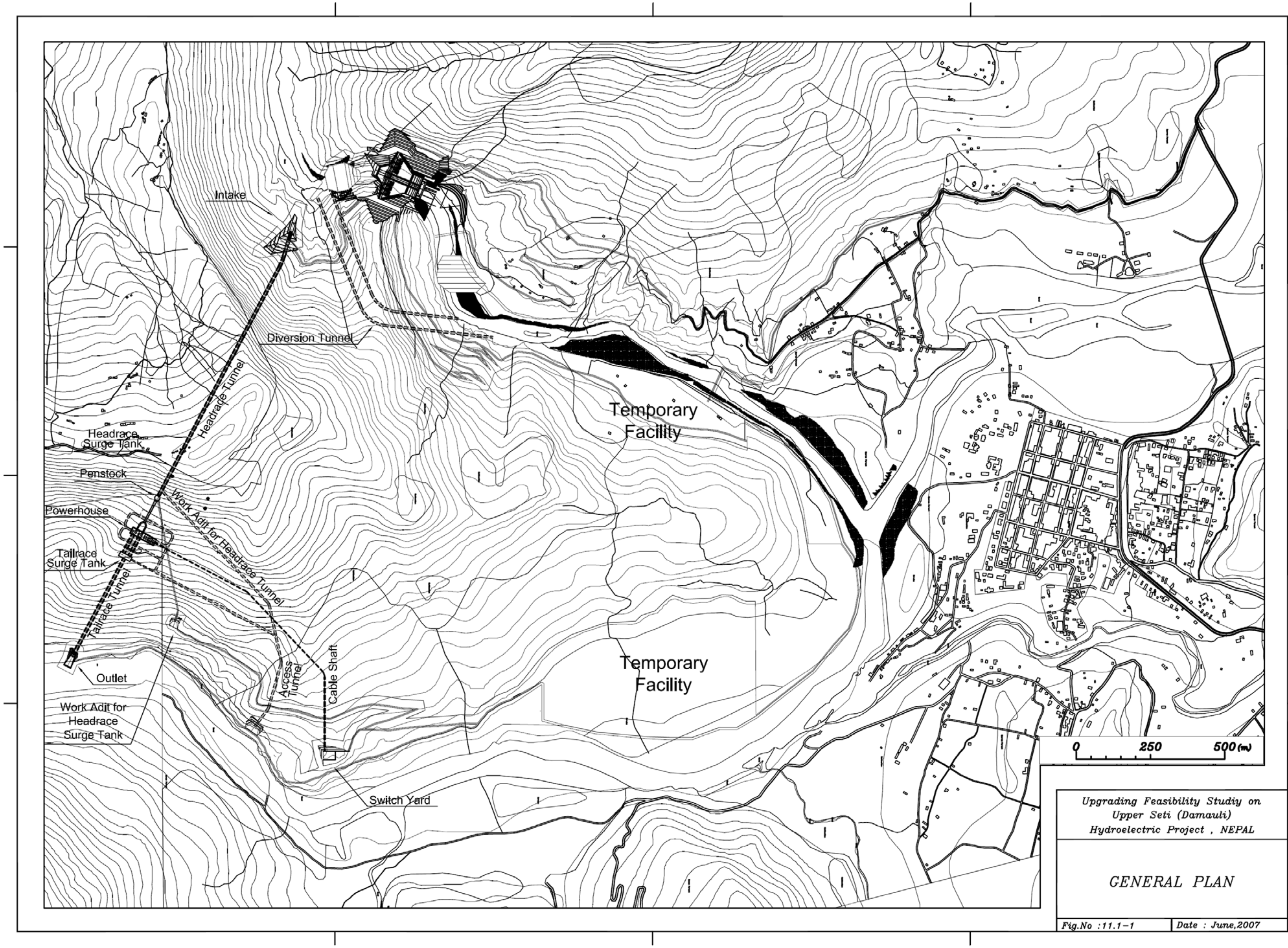
11 PROJECT DESIGN

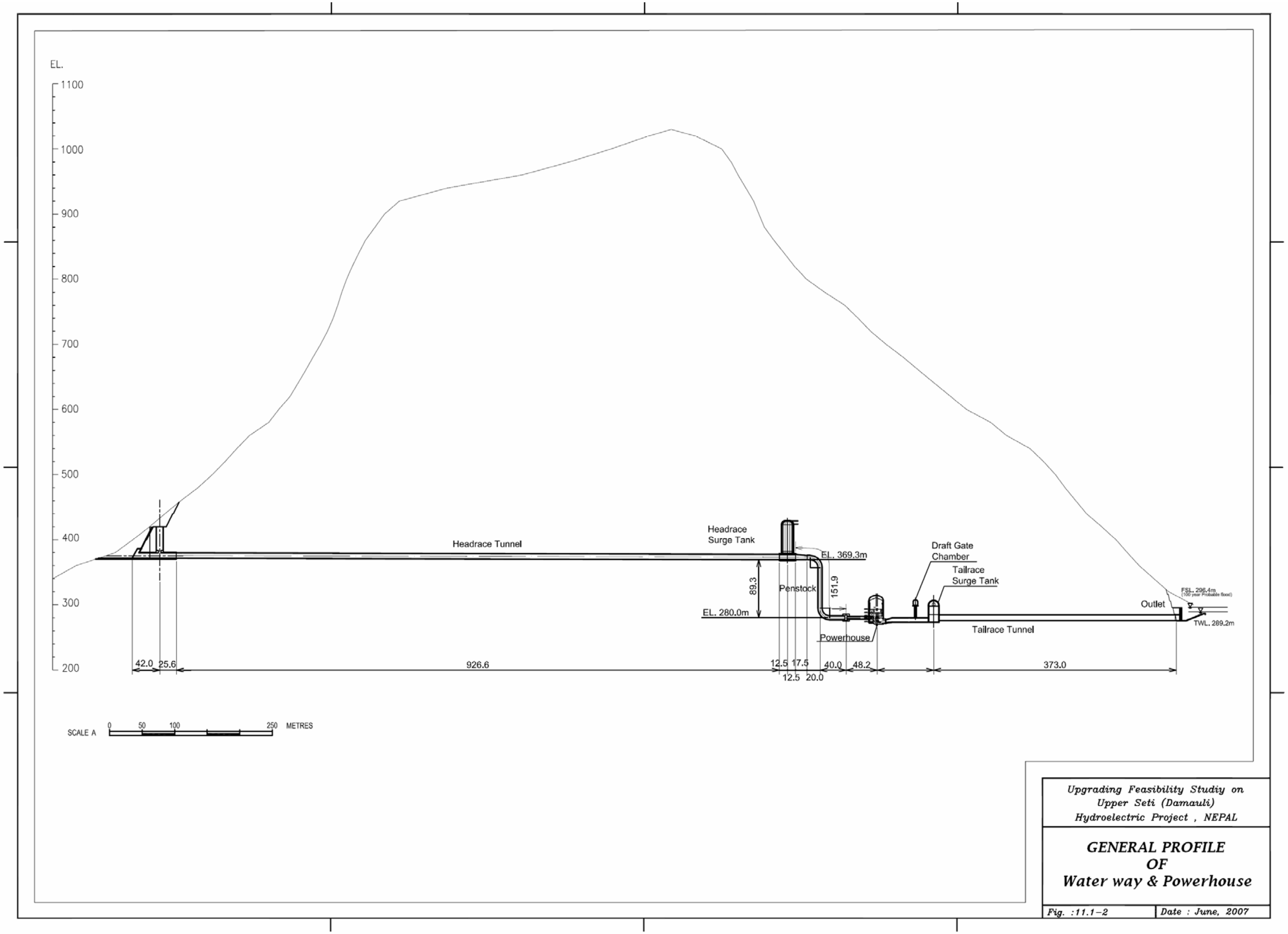
11.1 General

This Chapter describes designs, at feasibility study level, of civil structures and electromechanical equipment for the optimum development scheme selected in Section **10.5** of Chapter 10.

