RASUWAGADHI HYDROPOWER COMPANY LIMITED

RASUWAGADHI HYDROELECTRIC PROJECT (111 MW)

Executive Summary

Introduction

The Chilime Hydropower Company Limited (CHPCL) is a public limited company established in 1995 AD to harness the hydropower potential of the country at a reasonable rate with the full utilization of the national resources available in the country. The company has successfully completed the construction of Chilime Hydroelectric Project (22.10 MW Capacity) in Rasuwa district in 2060 and has set a milestone example in the national hydropower development. The financing of the Project was done through 40% equity share of Nepal Electricity Authority (NEA), NEA Employees & General public and 60% loan from the Employer's Provident Fund (EPF).

Rasuwagadhi Hydropower Company limited (RGHPCL), promoted by the Chilime Hydropower Company Limited (CHPCL), is established in 2011 as a public limited company. RGHPCL has planned to develop new project - Rasuwagadhi Hydroelectric Project (RGHEP) of capacity 111MW in Rasuwa district, of Bagmati Zone. The company has already signed a loan agreement for the debt portion required for the project with Employees Provident Fund (EPF) and equity investment shall be made from NEA, CHPCL and General public.

The project is accessible by the Kathmandu -Trisuli - Somdang road at a distance of 130 km to the north of Kathmandu and could be reached in 6 hours drive from Kathmandu to Syabrubesi. The construction of road between Syabrubesi to headwork site at Rasuwagadhi (almost 16 km) is under construction by the Government of Nepal in assistance with Chinese Government. Almost 5 km long internal access road and two bridges over Bhotekoshi River will be required to access the project work sites and the construction work will be carried out through the main Civil Works Contractor.

Rasuwagadhi Hydroelectric Project is located in Rasuwa district of Bagmati Zone. The design discharge of the project is 80m^3/sec in 40 percentile of time (Q_{40}). The headwork site is located about four hundred meters downstream from the confluence of Kerung khola and Lende khola which are the boundary rivers of Nepal and China (Tibet). The total headrace tunnel length of the project is 4203 m up to the surge tank. Tail water from the powerhouse will be released to main river course through 564 m long tailrace tunnel in the downstream of powerhouse site. The Headwork site of the project is located in the Thuman and Timure VDC, whereas all other project components lie in Thuman VDC. The project is a run-of-river type scheme having the capacity of 111 MW and the annual energy generation is 613.875 GWh with the available gross head of 167.9 m.

Topographic Survey

The survey works for the feasibility study of the proposed project were conducted from mid Janaury of 2009. The survey works have been carried out with the objective of preparing topographic maps of entire project area and its components located in the Thuman and Timure

VDC in appropriate scale and details to work out the structure layouts to be prepared. Detail topographical survey of the headwork site, intake, desanding basin, tunnel inlet portal and its alignment, adit locations, stream and gully crossing, surge tank area, penstock, powerhouse and tailrace site including surrounding peaks and valleys with 1m contour interval in the scale of 1:1000 and 1:5000.

All the major control points were established on the field by monument of control points by an iron pin in concrete pillars or with crosses chiseled on boulders or rocks. Altogether 22 permanent benchmarks were established at the project area, among which 3 benchmarks, BL-108 (GPS-7), BL-109 (RW-9) and BL-110 have been established at the powerhouse site. Similarly, benchmarks TRIG-1634, TRIG-1635, BL-100(GPS-10), BL-102(RW-2) and BL-103 have also been established at headwork area and rests of the Benchmarks have established in waterway alignment.

All the coordinates and elevations of each station and survey point were computed with respect to the given UTM coordinates and elevation of control points. After completely checking the data, mapping Software was used for map preparation.

Hydrology

The Trishuli River is one of the major rivers of Sapta Gandaki Basin which drains the Western Development Region of Nepal. The drainage area at the proposed intake site is about 3300 km2 and at the proposed powerhouse site is about 3350 km2.The average gradient of the river in between the weir site and powerhouse site is about 3.26%.The average annual precipitation over the entire Bhotekoshi basin is estimated to be about 1000 mm.

The long term mean monthly flow in the project area reveals a maximum of 216.30 m^3/s in August and minimum 20.60 m^3/s in March. Mean monthly flows at weir site were calculated based on the flow data available from Syabrubesi Gauging Station collected from 1994-2003 are tabulated below in Table 1.

