside in Skardu and come on project site during the working hours. However some labor force will reside in contractor's temporary camp near the project site, which will create some demand for vegetables and dairy products. The income of the inhabitants could increase by adjusting to new demands. Also with these new demands and activities land prices will increase. The recipients of compensation whose land is affected by the

project may invest their money in new business activities. The project could provide steady employment to some residents, which could release funds for making innovative changes in their agriculture. The potential for establishing a new urban center in the vicinity of the project, which may be economically viable because of the ready and firm availability of low cost power and freshwater including development of agro, and other local industries.

5.4.4.3 Human Resource Development

Both labor and semi-skilled workers can benefit by getting employed on the project. There are a number of semiskilled unemployed persons in the project area like driver, mason, electricians who could be employed. This will act as an economic catalyst bringing in additional demand for resources as the standard of living improves in the project area.

5.4.4.4 Health

Health and water supply facilities as mentioned in the construction stage of the project will remain continue in operation stage also. Hence no extra finances are involved for this purpose.

5.4.4.5 Conclusion – Operation Stage

The operation of the Satpara hydropower project will result in the following socio-economic changes in the project area.

- The provision of electricity in the area will bring prosperity and improve the standard of living of the locals.
- Irrigation of large area of barren land in the Skardu valley.
- Increase Improvement in civic and social services and increase in business and tourism are anticipated.
- Increase in on-farm employment is expected. About 30-35 locals will be employed permanently during operation stage.

CHAPTER - 6

ENVIRONMENTAL IMPACT – MITIGATION PLAN

6.1 GENERAL

The purpose of a mitigation program is to manage the environmental effects in a manner that minimizes adverse impacts and maximizes secondary benefits. As mitigation is a process of making a project more compatible with its environment, two approaches present themselves: (i) refine the project to reduce its effects on the resources, or (ii) alter its environment to achieve the same end. In general, planners prefer to keep the project in its optimum state and make compensatory changes in the environment, but, in fact, many acts of mitigation take place before the first project component reaches its ultimate configuration

6.1.1 Water related Mitigation

- The quality of Satpara nullah water will be affected during the construction of power project due to increase of sediment load. The inhabitants of Skardu are being provided water from the Satpara Nullah through a distribution system. The nullah also responsible to irrigate vast area of the valley.
- Septic tanks shall be provided to treat the wastewater from site installation camps and sanitary appliances.
- Drainage channels should be built around or at the downstream ends of all construction areas and these channels should lead the water to the treatment and settlement ponds.
- Sludge collected from septic tanks and solid waste shall be disposed of properly through landfill methods.
- Diesel, oil and lubricants shall be properly stored in accordance with the petroleum regulations

6.1.2 Land Related Mitigation

The land between the full supply level and existing level will come in the reservoir area and also 8 families located near existing weir will be

displaced. All the families will be compensated according to the Land Acquisition Act. At present thousands of trees located on right bank and in the island are there which will be submerged.

Mitigation measures that WAPDA will implement include planting native tree species in the area on right bank, front side and along the Satpara road. Plantation can also be made along the ridges to avoid sliding and to control erosion and dust. The plantation will also provide roost to the birds. Re-plantation will be carried out in consultation with the Forest Department, who will advise as to preferred trees. Several NGO's are actively working the in area have the capacity to undertake tree plantation. During plantation these non-government organizations should also be consulted and taken in to confidence. This can reduce the cost of plantation on WAPDA.

6.1.2.1 Local Infrastructure Maintenance

Northern Areas Public Works Department (NAPWD) is the only government agency, which is responsible for maintaining and construction of roads in the region. The same organization should be made responsible for maintenance of local infrastructures (road / truck) used by the contractor for 4 years construction period of the project.

6.1.2.2 Land and Resources

Land use changes are expected in the project area during construction. About 62.5 Acres of private land will be submerged in the water. Other land required for installing camps and deposition area on leased during construction period. This will exert pressure on already limited land resources available in the area. It is recommended that dialogue regarding the acquisition and leasing of land should be started with the community at an earlier stage and adequate compensation should be ensured to all affected people. The other land related proper management, planning, route selection and strict control of contractor activities could avoid

problems like traffic hindrance. This should include regular sprinkling of water along major traffic routes, placing signpost for direction and providing crossing points on route.

6.1.2.3 Widening of Existing Track

The road from Skardu to Deosai plain needs to be widened for shifting of heavy machinery. Also couple of bridges may be required on Satpara nullah. During low flow the nullah can be crossed by vehicles thus bridges can be avoided, which ultimately minimize the cost of project. The existing track needs to be widened for heavy traffic and machinery. From Skardu to Satpara Lake the road condition is very good.