The selected development scheme is a dam-waterway generation scheme which has an underground powerhouse in dam right abutment by utilizing topographic condition of meandering of Seti River and operated for peak time with regulation of stored water on the seasonal basis. The electromechanical equipment consists of the main equipment for peak generation and auxiliary equipment using environmental flow. Generated power is to be evacuated with a new transmission line to the Bharatpur switchyard which will be connected to NEA network.

The Project general plan drawing and water-way section drawing are shown in **Fig 11.1-1** and **2.**


Intake
Diversion Tunnel
Headrace Tunnel
Headrace Surge Tank
Penstock
Powerhouse
Work Adit for Headrace Tunnel
Tailrace Surge Tank
Tailrace Tunnel
Outlet
Work Adit for Headrace Surge Tank
Access Tunnel
Cable Shaft
Switch Yard
Temporary Facility
Temporary Facility
0 250 500(m)
Upgrading Feasibility Studiy on Upper Seti (Damauli) Hydroelectric Project , NEPAL
GENERAL PLAN
Fig.No :11.1-1
Date : June,2007


EL.
1100
1000
900
800
700
600
500
400
300
200
Headrace Tunnel
Headrace
Surge Tank
EL. 369.3m
89.3
Penstock
151.9
EL. 280.0m
Powerhouse
Draft Gate
Chamber
Tailrace
Surge Tank
Tailrace Tunnel
Outlet
FSL. 296.4m
(100 year Probable flood)
TWL. 289.2m
42.0
25.6
926.6
12.5
17.5
12.5
20.0
40.0
48.2
373.0
SCALE A
0
50
100
250
METRES
Upgrading Feasibility Studiy on
Upper Seti (Damauli)
Hydroelectric Project , NEPAL
GENERAL PROFILE
OF
Water way & Powerhouse
Fig. :11.1-2
Date : June, 2007

