EXECUTIVE SUMMARY

1. Introduction

Shigo Kas Hydropower Project was one of the several projects identified during the joint study of Pakhtunkhwa Energy Development Organization (PEDO) and its German Consultant, GTZ in 1992. Shigo kas Hydropower Project was proposed as run-of-river scheme on Panjkora River in lower Dir District of Khyber Pakhtunkhwa. The Site is located at 10 Km downstream of Timergara Town.

In the year 2012, PEDO appointed M/s ELECTRA in association with M/s INTGERATION to conduct feasibility study for Shigo Kas Hydropower Project i.e. 26 MW (Project TOR) in lower Dir District of KPK. Location of the project is shown on Figure 8.1 of the main report.

The present Feasibility Report pertains to Shigo Kas Hydropower Project is preceded by draft feasibility report, Mid Term Report and Inception Report submitted earlier. The latest planning studies and surveys reveal that the project can be upgraded to as much as 102 MW capacity instead of 26 MW mentioned in TOR. Salient features of the project are given in Table 1 at the end of the Executive Summary.

2. Topographic Survey and Satellite Images (GIS)

Topographic survey of Shigo Kas HPP area is conducted earlier in 2012/2013. Planning and layout studies are based on Topographic maps developed there from.

Topographic Survey has been carried out in the project area for establishing, inter alia, the existing ground levels. Locations of physical features like rivers, streams, roads and communication systems have been marked using modern equipments. Consultants also established control points at locations easily accessible and identifiable at later stage and acquired field survey data in digital format. The data has been processed using appropriate computer software.

To carry out the project layouts and the feasibility level engineering design of hydropower project sites, following main tasks have been included in the survey scope of work:

- Installation of Permanent survey control points established at appropriate locations with BM level.
- Processing of topographic survey digital data by using survey software.

- Generation of topographic sheets by using CAD/CAM techniques.
- Production of topographic survey drawings for different structures as per scale and mentioned in TOR.

Most of the survey mapping was carried out at different structures at a scale of 1:500 and contour interval of 1m. Survey maps were prepared on standard format containing location of each control point, its detailed description, final coordinates and elevation above sea level. Traversing was carried out to establish control points whereafter vertical control was established and detailed topographic survey was completed. Topographic map of the project area is shown in chapter 3 of main report.

3. Geology, Geotechnical Engineering and Construction Materials

Geological and geotechnical investigations have been carried out to study regional and local area geological and tectonic set up through geological mapping, scan line discontinuity survey, drilling works and geophysical survey. Test pits were excavated for determining potential sources of construction materials.

The project area lies at the margin of Kohistan island arc and Higher Himalaya near the Main Mantle Thrust, MMT. The southern part of project area is comprised of Higher Himalayan rocks while the northern part comprised of rock of Kohistan sequence.

Higher Himalayan rocks are comprised of granite gneisses and its cover metamorphosed amphibolites .These units further extended westward to Dir, Bajaur and Afghanistan.Two distinct varieties of gneisses can be characterized in the project area i.e. Granite Gneiss and Schistose Gneiss.

Rocks of Kohistan sequences are found in the north of MMT and it is comprised of ultramafics-mafic rocks of ophiolites and Kamila amphibolites and volcanics.

Following are the main units of the soil / rock in the project area

Stratigraphic sequence of the project area consists of Indian mass rocks of lower Sawat Buner group mainly consists of granitic gneiss (Chakdara Granite Gneisses), it is granite with siliceous schist layers on the peripheries. These rocks are medium to coarse grained with association of Schistose Gneisses and Quartz mica Schist phyllitic gneiss, Phyllite and quartzite intercalations have been observed in the project area at higher elevations.

Major rock group of the project area are Granitic gneiss and widely spread along weir, Intake area, Sand trap, intake of tunnel, along the tunnel and power house areas. Poorly to well outcropped in and around Tunnel and outlet portal, in most of the reaches along Tunnel, rock of the area is well exposed and widely distributed under thin to thick cover of Secree/Colluviums and terrace deposits, details are described in next relevant sections.