6.1.2.4 Erosion Control

Considering the site conditions and the various erosion control methods, which are known, the vegetation and forestation is the most effective and economical methods and it is recommended that it should be adopted as the preferred options for erosion control. A program of afforestation, especially planting of early maturing trees for fuel should be introduced.

Commonly Available Erosion Control Process

Grading
Compaction
Vegetation
Surfacing and pitching
Soil stabilization (chemical, stone surface pitching)
Hydrographic Modification (Channeling, diversion, culverts, stream crossing)
Retaining structures and terracing

The mitigation plan for soil erosion during construction and in the post construction period must include the following principles;

- Plan the alignment and construction activities to fit the topography, soils, waterways and natural vegetation at the site.
- Expose the smallest area of the land for work over shortest possible time.
- Apply soil erosion control practices as first line of defense against the site damages.
- Implement and monitor maintenance program after completion of construction.
- Protect and preserve forest and vegetation cover as much as possible through proper control and management of the site.

6.1.3 Disposal of Excavated Material

The excavated material produced during construction period, will be all used up as back fill material and as aggregate for different project structures and access roads. Therefore, disposal of excavated material is not an issue. As such identification of sites for disposal of excavated material was not undertaken.

6.1.4 Wildlife

Lubricants, waste oil and other lubricants should be collected and disposed off safely. Manpower working at construction site should be aware to protect wildlife. Noise produced by blasting and other construction activity may be kept to acceptable level. The animals who will stay in the vicinity of the project area, their movement will be impaired by penstock pipe and power channel. IUCN and other non-government organizations have planned to establish a game reserve area near by the project area. The animal whose habitat will be affected by inundation and by clearing of new land will migrate to this game reserve. Any stray animals found may be handed over to game watcher posted at Satpara valley.

6.1.5 Air Related Mitigation

6.1.5.1 Air Pollution

The provision of electricity is expected to reduce the trend of burning wood and kerosene oil, it is anticipated that the air quality of the project area will further improve.

In Satpara valley wood is used as fuel. The consumption of wood is very high, which is contributing in pollution of the area. Over the last decade, a consensus has emerged among scientists that global warming due to rising atmospheric concentrations of "greenhouse gases" is a real and potentially devastating problem. These gases absorb some of the sun's radiation as they are reflected from the Earth's surface, instead of allowing them to pass into the space. Scientists estimate that this additional heat energy might result in a 3 degree centigrade rise in average global temperature by year 2030. This could lead to serious environmental problems such as rising ocean levels, changes in rainfall patterns, and increase desertification (the process of arable land changing to desert).

Satpara hydropower project will in fact contribute towards improvement of air quality. According to an estimate, oil-fired steam units produce 0.75 tones of CO_2 for every MWh of energy generated whereas hydropower plants have zero emission levels. The increase in suspended dust and exhaust emission during the construction phase of the proposed hydropower can effectively be mitigated by adopting the following preventive measures:

- Constant sprinkling of water on the service roads and access track
- Controlling the vehicle speed within the limit
- Planting rapid growing trees in the project area.

- Control of exhaust gases of vehicles used for construction.
- Stone pitching of roads/tracks.
- Bricks masonry roads.

6.1.5.2 Noise

Following measures would be enforced to mitigate the effect of high noise level during construction. Special mitigation measures for abatement of high noise effect are not seen. The plant shall be designed in such a way that noise level do not exceed the following limits.

-	At a distance of 5 m from noise source	90 dB
-	At boundary of power house	55 dB
-	(night time level)	35 dB

All vehicles shall be equipped with effective mufflers and high noise machinery should not be used in night shifts.

- Noise level of machines used during constructions shall be controlled as far as possible and workers shall be provided earmuffs where necessary.
- The portals should be provided with noise shunting devices to diffuse blasting noise

6.1.6 Socio - Economic Mitigation

6.1.6.1 Employment

The construction of the proposed power plant will create job opportunities for the people living in the surrounding area. It is expected that 100 to 200 people will be employed, particularly in the category of laborers and semi skilled workers.

Based on their performance and training during the construction stage, some of them could be considered for

permanent employment during the operation stage of the power plant, or for maintenance works of the operators' village.