11.2 Dam and Auxiliary Structures

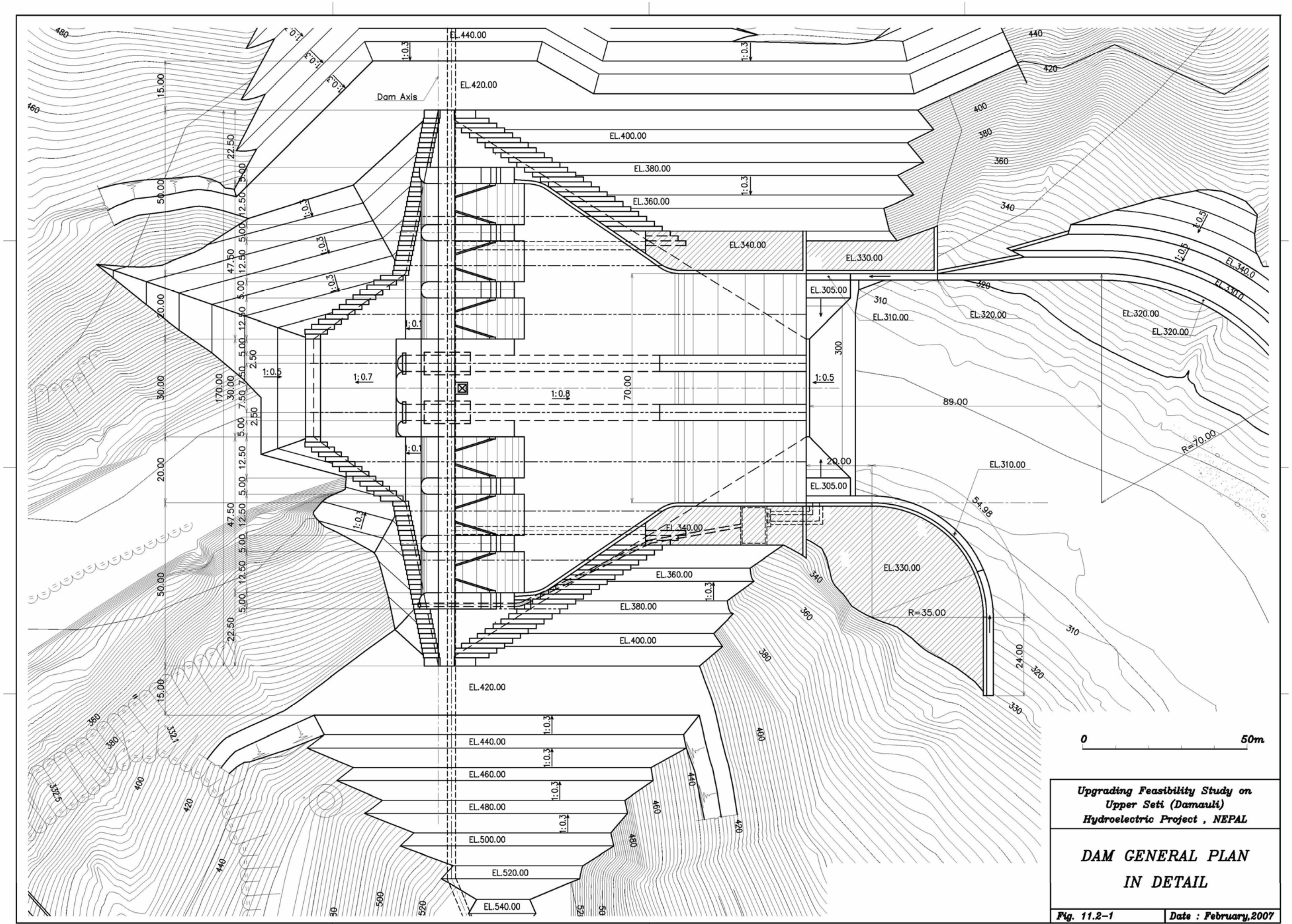
Dam general plan and its sections are shown between **Fig 11.2.1-1** and **2**.