River bed is composed of medium to coarse grained sand, gravel, pebble, cobble even boulders. These materials belong to all three type crustal rock but especially at weir metamorphic with few igneous boulder and gravel material are dominated. Riverbed of Panjkora River itself is narrow to sufficiently wide at places. Hence deltas and meander are happening to exist at different area.

Cultivated land of the project area is flat to medium terraces on slopes composed of Silty Clayey Sand/Clayey Sandy Silt with gravels and occasional boulders at the surface.

Geotechnical investigation study was carried out, aimed at provide the required surface and sub-surface information about the Rock, Overburden materials/Colluviums, terraces / river deposits (Alluviums) and Scree materials, sliding zones and the rock strata at the significant structures in the Project area and to develop the geotechnical design parameters for all the structures and most important part of this stage of study is to define the structures at sound and safe areas regarding geological and geotechnical conditions.

Various investigation and field testing were carried out i.e. Exploratory drilling of borehole (Bore hole logs), Test Pits logs, Field testing (Permeability Tests, Water Pressure Tests), Lab Results of material (Chemical Analysis of rock core samples, Rock core modulus, grain size analysis, ASR analysis), Shigo Kas Seismic Refraction Survey.

The availability of the construction materials for the Project has also been studied and it has been found that suitable materials for concrete aggregates shall be available at and near the vicinity of site. The Panjkora river bed and its higher terraces are the major source of nearly all types of the construction materials. The coarse and fine (sand) aggregates are currently being mined at numerous places from the river bed for local use. Second sources are the manufacturing crush plants in the vicinity of project area. Cohesive soils for the blanket can also be obtained from the upper terraces of Panjkora river, selecting the terraces which are relatively barren.

Cement can be transported from Cherat, Nizamabad and Bestway cement factories situated some 150 to 250 km from the Project area, near Nowshehra and Islamabad or other cement manufacturing industry.

Water in general seems quite suitable for construction purposes; however with reference to some other close vicinity Panjkora water analysis, results meet the requirement of portable water and can be used for all construction works.

Steel, like cement, is not locally available and shall have to be procured from markets in Peshawar, Rawalpindi and Lahore.

4. Hydrology and Sedimentation

The available Hydro-meteorological data such as daily and hourly rainfall, daily stream flows, temperatures, evaporations and sediment data etc. has been collected and used for determining power potential, maximum floods and flow duration curve.

Flow measurements are being performed on Panjkora River at hydrological station since the installation of the gauge by PEDO at Zulam Bridge. Daily flow data is available from year 2000 to 2004 and 2010 to 2011. The same has been collected from PEDO for further processing to study the behavior of the flows. Keeping in view the missing data series of this stream from August 1961 to Oct 2009, the flows of Panjkora River were extended with the help of runoff relationship of nearby rivers with long term recorded data.

Extension of flows for Panjkora River at Shigo Kas has been made with the help of available long term recorded daily flows of nearby rivers having same characteristics. In this regards nearby rivers Panjkora at Koto, Zulam, Bibior, Sharmai, Swat at Kalam and Chitral River at Chitral were considered and relationships were investigated. Long term flow series 1961-2011 of Panjkora River at Shigo kas have been used for the final selection of flow pattern for water availability. Location of these stations is given in Chapter-4 (Hydrology and Sedimentation) of the main report.

From flow duration curve and the subsequent optimization studies, it has been concluded that the optimum discharge for power generation is the one that is available for about 37% of the time during the year which comes to 150m^3/s.

Flood studies have been carried out using statistical approach, Flood Frequency Analysis, Unit Hydrograph method, Regional Method, Method of Relationship with Peak Floods in Sub-catchments, Slope Area Method, 24 hours maximum rainfall data and estimation of floods using HEC-HMS. It is concluded that 10,000 year return period flood of 5569 m^3/s is appropriate for the design of weir. The above mentioned analysis can be seen in Chapter-4 of Main Report.