With the construction of the project, other facilities like commodity market and medical clinic etc. will be established, that will result in opportunities for the local people to establish their small business in the form of shops and craftsmanship in the adjoining areas of the power plant and also use project medical and education facilities to their own benefit. The movement of heavy machinery and equipment to reservoir and channel sites would involve the widening and improvement of the existing road, bridges especially where it passes through the settlements.

The Satpara power project will produce energy of 81 GWh. The power production and irrigation of large area actually makes the project a financial bonanza as well as helping meet the projected vast increased power demand in into the future. With regular supply of electricity, professional like doctors and teachers would be encouraged to live in the area. Hence, the provision of social sector services is likely to improve. As the general economic conditions improves, during the construction and operation phases, small-scale industries like hotel, furniture making, agricultural, light engineering and tailoring are likely to creep up.

The importance of the area in the eyes of the Government line departments will increase which will result in the improved maintenance of government facilities and infrastructure. With the development of the project area, the value of land will automatically increase.

During the construction of the project, direct on job training will be provided to the workers. After gaining experience, the unskilled workers are likely to become skilled.

Since the effect of the project on the socio-economics of the area is generally positive. No special socio-economic mitigation measures are required. However, it is recommended that regular dialogue with the community is maintained during the operational period and the facilities provide to the community in the form of water supply schemes, irrigation channels etc., should be periodically monitored

6.1.6.2 Fisheries

Minimum compensation flow will be maintained in the Shatung nullah to protect the aquatic life. The flow will be 10% of the mean annual flows which is about 0.20 cumecs. Fish ladder for the migration of fish will be provided in the intake structure. This will help to freely movement of fish for spawning on both sides of structure.

6.1.6.3 Irrigation

The wheat, maize and potato are the major crops in the project area, however, barley is also sown in some fields. Satpara Nullah bed level is lower than the cultivated/ agriculture land in Satpara Valley. The cultivated fields in project area are irrigated by a nullah, which originates from glacier. The irrigation water demand for different villages in project area will be compensated by allowing minimum discharge during low flow season. There is no irrigation in the area from November to March.

6.1.6.4 Water Pollution

Water pollution likely to occur during the operation stage can be avoided by the following mitigation measures:

- Septic tanks and soakage pits shall be provided for sanitary drainage of operator village.
- Oil, grease and lubricants shall be properly stored and disposed.
- Quality of Satpara Nullah water shall be monitored.

6.1.6.5 Land Related Mitigation

There are no additional land related impacts during the operation phase. The important activities in term of mitigation at this stage are related to monitoring of compensation plan and explore possibilities of developing additional land.

6.1.6.6 Land Development

The land leased for construction period should be properly developed for agricultural use before it is returned to the original owners to compensate for the cultivable land used up permanently by project infrastructure. The leased land should be returned to the families whose land was acquired for different project infrastructure during the construction phase.

6.1.6.7 Wild Life

During operational phase strict vigilance of the wildlife officials to enforce wildlife protection laws and the active co-operation of the communities living in the area will ensure and mitigate any negative impact due to more flow of tourists due to better communications. Better means of communication will also be helpful in effective monitoring.

6.1.6.8 SAFETY MEASURES

- WHO environmental health and safety rules should be followed.
- Generally, the site should be adequately equipped to handle accidents.
- Medical aid, fire extinguishing equipment, artificial oxygen supply, oxygen masks and helmets should all be present on site in adequate numbers.
- Explosion handling and conveyance should be done according to rules laid down by the government.

- The Government of Pakistan rules for health and safety of workers under the Explosives Act 1984 and The Factories Act 1934 should be followed.
- Permanent signs should be erected in the areas under construction.
- WAPDA will need to erect safety fencing around any unsafe areas so as to keep out people and animals.

6.1.6.9 Fire Protection

- Fire fighting equipment at the proposed powerhouse shall consist of the following:
- Underground fire services main with valve pits
- Hydrants and fire hoses in cabinets
- Fire extinguishers (CO_2, dry gas, foam)
- Sufficient sets of breathing apparatus should be available at the site area.
- Fire walls shall also be constructed around main transform.

CHAPTER - 7

ENVIRONMENTAL MITIGATION COST

Major component of this cost is the cost of measures to be taken at the three stages i.e. pre-construction, construction and operational stages. Most of these costs therefore, shall be included as a part of the main power project contract costs.