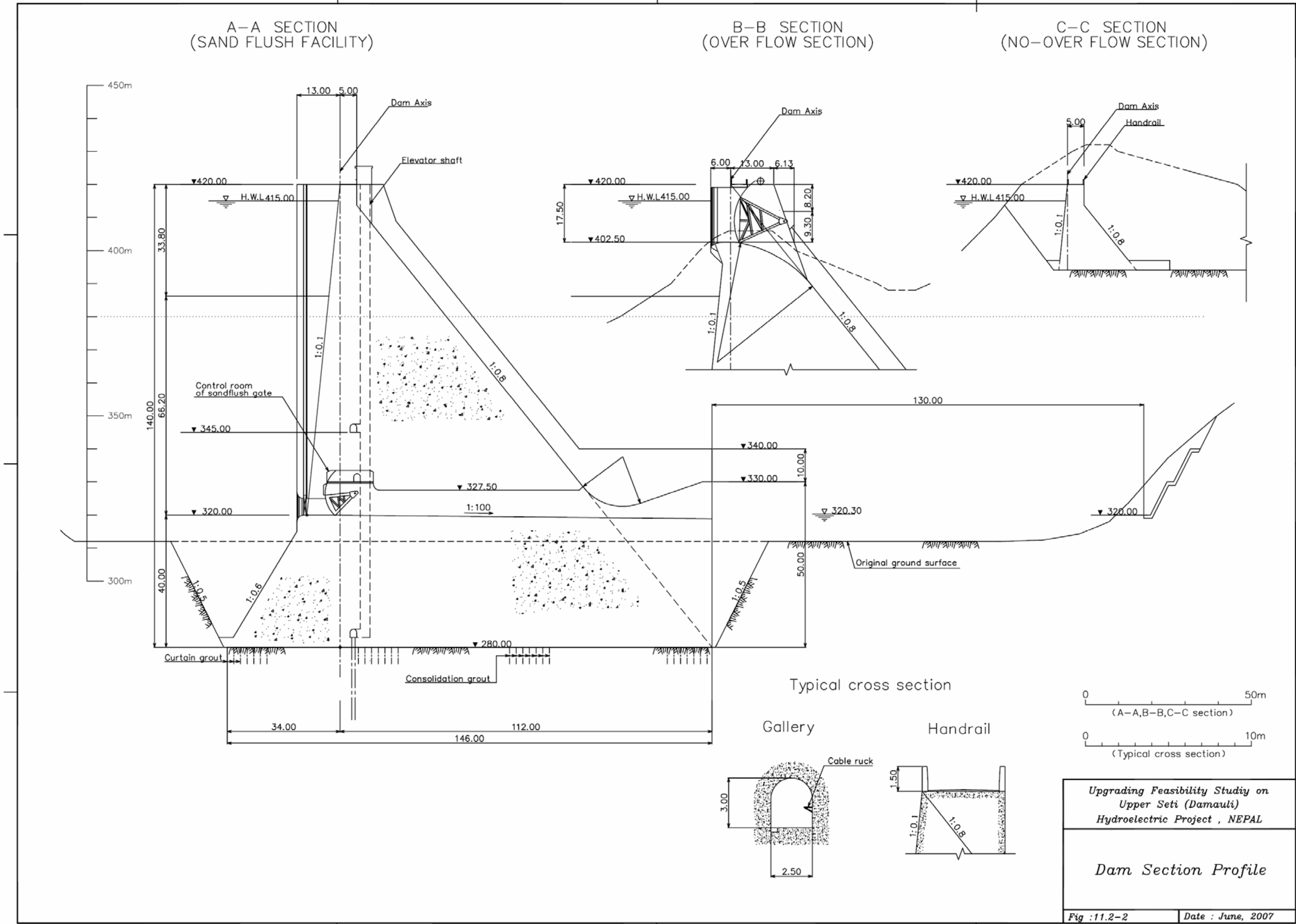
The dam axis was the same one as NEA selected in their feasibility study. To study the basic dam shape, a stability analysis of the dam was carried out. The dam slope gradient upstream is 1:0.1 with fillet and the downstream slope gradient is 1:0.8. The elevation at the dam crest is EL.420.0 m, determined by adding, to the full supply level, the hydraulic freeboard such as the wave height at the time of wind and earthquakes. The maximum dam height is 140 m, as measured from the bedrock to the dam crest, and the dam concrete volume is approximately 890,000 m^3. The excavated rocks in the dam area will be used for required concrete aggregates for the dam and other structures. This utilization will not disturb the environment of the rivers and minimize the volume of the spoil banks.

Due to the permeability of the dam foundation and ground water level observed, foundation treatment is to inject vertical curtain grouting along dam axis in the tunnels for grouting to be excavated at EL. 283 m, EL. 345 m, and EL. 420 m on both abutments.

The type of the spillway is of the center overflow type with the gates against the design flood of 7, 377 m^3/s. Six radial gates will be installed on the spillway arrest. The ski-jump type dissipater is adopted.

Due to the concrete dam, flood during construction should be treated not only by coffer dam and diversion tunnel system but also by outlet installed in dam body. Based on general idea, 994.6 m^3/sec of 2-year return period flood discharge is applied to design flood discharge for care of river.


