

EXECUTIVE SUMMARY

INTRODUCTION

The Madhya Bhotekoshi Jalavidyut Company Ltd. is a public limited company established in 2010 AD to harness country's hydropower potential at a reasonable price with the maximum utilization of resources (both technical and financial) available in the country. In the context of current annual growth in load demand in the country and lack of the projects of sizable capacity in the pipe line after Middle Marsyangdi Hydroelectric Project, the Company has planned to develop one of the projects of sizable capacity in the easily accessible area.

The Middle Bhotekoshi Hydroelectric Project is located in Sindhupalchowk District of Bagmati Zone about 101 km road head distance on Araniko Highway towards north-east of Kathmandu (Fig. MBKHEP ES 1). The headworks site lies in Marming VDC and the surge tank, penstock and powerhouse site in Gati VDC.

The project is basically a run-of-river type scheme (Fig. MBKHEP ES 2) having the capacity of 102 MW and the annual energy generation is 542 GWh with the available gross head of 235 m. The design discharge of the project is $50.8 \text{ m}^3/\text{sec}$ at exceedance Q_{40} . The headworks site is located about one hundred meters downstream from the confluence of Chaku Khola and Bhotekoshi river. The total headrace tunnel lengths from headrace inlet to the surge tank is 7124 m. Surface powerhouse is located at Jambu village about 4 km upstream of Barhabise bazaar. Tail water from the powerhouse will be released to main river course about 100 m downstream of powerhouse site.

TOPOGRAPHIC SURVEY

The detailed topographical mapping of headworks site, construction adit and powerhouse site have been completed and maps are prepared in the scale 1:1,000 and project layout map in the scale 1:20,000. Mapping covered altogether an area of 51.5 ha comprising of 30 ha in powerhouse site, 15 ha in headworks site and 6.5 ha in adit area.

All the major control points were made with monumentation of control points with an iron pin set in rock or boulder or with crosses chiseled on the boulders. Altogether 9 permanent control points/ benchmarks were established in the project area, 3 benchmarks (BM1, BM2 & BM3) were established at the powerhouse site, 3 benchmarks (BM4, BM5 and BM6) at construction adit location and 3 benchmarks (BM7, BM8 and BM9) at headworks area.

A closed traverse was carried out from headworks site to the powerhouse site. Several other control points were established by conventional traverse survey covering the entire area to be mapped from the damsite to the powerhouse site. All traverses formed by the conventional survey were closed loops or closed on existing traverse points.

HYDROLOGY

Bhotekoshi river is a main river in the Sapta Koshi basin of Nepal. The total length of the Poiqu (Bhotekosi) river within Tibet is about 81 km with a catchment area of 2000 km^2 . At Barhabise, its catchment area is about 2388 km^2 with the total catchment area about 360 km^2 in Nepal at Bahrabise.

The drainage area at the proposed weir site is about 2284 km^2 . The total catchment area at the powerhouse site is about 2347 km^2 . The average gradient of the river in between the weir site and powerhouse site is about 2.44%. The average annual precipitation over the entire Bhotekoshi basin upto Bahrabise is estimated to be about 900 mm.

The long term mean monthly flows in the project area reveals a maximum of $169.7 \text{ m}^3/\text{s}$ in August and minimum $19.8 \text{ m}^3/\text{s}$ in March.

Mean monthly flows at weir site were calculated based on the gauging station data of Barhabise gauging station collected from 1965 to 1995.

Long Term Mean Monthly Flow at Dam Site

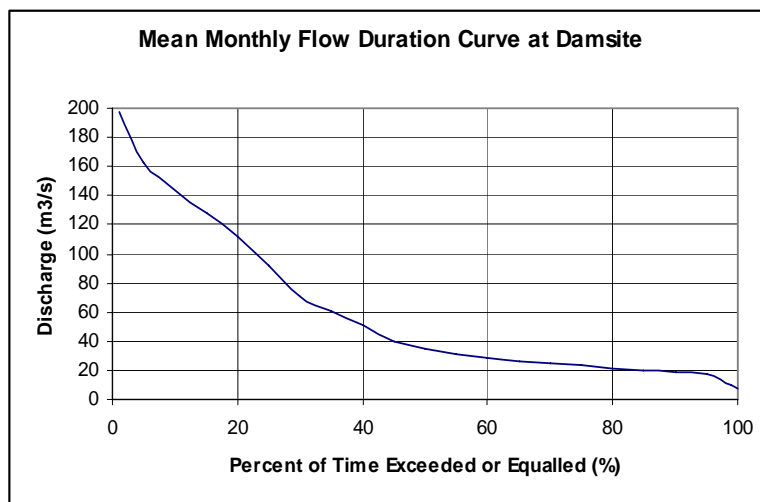
Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Mean Flow	22.7	20.6	19.8	24.1	35.3	68.4	131.9	169.7	120.0	62.6	35.9	25.9