Table 1: Long term Mean Monthly Flow at Rasuwagadhi, Intake site

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Mean flow	24.2	21.4	20.6	25.0	63.0	123.5	180.8	216.3	161.2	104.8	55.6	32.4

The flow duration curve was constructed from the generated mean monthly flow series for the duration of 1994-2003 at the weir site and is shown in Figure 1 below. It is noted that the design flow equivalent to 40% dependable is about 80.00 m3/s. For the design purpose 1000 year flood equivalent to 1761.0 m^3/s is recommended as the design flood. The flows depending on given time exceedance are tabulated below in Table 2.

Table 2: Time Exceedence of Mean Daily Discharges at Rasuwagadhi

Time Exceedence (%)	Days per Year	Daily Discharge Equalled Or Exceeded (m^3/s)
35	128	103.25
40	146	80.00
45	164	61.73
50	182	52.01
60	219	35.20
70	255	25.22
80	292	20.93
90	328	18.32
100	365	12.56

Figure 1: The Flow Duration Curve at weir site.

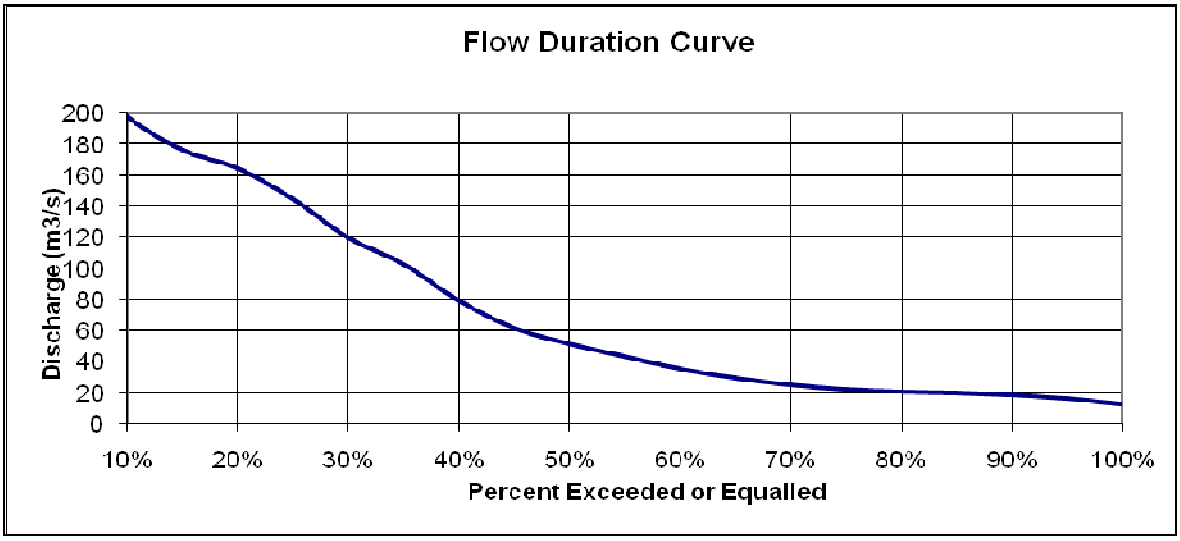


Table 3: Flood Estimates calculated for Rasuwagadhi HEP (m^3/s)

Return Period	Flood at Intake site (m^3/s)
2	421
10	701
20	828
100	1167
1000	1761

Geology

The Project area lies in the Higher Himalayan succession. The migmatitic gneisses and banded gneisses occupy the intake area whereas quartzites comprise the headrace tunnel and powerhouse area.

The diversion weir is located at a straight course of the Bhote Koshi River. At the proposed site of the diversion weir, alluvium terrace of river is seen. Large boulders of augen gneiss, granitic gneiss, and granite occupy the river terrace. Some boulders are up to 10 m in diameter.

The headrace tunnel passes through the migmatitic gneisses, quartzite, schists, banded gneisses, and weak or shear zones. The tunnel alignment will be oriented obliquely to the foliation plane. Hence, the tunnel driving conditions are fair. Based on the surface rock mass classification, about 4% of the headrace tunnel length runs through poor to extremely poor rock and 96% through fair to good rock. It is important to note that extremely poor conditions are encountered only at the minor shear zones of less than 10 m in length whereas fair to poor conditions are confined to the schist.

The main rock type of the powerhouse area is thick to very thick-banded, coarse-grained, light grey to grey and white, massive quartzite with schist partings. There are a number of quartz veins intersecting the rocks. The adjusted RMR values lie between 58 and 59 (Fair Rock, Class III).

Seven construction material sites and two rock quarry sites and three much and spoil disposal sites were identified. All these sites lie near the project area on the banks of the Bhote Koshi River.