Table 7.1: Environmental Mitigation Cost

Particular	Total Units	Unit Cost ($)	Total Cost ($)
Area Development	5000	5000	5000
Forest restoration	Lump sum	5000	5000
Compensation for small size trees removed	6000	3.33	20000
Compensation for medium trees removed	3000	6.67	20000
Compensation large trees removed	1000	10	10000
Removal of 3 Houses 5 Hotels and PAF Rest house	8	8350	66600
Land Acquisition Cost	25 ha	2250	1125000
Temporary relocation cost	Lump sum	3000	3000
Cost for environmental impact mitigation			10000
5% contingency cost			63500
Total environmental impact mitigation cost			**1,328,130**
INSTITUTIONAL COST			
Subject	Activity	Frequency	Remarks
Environmental management (EM) and training	Establishment of EM cell	Full time	Included in the operation cost
Medical facilities	Facilities to the population of adjoining villages	Ongoing	Included in the operation cost
Fisheries Management	Upstream fisheries management plan	Ongoing	

The main cost components covered in environmental costs are land acquisition, infrastructure maintenance, land leasing cost, compensation for loss of trees and construction of new irrigation channel etc. The environmental cost also includes the compensation for afforestation.

CHAPTER - 8

ENVIRONMENTAL MANAGEMENT AND TRAINING

8.1 GENERAL

The environmental assessment of the project indicates no major impacts during the construction and operation of the proposed project. Nevertheless, it is important that a management program to ensure clean and healthy environment is pursued during the construction and operation stages of the project. This would involve establishment of a unit, who would be responsible for developing operational guidelines and ensuring compliance with these standards during the plant life.

Table 8.1: Environmental Unit Objectives

Sr. No.	Description
1	To verify compliance with regard to National and Local Environmental laws and regulations and internal policies and procedures.
2	To support all people in the management of environmental issues, through sharing of task force findings and recommendations, with the goal of strengthening environmental program and knowledge base.
3	To initiate and develop individual and group interest and awareness of the environment concerns by dissemination of environmental knowledge, sharing ideas and teaching each other.
4	To promote vision of environmental excellence by striving for global leadership in providing clean and reliable generation.
5	To encourage networking, free thinking and discussions of innovative solutions to environmental issues, while supporting the system of responsibility and accountability.
6	To initiate and follow-up the fisheries management plan for the reservoir and Satpara Nullah.

8.1.1 Rehabilitation and Plantation Programs

Responsible agency will collaborate with the Forests and Agriculture Department and other Authorities to develop effective tree planting and landscaping program near the project site to improve its natural environment.

8.2 ENVIRONMENTAL MONITORING PLANS

8.2.1 General

It is clear that environmental control and environment monitoring are important both during construction and operation stages of the project. It will be the responsibility of the Environmental Unit to follow the monitoring plan. The monitoring required during construction and operation stages is described in the preceding paragraphs. Similarly, a special external activities program will be implemented during both the construction and the operation of the power plant.

8.2.2 Construction Stage

It is necessary that project owner should keep strict environmental monitoring of different construction activities to avoid any environment hazards or inconvenience to local people. The following parameters shall require special attention:

- During excavation and equipment movement, dust and noise should not increase to undesirable limits especially in the Shatung Deosai which is a natural habitat and protected area. The brown bear which is endangered species exits here;
- It should be carefully monitored that the traffic hazard and hindrance should not occur at the Gilgit - Skardu road and the Satpara valley track passing through the village area.
- Since the labour will be hired from the project area and some skilled force will come from other parts of the country and probably from other countries, it should be monitored that no cultural, religious, legal or other conflicts arise;
- It should be ensured that the contractor provides proper medical, sanitary and residential facilities to its workers; proper safety measures should also be provided and maintained by the contractor;
- Since the project area and adjoining regions are tourist oriented places, it should be observed that the aesthetic value

of the area shall not be disturbed and that the plans for rehabilitation are followed;

- Care should be taken that local people should be hired as far as possible for all construction activities;
- Compensation plan should be carefully monitored;
- The contractor will be monitored to ensure that he/she is operating according to the landuse plan and observes strict housekeeping measures
- It should be ensured that contractor should provide fuel to labours and other necessities to reduce pressure on forest and wildlife.

8.2.3 Operation Stage

Following parameters shall be monitored regularly during the operation stage:

- Noise of powerhouse
- Sanitation of settlements downstream of dam
- Sanitation of residential colony or operators village
- Fire protection system
- Water quality of Satpara Nullah downstream of Dam
- Water quality of the lake
- Social-economic monitoring
- Wildlife in Deosai plain
- Fishes in Shatung nullah

Environmental costs are based on the expenditures required to alleviate the impact of pollution. The overall environmental cost of USD 1,328,130 has been reserved to cover the mitigation cost.