The flow duration curve was prepared from the generated mean monthly project inflow time series 1965-1995 at the weir site and is shown in Fig. MBKHEP ES 3. The flows depending on given time exceedence are tabulated below:

Time Exceedence of Mean Monthly Flows at the Weir Site

Time Exceedence (%)	Days per Year	Discharge Equaled Or Exceeded (m ³ /s)
30	109	71.1
35	128	60.3
40	146	50.8
45	164	39.5
50	183	34.7
60	219	28.8
70	256	25.0
80	292	21.7
90	329	18.4
99	361	10.5

Fig. MBKHEP ES 3: Flow Duration Curve at Weir site



The Middle Bhotekosi Hydroelectric Project will consist of gated weir to divert design discharge from the river to the conveyance system through intake. The 100 year flood of 1330 m³/s is recommended as the design flood.

Estimated Floods for Middle Bhotekoshi HEP (m³/s)

Return Period, Years	2	5	10	20	50	100	200	500	1,000	10,000
Adopted Flood at Dam Site, m ³ /sec	438	599	736	890	1130	1330	1560	1900	2195	3415

GEOLOGY

The main rock types in the project area are phyllitic schist, quartzite and dolomite. Entire sequence of the bedrock is typically monoclinial with approximate dip angle of 15° upstream.

In the headworks site, bedrock is at the depth of 10 m. River bed deposit is partly compacted. Foundation on bedrock is designed for diversion weir structures in the headworks site.

An inverted "D" shaped 5.7 m wide and 5.7 m high excavation dimension of headrace tunnel of the length 7124 m is the major water conveyance structure of the project. From the inlet portal to 50 m and 1120 m to 2420 m, the headrace tunnel is expected to pass through quartzite rock, dolomite in between chainages 50 m to 1120 m for the length of 1070 m and phyllitic schist and quartzite rocks in the last stretch between 2480 m to the end of the headrace tunnel for the length of 4704 m. For the rock density of 25 KN/m³ for dolomite, the uniaxial compressive strength is estimated around 80 MPa as estimated using Schmidt hammer. Similarly, for dolomitic quartzite and phyllitic schist, the uniaxial compressive strength is estimated as 150 and 50 MPa respectively.

Regarding the rock mass classification, about 18% tunnel lengths, i.e about 1282 m has been estimated to lie in good rock. Similarly, 60% tunnel length i.e. 4274 m lies in fair rock, 19% tunnel length i.e. 1354 m lies in poor rock and remaining 3% length i.e. 214 m lies in very poor rock mass. Remarkably thick rock cover of about 825 m is encountered at 2173 m downstream of Intake portal.

The phyllitic schist rock is the rock type in the powerhouse area and the rock mass is classified as fair rock. The rock in the powerhouse area is medium hard with the uniaxial compressive strength of 45 MPa.

SOCIO-ECONOMIC AND ENVIRONMENTAL IMPACT ASSESSMENT

Scoping Document and the Terms of References for the Environmental Impact Assessment study of this project have been carried out including five village development committees. Out of five VDCs, three VDCs are categorized into most affected VDCs namely, Marming VDC, Listikot VDC and Gati VDC and other two VDCs namely, Ghumthan VDC and Maneswora VDC are less affected VDCs. 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 raised from all five VDCs are categorized into physical environment, biological environment and socio-economic and cultural environment. Scoping Document and the Terms of References for the Environmental Impact Assessment study of this project has been approved from the Ministry of Environment. EIA study is in final stage.

PROJECT DESCRIPTION

The Middle Bhotekoshi Hydroelectric Project is a run-of-river scheme. The whole scheme is divided into three work sites: Headworks Site – covering diversion weir, undersluice structure, Desanding basin, forebay and pressure conduit; Underground works – headrace tunnel, rock trap, surge tank, vertical shaft and lower horizontal penstock tunnel and construction adits; and, Powerhouse site – powerhouse, Access to emergency valve chamber, emergency valve chamber, switchyard and other auxiliaries.