Socio-Economic and Environmental Impact Assessment

Scoping document and the terms of reference for the environmental impact assessment study of this project has been carried out including two Village Development Committees namely Thuman and Timure. In these two affected VDC's, to minimize the envisaged impacts and to maximize the beneficial impacts, the project has originated a various mitigation measures.

With the publication of public notice .pros and cons to the villages, opinions and suggestions on implementation of this project have been collected and included in the scoping document and terms of references. The issues raise from the these two VDC's are categorized to physical environment and biological environment and socio-economic and cultural environment.

The 'Scoping Document and Terms of Reference (ToR) of the Environmental Impact Assessment (EIA) has approved from the concerned authority and the EIA report is under approval process.

Project Description

Rasuwagadhi Hydroelectric Project is a run of the river type project located in Rasuwa District. The project utilizes a gross head of 167.90 m by diverting the Bhotekoshi River flow through a 4.203 km long tunnel to an underground powerhouse. The design discharge of the project is 80 m3/s and installed capacity is 111 MW.

The net head of the project is about 158.48 m. The headworks of the project comprises of a diversion weir having crest length 61.50 m, a two bays undersluice of each clear crest length 6.5 m and height 5 m, a side intake with three bays of opening size of 9.0m x 4.5m each along with 40.90 m long intake bay will be provided to off take the design flow from the river. Three

separate RCC pressure conduits and desander intake tunnel is designed to reach up to inlet structure of underground desanding basin. A 125 m long, 15m wide and 10m deep three separate underground desanding basin with 30.0m long inlet zone is designed to settle the sediment particle up to the size of 0.2mm. The outlet tunnel of these three individual desanding basins of an average length of 125 m each will finally be merged into a single point to connect the headrace tunnel of this option.

Waterways of the project comprise of 4.203 km long headrace tunnel with a 6m dia. finished circular section for concrete lined portion. It includes a restricted orifice surge shaft with a diameter of 16m and height 60.0m and 313.0 m long underground penstock (vertical shaft and horizontal tunnel) of 4.80m~2.50 m dia. finished section The underground powerhouse of size 60m x 14.0 m x 27.0m consists of three vertical shafts Francis turbine each of 37.0 MW installed capacity. About 25 m downstream of powerhouse cavern, a transformer cavern of size 90 m long, 12.0 m wide and 10.50 m high is planned to place step up transformers. Finally, the tailrace tunnel of length 564 m will dispose the plant discharge into Bhotekoshi River just upstream of the suspension bridge located below the Dalphedi village.

Power Transmission

Generated power from the Rasuwagadhi Hydroelectric Project will be evacuated through 10 km long 132 kV Transmission Line. The Transmission Line will be constructed from the powerhouse of the project to proposed Chilime Hub Switchyard to be located at the Thambuchet of the Chilime VDC.

Power and Energy Outputs

With the design discharge of 80.0m3/s and the available Gross Head of 167.9 m the Installed Capacity of the Project is 111 MW and the total Annual Sellable Energy will be 613.875 GWh.