8.3 ENVIRONMENTAL ACTION PLAN

The management and monitoring actions proposed to avoid minimize impacts during construction and operation of the Satpara hydropower project were identified and mentioned in the above section of this IEE. This section presents the specific plan for implementing the management and monitoring requirements within the framework of an Environmental Action Plan (EAP).

The following principles were used to guide the preparation of the EAP:

- Focus on occupational health, safety, and environment risk prevention;
- Conformance with relevant standards, codes, and practices in the application of safe technologies;
- All activities will be performed in a safe and effective manner and all equipment will be aintained in good operating condition for the protection of the health and safety of all persons and to conserve the environment and property;
- All necessary precautions will be taken to control, remove, or otherwise correct any leaks and/or spills of hazardous materials, or other health and safety hazards; and,
- Construction of the hydropower facility will meet relevant international standards that ensure sufficient technical levels of safety.

8.4 ENVIRONMENTAL MANAGEMENT

WAPDA is the project sponsor and will have overall responsibility for design and building of the Hydropower Facility. WAPDA will own and operate the hydropower facility. A joint venture company will be selected for the construction of the project. The contractor will be selected based on its previous experience of such projects.

The contractors are responsible for implementing the majority of the day-to-day, construction-related environmental mitigation and monitoring measures specified in above section of this IEE, and the measures stipulated in the

contract ensuring full compliance with ISO 14001 standards. WAPDA will be responsible for implementing the higher-level, project-related mitigation measures such as implementation of the resettlement action plan, and for operations-related mitigation measures. This EAP addresses both the construction and operational phases of the hydropower facility. WAPDA will continue to meet its social responsibilities after the hydropower facility till the handing over. In other words, WAPDA support to community development projects and committed to executing their respective responsibilities in an environmentally responsible manner and in compliance with all applicable environmental laws, regulations, and guidelines.

8.4.1 Dam Safety Risk Assessment

An independent panel of expert to be commissioned to review and to advise the project proponent on matters related to design and safety as part of planning for any dam project height greater than 15 meter.

To address this requirement WAPDA has already established panel of technical experts on dam that has to advice through final design, construction, filling and startup phases of the dam. Following key issues should be considered, which include;

- Determination of maximum ground acceleration values;
- Spillway design capacity is adequate
- Backup power system for the spillway and powerhouse are adequate provided that they are subject to regular testing;
- Acknowledgement that vibration induced by blasting of rock on the safety and performance of structures.
- The design discharge for the river diversion flows during construction period is more than the adequate to meet the risk of 1% exceedance of the 20-year return.
- Avalanches from the mountains in the Satpara lake area which may create severe problems.

Table 8.2 General Responsibilities for Environmental Measures

Parameters to be monitors	Reason for monitoring	Monitoring Location	Monitoring Method	Recommended trigger level	Responsibility for initiation	Responsibility for execution
Baseline Water quality: suspended solids	Baseline data to monitor impact on fish	Two at Shatung nullah one at Satpara and one downstream	Differential gravimetry	100 mg/l (alert); 400 mg/l (intervene)	WAPDA	WAPDA
Water quality: nutrients	Baseline data to monitor impact on fish	Two at Shatung nullah one at Satpara and one downstream	Colorimetric	None	WAPDA	WAPDA
Water quality: chlorophyll	Baseline data to monitor impact on fish	Two at Shatung nullah one at Satpara and one downstream	Acetone/alcohol and spectrophotometery	None	WAPDA	WAPDA
Commercial fish species	Baseline data	Two at Shatung nullah one at Satpara and one downstream		None	WAPDA	WAPDA
Invertebrates	Baseline data	Two at Shatung nullah one at Satpara and one downstream		None	WAPDA	WAPDA
Macrophytes	Baseline data	Two at Shatung nullah one at Satpara and one downstream		None	WAPDA	WAPDA
Schistosomiasis vector	Baseline data	Both banks of lakes	Visual surveys by experienced biologist	None	WAPDA	WAPDA
Tourism	Baseline data	Satpara lake	Collect baseline tourist data for Satpara, reason of visit	None	WAPDA	Local govt. Department