The headworks site is proposed at Chaku village about 100 m downstream from the confluence of Bhot

Koshi river and its tributary Chaku Khola. The headworks consist of gated diversion weir with three numbers of gates of size 10 m wide and 7.4 m high and one number of undersluice of size 10 m wide and 9.4 m high, side intake structure; 100 m long, 13 m wide and 8.5 m high triple chamber desanding basin; forebay and 360 m long pressure conduit.

The headrace tunnel is 7124 m long, out of which about 4274 m of the tunnel length (60% of total tunnel length) will be shotcrete lined and 2850 m of the tunnel length (40% of tunnel length) concrete lined.

A cylindrical restricted orifice type of surge tank with 15 m diameter and 59 m height with 500 mm thick concrete lining is proposed in Jambu village.

Underground penstock is proposed between surge tank and powerhouse. A 183m long vertical shaft and 430 m long lower horizontal penstock is proposed. Total length of the penstock is 667 m. The uniform diameter of 3.6 m penstock pipe is proposed between surge tank and wye branch close to the powerhouse.

The surface powerhouse is located at Jambu village at the side of Araniko highway at a distance of 92 km from Kathmandu. The surface powerhouse is proposed on the rock foundation by cutting the steep rock cliff of around 40 m height. The powerhouse will accommodate three units of Francis turbine and generators of 34 MW capacity each positioned in vertical axis providing the space for service bay. A 100 m long tailrace canal will discharge the tailwater back to the Bhotekoshi River.

POWER TRANSMISSION

Generated power from the Middle Bhotekoshi Hydroelectric Project will be evacuated through newly constructing 4 km long 220 kV transmission line to connect from powerhouse site to the proposed Barhabise Hub in 220 kV Upper Tamakoshi – Barhabise – Kathmandu transmission line.

POWER AND ENERGY OUTPUTS

With the design discharge of 50.8 m³/sec and available gross head of 235 m, the installed capacity of the project is 102 MW. Total annual energy generation will be 565 GWh. The overall outage of 4% is considered to compute the salable energy. The total annual salable energy will be 542 GWh. The plant factor is found to be 65%. Monthly energy generation is tabulated below:

Month	Jul-Aug Srawan	Aug-Sept Bhadra	Sept-Oct Ashoj	Oct-Nov Kartik	Nov-Dec Mangsir	Dec-Jan Poush	Jan -Feb Magh	Feb -Mar Falgun	Mar-Apr Chaitra	Apr -May Baishakh	May- Jun Jestha	Jun - Jul Ashad
Energy, GWh	73.9	73.9	73.9	50.7	30.6	24.3	19.9	20.6	22.3	35.2	62.9	76.3