Construction Planning and Scheduling

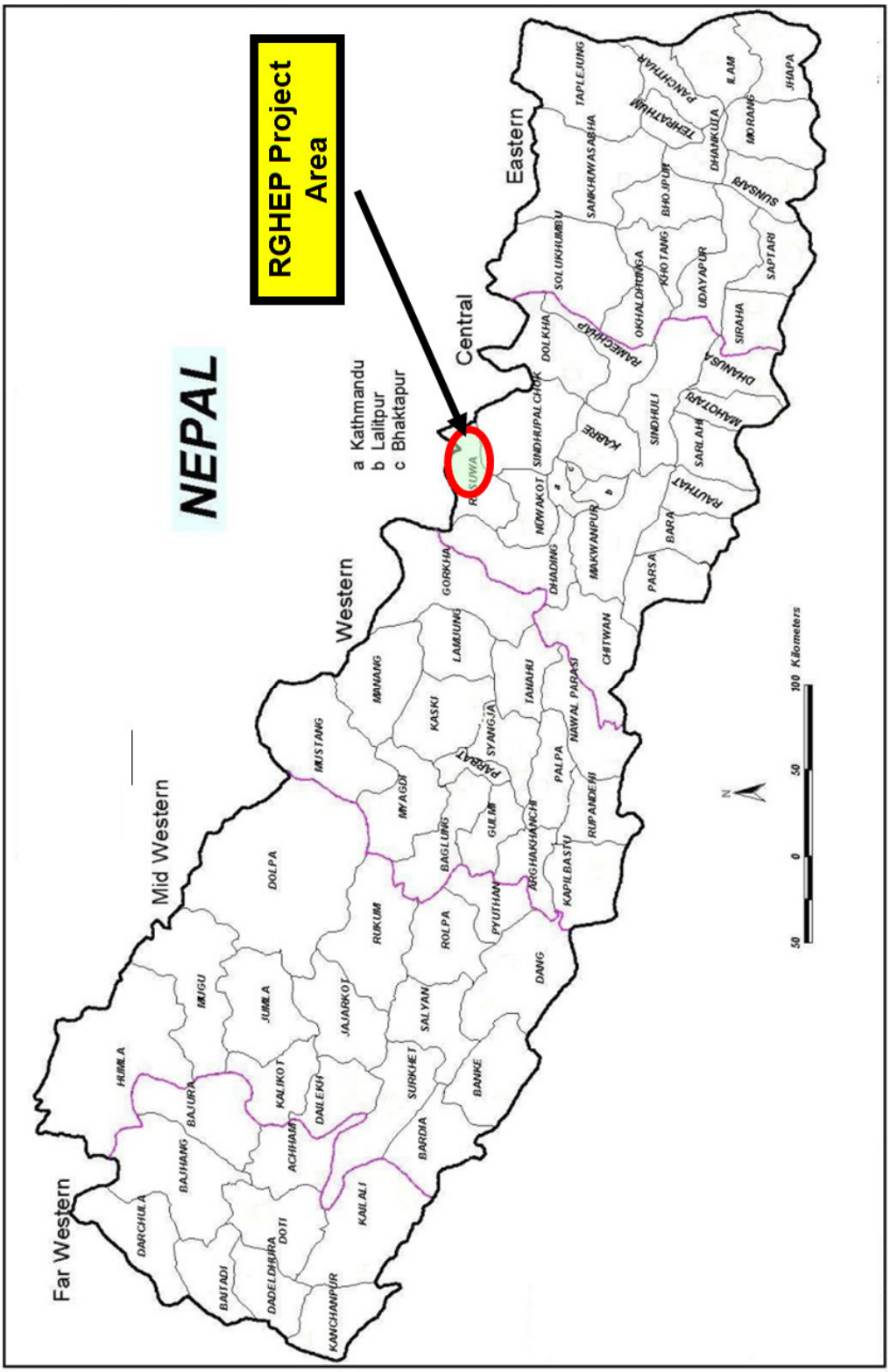
It is planned to start the project construction activities from the beginning of 2012 and targeted to complete by the end of 2016. All preparatory works including tender document preparation, land acquisition, construction of camp facilities and infrastructure development will be executed in the first year. The main construction work of the project is scheduled to begin from early 2013 and will be commissioned within 4 years duration.