Total sediment load at proposed dam site has been computed by adding the bed load to the estimated suspended sediment load as given below:

Sr. No.	Description	Sediment Load (Million Tons)
1	Mean Annual Suspended Sediment Load	4.66
2	Mean Annual Bed Load	0.89
3	Total Annual Load	5.55

Mean monthly variation of the total sediment load is shown in Figure 4.85 of the main report.

The results show a large amount of sediment inflow which requires appropriate arrangements and design for effective and timely flushing of the sediments for proper operation of the power plant.

5. Seismic Hazards

Geotectonic of the Northern Pakistan is related to the collision of the two plates namely Indian Plate with Eurasian plate, and subsequent formation process of the Himalayan ranges. The intercontinental collision has resulted in intense deformation with complex folding involving strike-slip and thrust faulting. This tectonic process is the origin of the seismicity along the Himalayas and in particular where Northern Pakistan is located. The major regional faults related to the intercontinental collision and considered to be active and capable of generating earthquakes, include;

- Hazara Thrust Fault System
- Main Boundary Thrust (MBT)
- Main Frontal Thrust (MFT)
- Kashmir Thrust (KT)
- Main Mantel Thrust (MMT)

Shigo kas Hydropower project is located in Dir, near the vicinity of Main Mantle Thrust (MMT), in a zone which is seismically active due to the Continuing northward drifting of the Indian plate and its subduction under the Eurasian plate. This tectonic activity has resulted in the production of a crustal accretion wedge; The Himalayan range. Seismic Hazard Evaluation, based on available data / literature regarding regional geology, tectonics, non-instrumental and instrumental seismicity, has been carried out for Shigo kas Hydro Power Project by including some 618 events in the present study (since 1927).

The Deterministic Seismic Hazard Analysis (DSHA) has revealed that for Shigo kas Hydropower Project, Main Mantle Thrust/Reshun Fault could be the critical fault, capable of generating a magnitude 7.6 Mw Earthquake (equivalent October 8, 2005 Kashmir Earthquake). Maximum Credible Earthquake due to active faults in the region is calculated to be of the order of 0.46g due to an earthquake 7.6 magnitude, having a hypocenter at 30 km from the site.
Operating Basis Earthquake (OBE) acceleration can be assumed to be half of MCE value, but keeping the fact in mind that the seismic gap perpetually floats on the fault and wherever the situation is seismically suitable, a quake is triggered. Once an area experiences a quake, its epicentral volume is crushed and it becomes unable to accept any further geo-technical stress. This means that once an area has experienced an earthquake, it will not experience another earthquake of a similar magnitude for a long time. The time gap is usually about three to five times the return period of the earthquake. The available seismic data has been analyzed to evaluate Peak Ground acceleration (PGA) at the site. The calculated value of Peak Ground acceleration for Shigo kas Hydropower project site is 0.05g. After applying the necessary safety factor and calculating the rupture of MMT and Reshun fault the calculated PGA again comes out to be 0.31g.

Peak Ground Acceleration at Shigo kas Hydropower Project Site from Earthquake records since 1927.	0.05g
Design Spectral Acceleration Value	0.11g to 0.5g (mean 0.31g)
Half of MCE value	0.31g
Operational Basis Earthquake value at Shigo kas Hydropower Project site	**0.31g**

Shigo kas site is around 80 km from major tectonic features called Main Mantle Thrust (MMT) and appears to be a seismically active tectonic zone. Data of 618 earthquake events within 110 kilometers (1 degree) quadrangle distance, around Shigo kas has been collected from International and National agencies. The density of earthquakes is quite scattered, and apparently no structural/tectonic features can be interpreted from that data.