CONSTRUCTION SCHEDULE

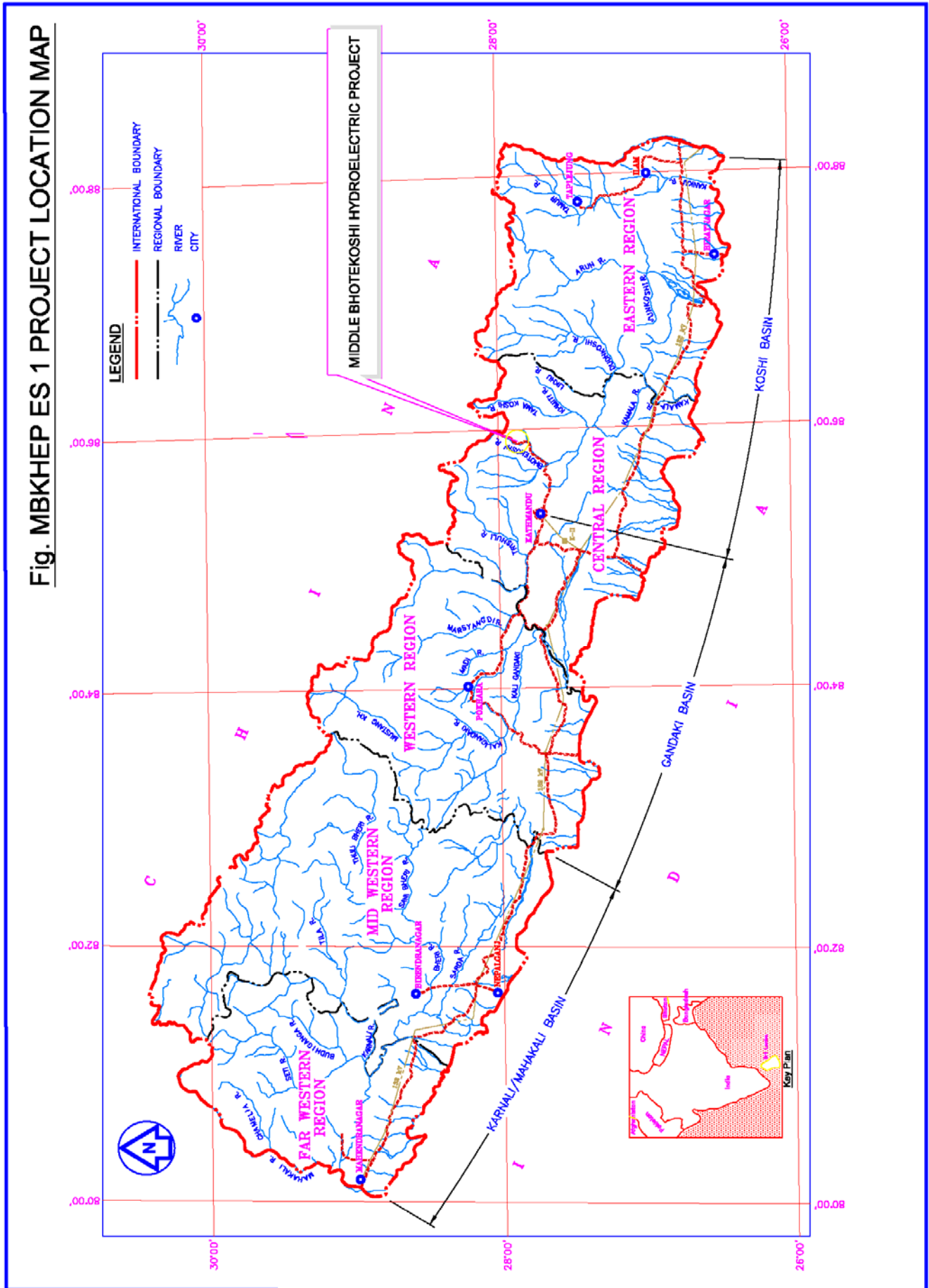
It is planned to start the project from 2013 and targetted to complete by the end of 2016. All preparatory works including tender document preparation, land acquisition, construction of camp facilities and infrastructure development will be executed in the first year. The main construction work of the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

MIDDLE BHOTEKOSHI HYDROELECTRIC PROJECT (102 MW)

SALIENT FEATURES

S. No.	Features	Description
1.	Location	Sindhupalchowk District
2.	Type of Project	Run-of-River (ROR)
3.	Hydrology	
	Catchment area (Dam site)	2284 km ²
	90% dependable flow	17.0 m ³ /sec
	Design flow	50.8 m ³ /sec
	Design flood (100 years)	1330 m ³ /sec
4.	Geology	Biotite schist, quartzite and siliceous dolomite
5.	Head	
	Gross	235 m
	Net	222 m
6.	Headworks	
	Weir Type	Gated Weir Type
	Gate Size & Nos.	10 m (w) x 7.4 m (h) & 3 Nos.
	Undersluice Size	Single Bay 10 m (w) & x 9.4 m (h)
	Foundation Material	Bed rock
	Maximum Discharge	1330 m ³ /sec
	Type of Energy Dissipation	Downstream Stilling Pool
7.	Desanding Basin	
	Type	Triple Chamber
	Size	100 m (l) x 13 m (w) x 8.5 m (h)
8.	Pressure Conduit	
	RCC Conduit Size	281 m (l) x 5 m (w) x 5 m (h)
	Steel Pipe	95 m (l) x ϕ 4 m
9.	Headrace Tunnel	
	Length	7124 m
	Size	5.7 m (w) x 5.7 m (h)
10.	Surge Tank	
	Type	Semi-underground, Restricted Orifice
	Size	15 m (dia.) x 59 m (h)
11.	Penstock	
	Type	Underground, 1 No.
	Size	667 m (l), 3.6 m (dia.)
12.	Powerhouse	
	Type	Surface
	Size	52 m (l) x 15.0 m (b), 25.5 m (h)
13.	Tailrace	50 m (l) x 6 m (b) x 6 m (h)
14.	Turbine	
	Type, Orientation & Number	Francis, Vertical Axis & 3 Nos.
	Unit Capacity	36 MW
15.	Generator	
	Type & Number	AC 3 Phase Synchronous & 3 Nos.
	Unit Capacity	40 MVA
16.	Installed Capacity	102 MW (3 x 34 MW)
17.	Annual Salable Energy	542 GWh
	Dry Energy	84 GWh
	Wet Energy	458 GWh
18.	Transmission Line	
	Length/ voltage	4 km/220 kV