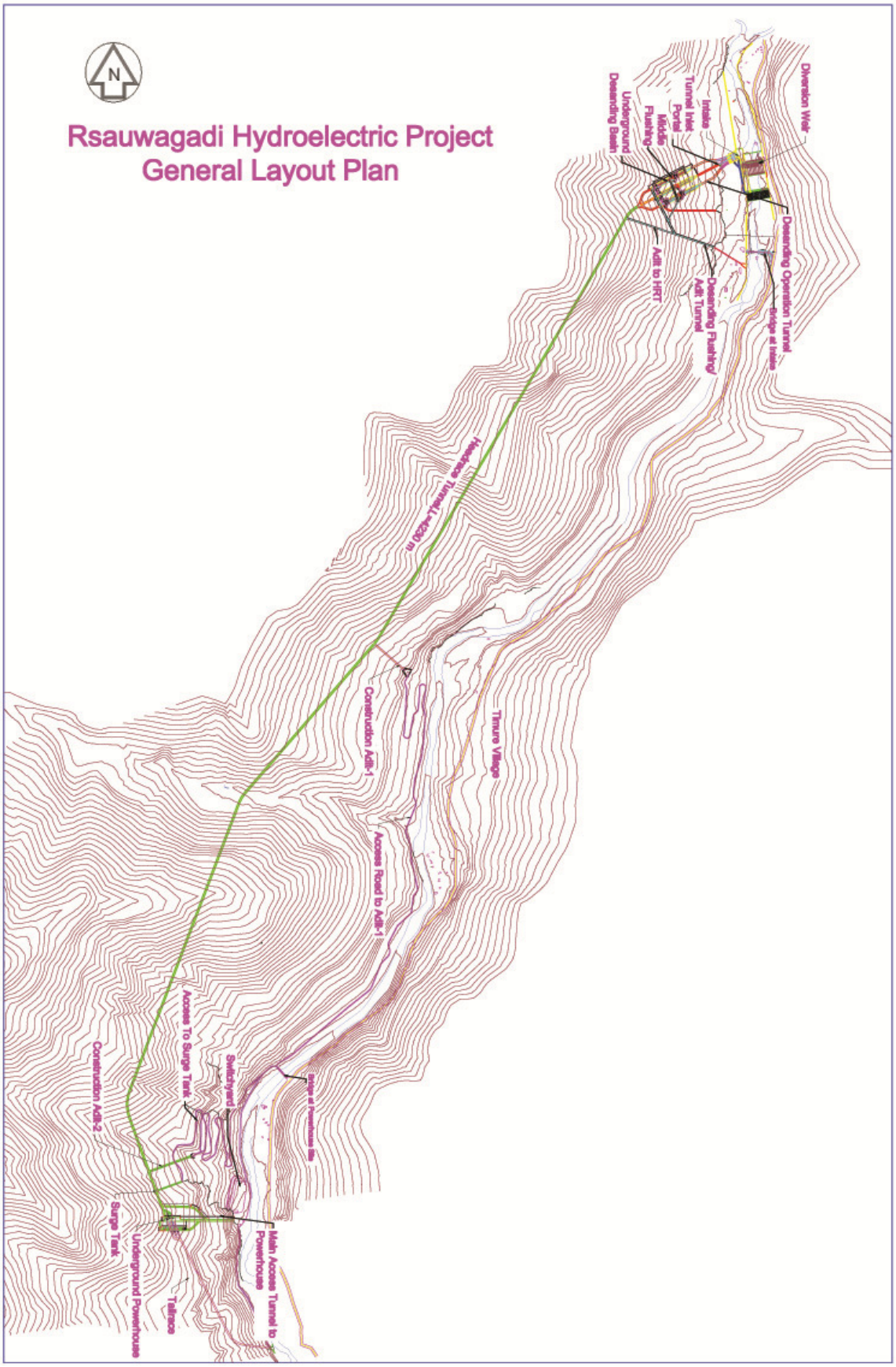
SALIENT FEATURES

Location	Thuman & Timure V.D.C. of Rasuwa district.
Type of Project	Run-of-river
Hydrology	
Catchment area (Dam site)	3300 km^2
Design flow (Q_{40})	80.00 m^3/s
Design flood (1000yrs)	1761.0 m^3/s
Geology	
Rock Type:	Quartzite, Migmatite and Gneiss
Head	
Gross	167.90 m
Net	158.48 m
Headworks	
Weir Type	Overflow Diversion Weir
Crest Length and its Elevation	61.50 m, 1790.00masl
Height	8.5 m
Intake Type	Side Off take
Normal Water Level	EL. 1790.00 masl
Desander Type	Underground, Dufour(Three Camber)
Dimensions of Chamber	125 m x 15 m x 10 m
Headrace Tunnel	
Length	4203.0 m
Size of Shotcreted Section	6.4m (w) x 6.4 m (h): Horseshoe- shaped
Size of Concrete Lined	6.0 m Dia. : Circular Section
Surge Tank	
Type	Restricted Orifice
Size	60.0 m (h), 16.0 m (dia)
Size of Orifice	3.50 m (dia).
Penstock	
Type	Vertical Shaft/Horizontal Tunnel
Size	313 m (l), 4.80~2.50 m (dia)

Powerhouse	
Type	Underground
Size	60 m (l) x 12.50 m (b), 27 m (h)
Tail Water Level	EL. 1622.10 masl
Tailrace Length & Size	564 m (l) x 6.0 m (b) x 6.0 m (h)
Turbine	
Type	Francis, Vertical Axis
Capacity	3 Nos., 37 MW each
Generator	
Type	3 Phase Synchronous AC
Rated Power	3 Nos., 43.75 MVA each
Installed Capacity	**111 MW**
Saleable Energy	**613.875 GWh**
Dry Month Energy	84.318 GWh
Wet Month Energy	529.556 GWh
Transmission Line	
Length	10.0 km(Upto Chilime Hub)
Voltage	132 kV (Double Circuit)

Project Location




Rsauwagadi Hydroelectric Project
General Layout Plan
N
Diversion Weir
Intake
Tunnel Inlet Portal
Middle Flushing
Underground Desanding Basin
Adit to HRT
Desanding Flushing Adit Tunnel
Desanding Operation Tunnel
Bridge at Intake
Headrace Tunnel L=4200 m
Construction Adit-1
Timure Village
Access Road to Adit-1
Access To Surge Tank
Switchyard
Construction Adit-2
Surge Tank
Underground Powerhouse
Tailrace
Main Access Tunnel to Powerhouse