6. Project Layout and Hydraulic Design Considerations

6.1 Project Layout

The head works site from GTZ report has been recommended by the Client and therefore adopted by the Consultants. The headwork is proposed near Shigo kas village. The headwork comprises of concrete weir having two distinct sections in plan view, one overflow section and other Gated section. The intake of water is located on the left bank of Panjkora River. The sand trap is just downstream the intake. Three chambered sand trap has been proposed along the left bank for sediment exclusion. From the end of the sand trap, the water is conveyed to the headrace tunnel by a 65 m connecting rectangular channel. The headrace tunnel is 10.22 Km long having7m diameter horseshoe section with cross-sectional area of 40.63 m^2- finish. Surge shaft (20m Dia) is located at end of the tunnel is exposed to the surface. A horizontal pressure tunnel of 6m diameter leads to a valve chamber. An inclined penstock 5.5 m in diameter will drop from valve chamber to penstock manifold, feeding three generating units accommodated in the powerhouse in open cut on the left bank of Panjkora River. The powerhouse site is located at village Mitta which is downstream of village Utala. A 31 m long tailrace channel conveys water from powerhouse and discharges into the Panjkora River.

6.2 Hydraulic Design Considerations

The hydraulic design studies of Shigo kas Hydropower Project include design of weir, intake, sand trap, power tunnel, surge shaft, penstock, powerhouse and tailrace.

The hydrological studies show that minimum and maximum mean monthly discharges in Panjkora River at Shigo Kas site are 40 m^3/s and 366 m^3/s respectively. Based on economic evaluation and optimization, it was decided that power intake would be designed for rated discharge of 150 cumecs that will produce approximately 102 MW of power.

The overall weir length is 113 m comprising of an overflow section of 25 m and two gated section. The full reservoir elevation is 650 masl. The average river bed level is at El. 639 masl. The total height of the weir is 11 m above the average bed. The weir is designed to pass a flood of 5600 cumecs corresponding to a flood level of 654 masl. The gated section with stilling basin will be provided in the center of existing river course. It will be used to spill excess flows and small floods in summer season while the powerhouse is still in operation. It has a discharge capacity of up to 2000 m^3/s at normal operating level of 650 masl.

The gated section with roller buckets will be provided at the left bank. It will only be used during extreme floods when the tailwater level is sufficiently high for proper operation of roller buckets.

It will also be used occasionally to flush the river bed load which has been deposited in front of the power intake. The plan and sections of weir structure are shown in Figures 8.3 to 8.8 of the main report.

The intake structure off takes from the left bank of Panjkora River, The intake consists of 03 no. culvert inlets each 9.8m x 5m. The height of inlet gradually reduces from 5m to 3m through a parabolic profile of roof curve. The width of inlets reduces from 5m to 3.5m in a length of 5m. Three vertical lift type intake gates, each 5.8m x 3.5m, are provided after the bend section. There is provision of stop logs at the downstream side of intake gates in order to carry our repairs of one gate while the other gate is still open and transferring flows to the connecting channel. The inlet structure is shown in Figure 8.9 & 8.10 of the Main Report.

The inlet of sandtrap is located 15m downstream of the centerline of gates for intake structure The flows from intake directly enter the sand trap . The inlet width of sandtrap is 20.5 m which gradually increases to its maximum width of 49m in a length of 31.1 m. The sand trap is divided into three main chambers each 15m in width. Each chamber has been further divided into three hopper shaped compartments through vertical vanes/walls. There will be two locations for flushing ducts/galleries along the entire 115 m length of sandtrap. This arrangement is required because the optimal depth of sandtrap could not be achieved due to the relatively mild slope of river viz-a-viz the lower elevation of sandtrap flushing ducts as compared to river bed level. It is designed to retain 0.2 mm and bigger sized sediment. Complete arrangement of the sandtrap is shown on Figures 8.11 to 8.13 of the Main Report.