Upgrading Feasibility Study on Upper Seti (Damauli) Hydroelectric Project , NEPAL
DAM GENERAL PLAN IN DETAIL
Fig. 11.2-1
Date : February,2007
0
50m
Dam Axis
EL.440.00
EL.420.00
EL.400.00
EL.380.00
EL.360.00
EL.340.00
EL.330.00
EL.305.00
EL.310.00
EL.320.00
EL.460.00
EL.480.00
EL.500.00
EL.520.00
EL.540.00
89.00
70.00
170.00
R=70.00
R=35.00
54.98
24.00
20.00


A–A SECTION
(SAND FLUSH FACILITY)
B–B SECTION
(OVER FLOW SECTION)
C–C SECTION
(NO–OVER FLOW SECTION)
Dam Axis
Elevator shaft
Handrail
H.W.L415.00
Control room of sandflush gate
Curtain grout
Consolidation grout
Original ground surface
Typical cross section
Gallery
Cable ruck
Handrail
(A–A,B–B,C–C section)
(Typical cross section)
Upgrading Feasibility Studiy on Upper Seti (Damauli) Hydroelectric Project , NEPAL
Dam Section Profile
Fig :11.2–2
Date : June, 2007

11.3 Waterway and Powerhouse

The design of the waterway and powerhouse at the feasibility study level is described below (see **Fig, 11.3-1** to **3**):

(1) Intake

Intake is to be constructed 400 m upstream of the dam. MOL is set 1 m above the sediment level, in order to lower FSL as much as possible in consideration of effective use of reservoir water. It is necessary to determine the elevation of Intake sill, in order that air will not enter inside the headrace tunnel because the headrace tunnel is of a pressure type. Intake type is considered to take surface water in the case of water level near MOL. The water depth from MOL to the intake sill of such existing intake facilities in Japan is Hi;

Hi = 2 × D + 1 to 2 m in margine

Where, D; Diameter of headrace tunnel (m)

Because detailed structures of such facilities were generally determined with hydraulic model tests, it is recommended to perform a model test on the intake facilities for the project in the detailed design stage and to determine their details.

(2) Headrace Tunnel

A 927 m long headrace tunnel is designed as a single lane pressure tunnel with circular section. It is planned to be located on the right bank of the Seti River.

The internal diameter of 7.8 m was selected as the optimum diameter of the headrace tunnel.

(3) Penstock

The 195 m long steel penstock is designed as an underground type in a single lane tunnel. A circular section is adopted for the vertical shaft and a circular section with flat bottom for the horizontal tunnel for ease of construction. It is bifurcated at the upstream of the powerhouse to accommodate two steel penstock lines. The diameter of penstock steel pipes in the 1-line section is 5.9 m as the examination result of the optimum diameter.

(4) Headrace Surge Tank

The surge tank was designed applying the restricted orifice type, which is generally the most economical type for the medium scale hydropower. The following are main features of the surge tank designed based on the surging calculation.

Orifice diameter:	3.7 m
Diameter of chamber:	17.0 m

(5) Powerhouse

Underground powerhouse is planned to be located in the sound dolomite layer. The powerhouse cavern is selected as a bullet type from the viewpoint of easiness of the construction. The turbine level is set at EL. 280.0 m to secure enough draft head to avoid cavitation. The size of the cavern is 22 m width, 42 m height and 90 m length for housing 2 units of generating equipment and main transformer.

The analysis of stability during excavation was carried out utilizing the two-dimensional finite element method (FEM).

(6) Tailrace Surge Tank

Water used for generating is released to the Seti River through the pressure type tailrace tunnel. The tailrace surge tank has to be provided at the conjunction of the tailrace tunnel and draft tunnel to prevent from producing the negative pressure at the load rejection. The section of the tailrace surge tank is bullet shape, being 15 m in width, 32.5 m in height and 40 m in length