Parameters to be monitors	Reason for monitoring	Monitoring Location	Monitoring Method	Recommended trigger level	Responsibility for initiation	Responsibility for execution
Construction Involuntary resettlement				To be determined by independent body	Independent Auditor	WAPDA
Water quality: suspended solids	Alert if detailed monitoring required	Downstream of Satpara lake	Visual inspection	Visible cloud	Contractor	Contractor
Water quality: suspended solids	Achieve National Standard	Baseline monitoring sites at Shatung and d/s Satpara	Differential gravimetry	100 mg/l (alert); 400 mg/l (intervene)	Contractor	Contractor
Water quality: oil and grease	Alert if detailed monitoring required	Immediately downstream of Satpara lake	Visual inspection	Visible slicks	Contractor	Contractor
Water quality: oil and grease	Protect d/s water quality	Immediately downstream of Satpara lake	Extraction and evaporation	20 mg/l	Contractor	Contractor
Water quality: spill contingency planning	Protect d/s water quality	Construction site	Audit spill contingency plan	Plan or equipment is inadequate	Contractor	Contractor
Site drinking water quality	Ensure quality to National standards	Point of supply	Sampling & analysis	Exceedance of National Standards	Contractor	Contractor via field inspector)
Effluent quality	Comply National standards	U/s of water supply source	Sampling & analysis	National guidelines	Contractor	Contractor via field inspector)
Effluent quality, BOD, TSS, bacteria, nutrients, pH, temperature, EC	Comply National standards	Site effluent discharge location	Sampling & analysis	National guidelines	WAPDA	WAPDA
Water resources	Ensure safe & adequate supply to residents	Alternative water supply	Monitor yield, sample and analysis	National guidelines/WBG	WAPDA	WAPDA

Parameters to be monitors	Reason for monitoring	Monitoring Location	Monitoring Method	Recommended trigger level	Responsibility for initiation	Responsibility for execution
Construction noise: working hours & public complaints	Minimise impact on residents	On site	Record hours of gravel crushing & blasting & public complaints	To be determined by ERP	WAPDA	WAPDA
Construction noise	Minimise impact on residents	Nearest affected building	Instrumental monitoring	National guidelines/WBG	WAPDA	WAPDA
Air quality	Nuisance, potential impacts on health and crops	As for noise monitoring	PM_{10}, SO_2, NO_2 measurements	National guidelines/WBG	WAPDA	WAPDA
Communicable diseases	Minimise impact on residents & workers	First Aid clinic at site	Inspect site clinic regularly for incidences	To be determined by site doctor	WAPDA	Northern Areas Health department
Malaria incidence	Minimise impact on expatriate workers	First Aid clinic at site	Inspect site clinic regularly for incidences	To be determined by site doctor	WAPDA	Northern Areas Health Department
Hazardous Waste Management	Minimise Environment impact	Working area of site	Monitor storage, handling and procedures	Non-compliance with WMP	WAPDA	WAPDA
Erosion of cut slopes	Long-term agricultural viability/water quality	Temporary works area	Visual inspection	Significant erosion	Agriculture Department NAs	Agriculture Department NAs
Tourism	Identify negative impacts on tourism	Satpara	Collect baseline tourist data	None	Tourism department	Forest Department
Downstream flow	Prevent downstream flow depletion	At gauging point	Monitor water level with gauging boards	Downstream water requirement	WAPDA	WAPDA

Parameters to be monitors	Reason for monitoring	Monitoring Location	Monitoring Method	Recommended trigger level	Responsibility for initiation	Responsibility for execution
Wildlife	Danger to wildlife of rising of reservoir level.	Satpara lake	Visual inspection	None	Forest Department	Forest Department
Operation Water quality: nutrients impoundment	Prevent eutrophication	Monitoring site	Colorimetric	None	WAPDA	WAPDA
Water quality: stratification of impoundment	Prevent impacts on animal species	Monitoring site	Temperature and DO to be measured by meter and probe.	Hypolimnetic DO<5 mg/l	WEC	WAPDA
Schistosomiasis vector habitat	Prevent Schistosomiasis risk	Reservoir banks	By disease vector specialist	To be determined by inspector	Health Department	Health Department
Vector born diseases	Identify need for further action	Satpara lake	Inspect site clinic regularly for incidences	None	Health Department	Health Department
Fisheries	Identify need for re-stocking or other action	On site impoundment	Assessment and interviews with fishermen	Significant decrease in stocks post construction	Fisheries Department	Fisheries Department
Fish entrainment in power station screen	Identify if further precaution necessary	Intake screens	Visual inspection	To be determined in consultation with Fisheries Department	Fisheries Department	Fisheries Department
Vegetation on Lake site	Ensure establishment	After reservoir filling remaining places	Visual inspection by Forestry expert	None	Fisheries Department	Fisheries Department