The flows from sandtrap will be carried to the tunnel inlet through a 65m concrete lined rectangular headrace channel (18m bed width and 8m depth) excavated along the left bank of river. A freeboard of 0.5 m will still be available for operation at maximum headwater level with design flow velocity at normal operating level will be 2.1 m/s using a Manning's roughness coefficient of n=0.016.detail of channel is shown in Figure 8.14 of Main Report.

The power tunnel is designed as a Horseshoe conduit of 7 m diameter having 40.63 m^2 area. It is 10.22 km long, and has a slope of 1 in 500. At start of the power tunnel the invert has an elevation of 630 masl and at the end elevation of 610 masl. The velocity in the power tunnel will be 3.5 m/sec. The plan, profile and cross section of the power tunnel are shown on Figures 8.15 and 8.16 of the Main Report.

Surge tank has been provided at the end of concrete lined tunnel. Based on the hydraulic considerations, restricted orifice type surge tank has been selected with finished diameter of 20 m as required by Thoama's criteria. The diameter of orifice at the inlet of surge tank is 3m. The total height of surge tank will be 42 m including 6 m freeboard. The details are shown in Figure 8.17.

A 197.96m horizontal pressure tunnel having 6m inner diameter, comprises of two sections 107.97 concrete lined ant 90m steel lined, leads to a valve chamber at El. 606. An inclined Penstock 105 m having diameter 5.5m will drop from valve chamber at El. 606 masl up to El. 558 masl from where penstock manifold starts, branches to the three units. The arrangements are shown in Figure 8.18 of main report.

A surface type powerhouse in open cut has been proposed on the left bank of the river. The powerhouse will be equipped with three vertical Francis turbine units. The plan of powerhouse is shown in Figure 8.20 and the section is shown in Figure 8.21 of the main report.

The concrete lined tailrace length is about 31m from the draft tube outlet gates up to the left overbank of Panjkora River. Details of plan and section of tail race are shown in Figure 8.22 of main report

The diversion arrangements on the Panjkora River for constructing the main weir cater for 26 months of construction period.

7. Mechanical Equipment Studies

Mechanical equipment and systems will include turbines, governors, inlet valves, gates, stoplogs, trashracks, cranes and hoists etc. The turbine selection was made considering 78.5m as rated head. As stated earlier, for the installed capacity of power plant 150 m^3/sec flow at 38% exceedence has been selected. From the comparative study of various turbine sizes and combinations, three units of vertical Francis turbines each with 50m^3/sec flow have been selected. Considering turbine efficiency of 92% for the net head of 78.5m and design flow of 50m^3/s, the power will be 35.4 MW for each turbine. These values will result in the turbine specific speed (Ns) of 272.7 rpm. An average runner diameter is considered as 2.46m.

For determining the appropriate unit capacity, both technical as well as economic aspects have been examined in a comparative study taking into account equipment dimensions, transport limitations, power and energy benefits, manufacturing experience, power system regulation, and cost estimates etc. Considering generator efficiency as 97% and turbine efficiency as 93%, the turbine output will be 102MW corresponding to total rated discharge of 150m^3/s and rated head of 78.5m.

8. Electrical Equipment Studies

The most important components of the main electrical equipment are the 11 kV with all its excitation equipment and other auxiliary equipment as specified. The generators with generating capacity of 40 MVA have thus been selected. The electric power generated at Shigo kas hydropower station will be fed to Timergara Grid Station through single circuit 132KV transmission line.

9. Initial Environmental Examination, Resettlement and Social Assessment

Lands in Shigo kas HPP area comprise very less cultivated lands, and settlements and larger area is waste lands. The project will consume 957 kanals of private land, of which 52 kanals are under cultivation and while the rest include community land and waste land.

The present EIA reveals that some moderate to significant negative environmental impacts are likely to occur due to the construction activities with few minor impacts during operations after the proposed construction. Recommendations are made to mitigate expected negative impacts. Implementation of appropriate mitigation measures during the construction, and operation phases will minimize the negative impacts of the Project to acceptable levels.
The Project will have an overall beneficial impact and any negative environmental impacts will be carefully monitored and mitigated. Therefore, the completion of this EIA fully meets both the ADB and EPA standards.