Fig. MBKHEP ES 1 PROJECT LOCATION MAP



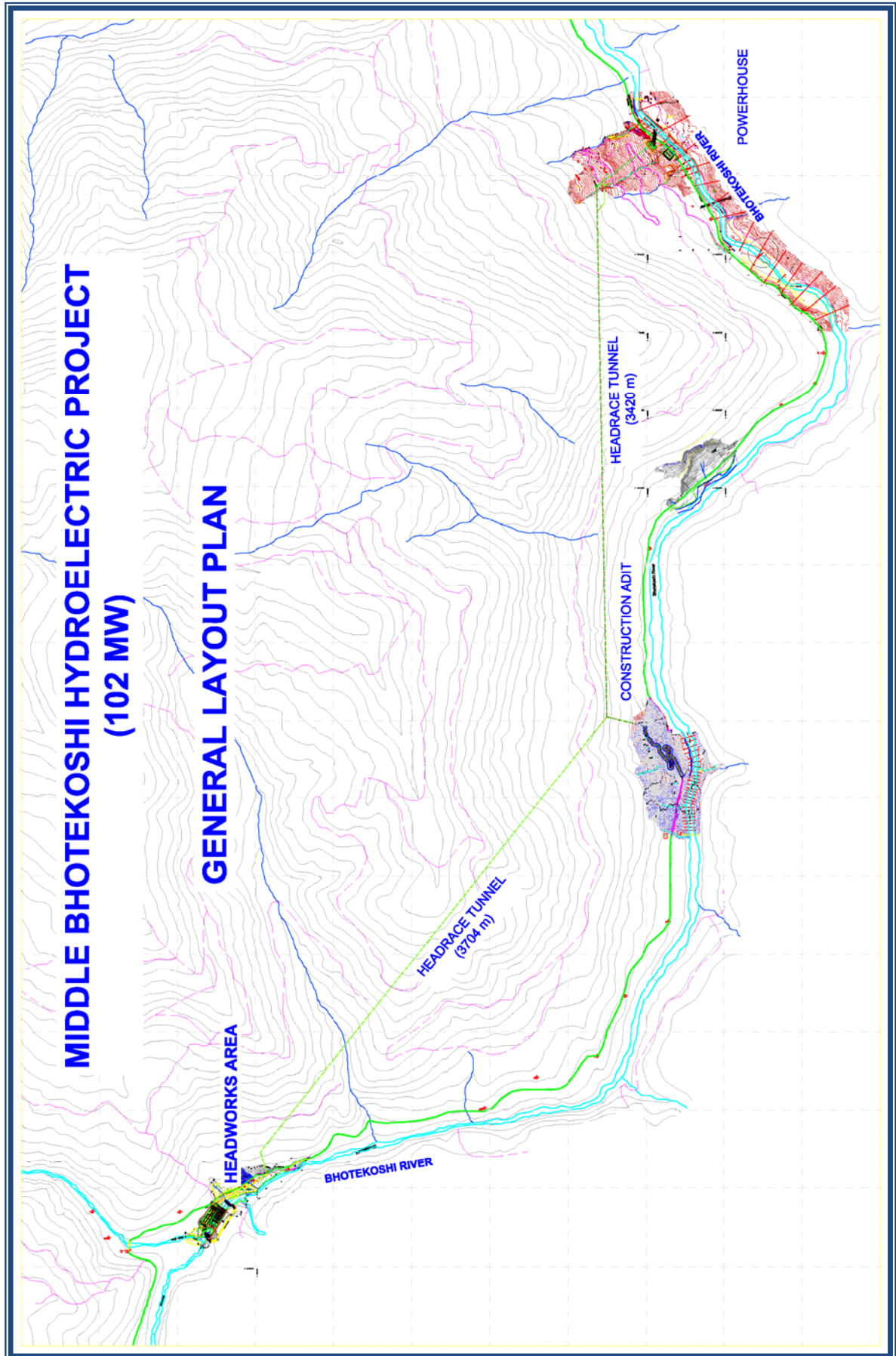


Fig. MBKHEP ES 2 General Layout Plan.