The construction of the project will open job opportunities for the local people. This will help in raising their livelihood.

The total environmental and resettlement cost is estimated as Rs. 560.17 million including land acquisitions.

The client should make necessary arrangements such that during operation of the project sufficient release of water is ensured from the Weir for downstream uses because some agricultural practices do depend on river water.

10. Construction Planning, Cost Estimate and Economic and Financial Analysis

10.1 Construction Planning

The construction planning for 102 MW Shigo kas Hydropower project is largely dependent on Construction of weir, power tunnel and powerhouse, which are on the critical path, High and low flow periods in the Panjkora River, Excavation in hard strata of powerhouse & power tunnel and Transmission line.

Main components of the project are Weir & intake, Connecting channel, Sandtrap, Power Tunnel, Surge Tank, Penstock, Powerhouse, Switchyard, Colony and Transmission line.

The work on all these components can be carried out independently and the schedule has been prepared in such a way, that the work is taken up simultaneously on various sites in order to complete the project in the shortest possible time. It is thereby estimated that the construction of the project will be completed in 81 months. The sequence, in which the construction of various components of the project will be taken up, has been shown in Figure-14.1 of the Main Report. The construction activities along with time required to complete them is summarized as follows:

Summary of Construction Schedule

Sr. No.	Description of Activity	Duration
1.	Mobilization	30 Days
2.	Acquisition of Land	7 Months
3.	Temporary and Preliminary works	12 Months
4.	Coffer Dams (two Nos.)	3/2.5 Months
5.	Left part of main Weir, Intake and ancillary works	08 Months
6.	Right part of main Weir and ancillary works	10.5 Months
7.	Connecting channel	5 Months
8.	Sandtrap and ancillary works	18 Months
9.	Power Tunnel and ancillary works	46 Months
10.	Surge Shaft	8 Months
11.	Penstock	11 Months
12.	Powerhouse Civil works	32.5 Months
13.	Tailrace and ancillary works	6.5 Months
14.	Powerhouse E&M manufacturing and installation	35 Months
15.	Switchyard, Transmission Line ancillary works	24.5 Months
16.	Testing and Commissioning	9 Months

10.2 Cost Estimate

1. The estimated cost of the project has been worked out as Rs. 32,623 million out of which local cost is Rs. 27,834 million, while for import of Electrical / Mechanical &

transmission line equipment, a provision of Rs. 4,789 Million has been made. For realistic cost estimate the following factors / criteria has been considered.

i. Market Rate System 2013 Khyber Pakhtunkhwa.
ii. Prevailing market Rates
iii. Unit rates adopted for similar constructed / under construction projects
iv. US$ versus Pak rupee impact.

2. The summary of the project capital cost (Amount in Million Rs.) is given as under:

(Amount in Million Rs.)

Sr. No.	Component	Estimated Cost		
		Local	FEC	Total
A	Preliminary Works	600.20	0.00	600.20
B	Environment & Resettlement Costs(Land Acquisition)	560.17	0.00	560.17
C	Civil Works	18502.45	0.00	18502.45
D	Electrical & Mechanical Works	478.36	4305.20	4783.56
	Transmission Line	105.00	245.00	350.00
	Total Works Cost	**20246.18**	**4550.20**	**24796.38**
E	Physical Contingencies (Unforeseen) @ 3% of C+D	572.58	136.50	709.08
F	Transportation and Erection Charges of E&M Equipments @3% of D	131.48	0.00	131.48
G	Survey, geotech investigation and Detail Design of Civil and E&M Works @ 2% of (C + D)	472.72	0.00	472.72
H	Management Consultancy Cost @ 3% of (A + C + D)	727.08	0.00	727.08
	Total Base Cost	**22150.04**	**4686.70**	**26836.74**
I	Client Expenses, Administration and Legal Costs @1% Base Cost	268.37	0.00	268.37

J	Custom Duty@ 5% of D (on FEC)	227.51	0.00	227.51
K	Escalation @ 6.50% on Local cost & 1.3% on FEC	2330.24	102.06	2432.30
L	Interest during Construction (IDC) @10.65% of Base Cost	2858.12	0.00	2858.12
	Total Project Cost	**27834.28**	**4788.76**	**32623.04**

10.3 Economic and Financial Analysis

The annual energy of the Project is 520 GWh. Based on it the unit generation cost comes out to be Rs. 8.05 & US cent 8.13. A summary of Economic and Financial Analysis indicator is given as under:

NPV (Million Rs.)	13,289
BCR	1.61
EIRR	21.58%
FIRR (Without CDM)	14.85 %
FIRR (With CDM)	15.60 %

The sensitivity analysis results are summarized as under:-

Scenario	**NPV (Rs. Millions)**	**EIRR**	**BC Ratio**
10 % cost over-run.	11,118	19.21%	1.47
One year delay in benefits	9530	17.69%	1.44
Combination of above	7368	16.03%	1.31

11. Conclusions & Recommendations

11.1 Conclusions

- Base cost of the project is estimated as Rs. 26,837 million, while the capital cost is estimated as Rs. 32,623 million.

- Environmental Impact Assessment Studies have determined the overall impact rating of the project activities as “low to medium”.

- The EIRR calculated in comparison with equivalent thermal plants as replacement alternative to the proposed Hydropower Project, comes to 21.58 %.

- Financial analysis indicates a Financial Internal Rate of Return (FIRR) as 14.85 % and the project is adjudged viable.

11.2 Recommendations

- Flow measurements and gauge observations should be continued at PEDO Gauge Station located near proposed weir site in order to have essential data of flows, floods and sediment before project implementation.

- The geological and geotechnical investigations, conducted during the feasibility studies, have provided the data required for feasibility level design of the Shigo Kas Hydropower Project. At detailed design stage, additional investigations are recommended

- The access road to weir site, surge area and powerhouse need to be constructed and bridges are to be strengthened.

- Engineering, economic and financial studies have classified Shigo Kas Hydropower Project as viable. **Hence the project is recommended for detailed engineering design or Engineering Procurement Contract and execution**.

Table 1: SALIENT FEATURES

Hydrology	
Catchment Area	5816 km^2
Design Discharge	150 m^3/s
Working Head	
Normal Head Water Level	650 masl
Tailrace Water Level	558.5 masl
Gross Head	91.5 m
Net Head	78.5 m
Diversion Weir	
Type of Intake	Gated (3 Nos. Each Gate 5.8m x 3.5m)
Height Above River Bed	11 m
Length of the Overflow Crest	25 m
Gated Section with stilling basin	56 m with 4 radial gates (10m x 12m)
Sluicing section (Gated Section with roller bucket)	28 m with 2 radial gates (10m x 12m)
Type of Energy Dissipater	Stilling Basin Type II
Stilling Basin Length	75 m
Sand Trap	
Number of Chambers	3
Total Width of Sand Trap	53.5 m
Length of Sand Trap	115 m
Height of Chamber	09 m
Headrace Tunnel	
Length	10.22 km
Diameter	7 m Horseshoe
Surge Shaft	
Diameter	20 m
Height	42 m
Power House	
Type	Surface
Size (l x w x h)	73m x 35m x 36m
No. of Turbines	3
Type of Turbine	Francis vertical
Tailrace Channel	

Section (w x h)	20m x 9.5m
Length of the Channel	31 m
Power Potential	
Gross Power	102 MW
Annual Energy	520 GWh
Plant Factor	58.2 %
Project Cost & Economic Viability	
Total Project Cost	**32,623** Million Rs.
Benefit / Cost Ratio	1.61
Unit Cost Generated	8.05 Rs. / kWh
Unit Cost Generated	8.13 US cent / kWh