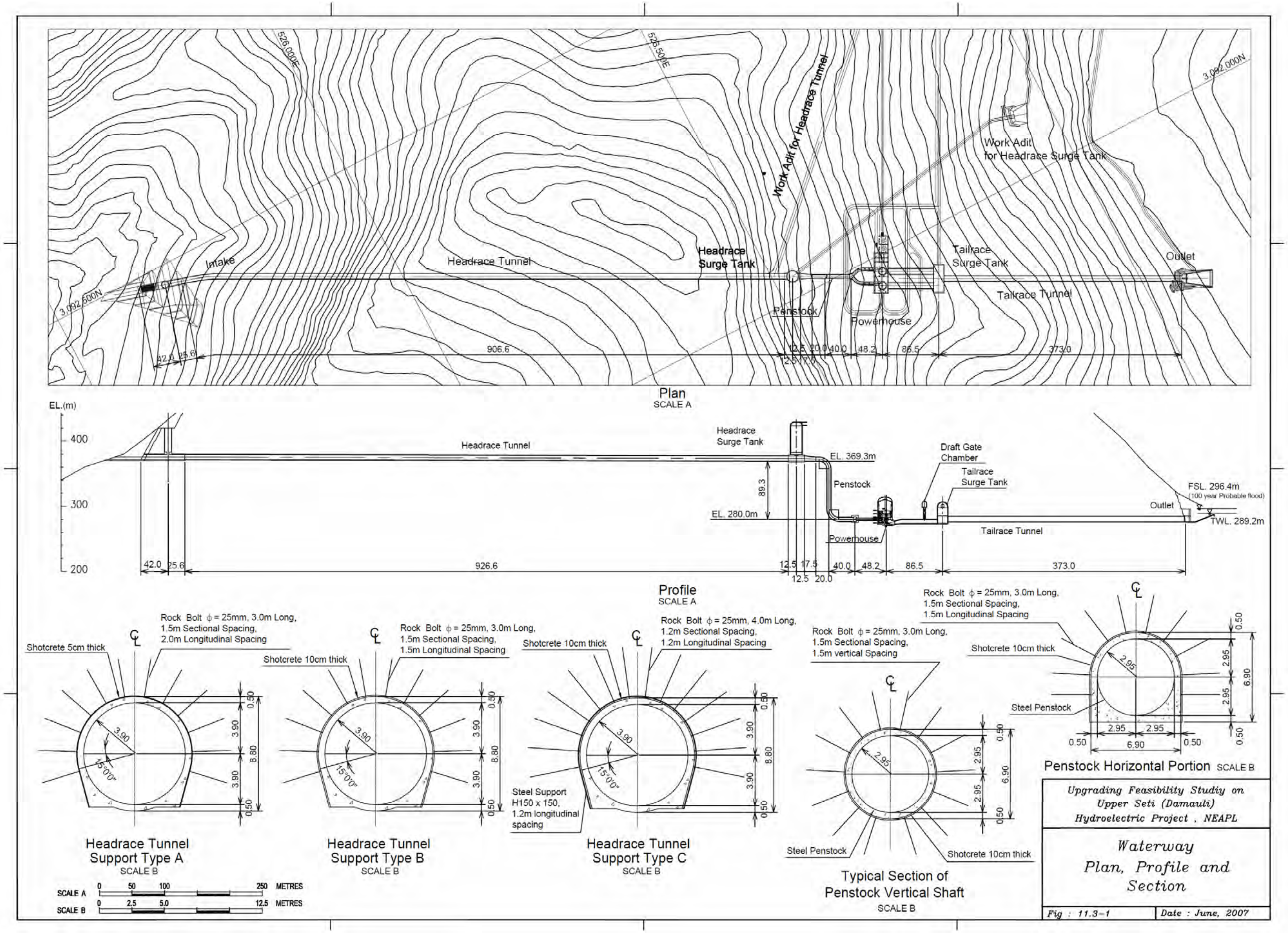
(7) Tailrace Tunnel

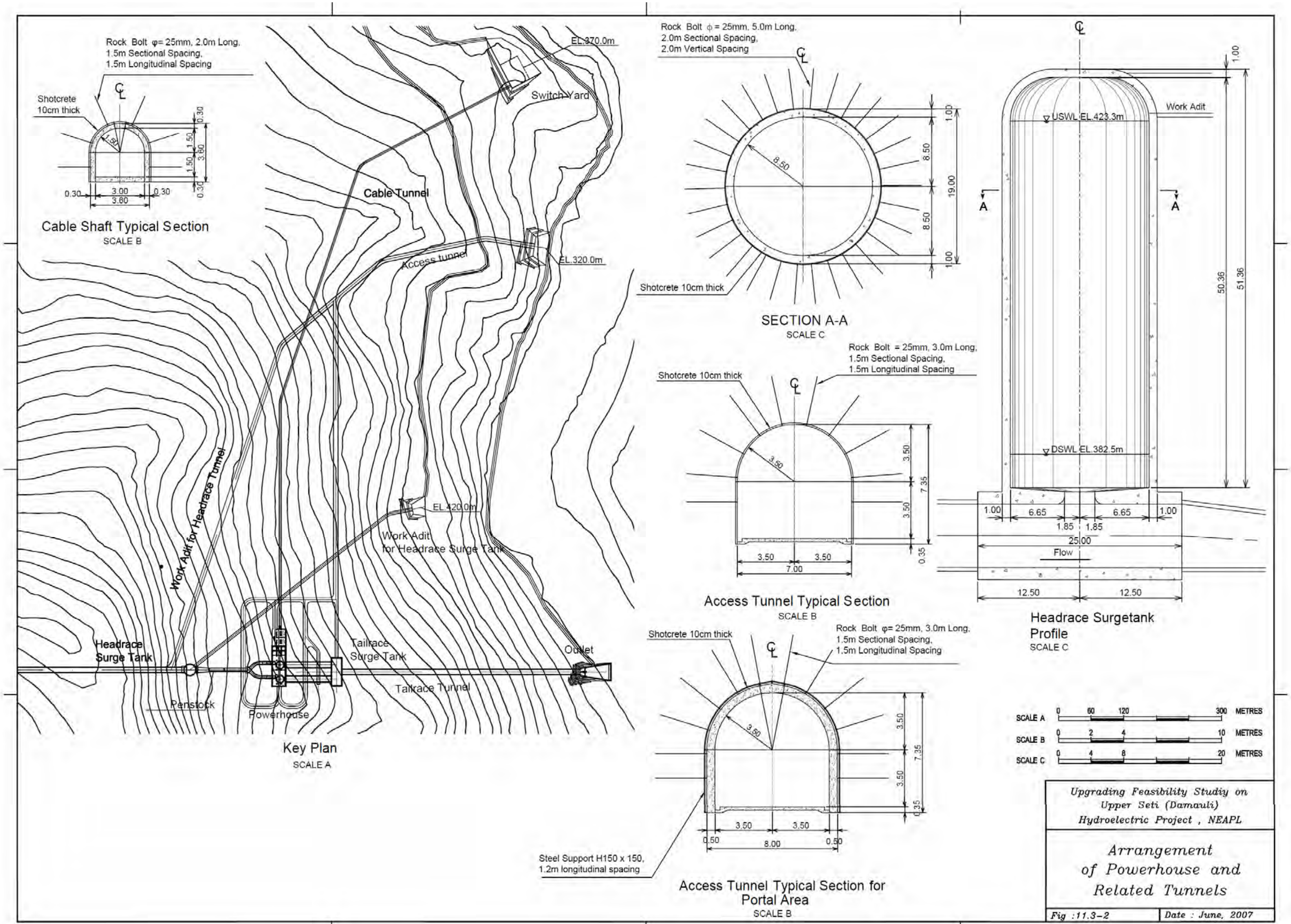
The tailrace tunnel leads the water from the tailrace surge tank to the tailrace outlet. Total length is 365 m and the tunnel section is circular shape with a concrete lining. The internal diameter of 8.2 m was selected as the optimum diameter of the headrace tunnel.

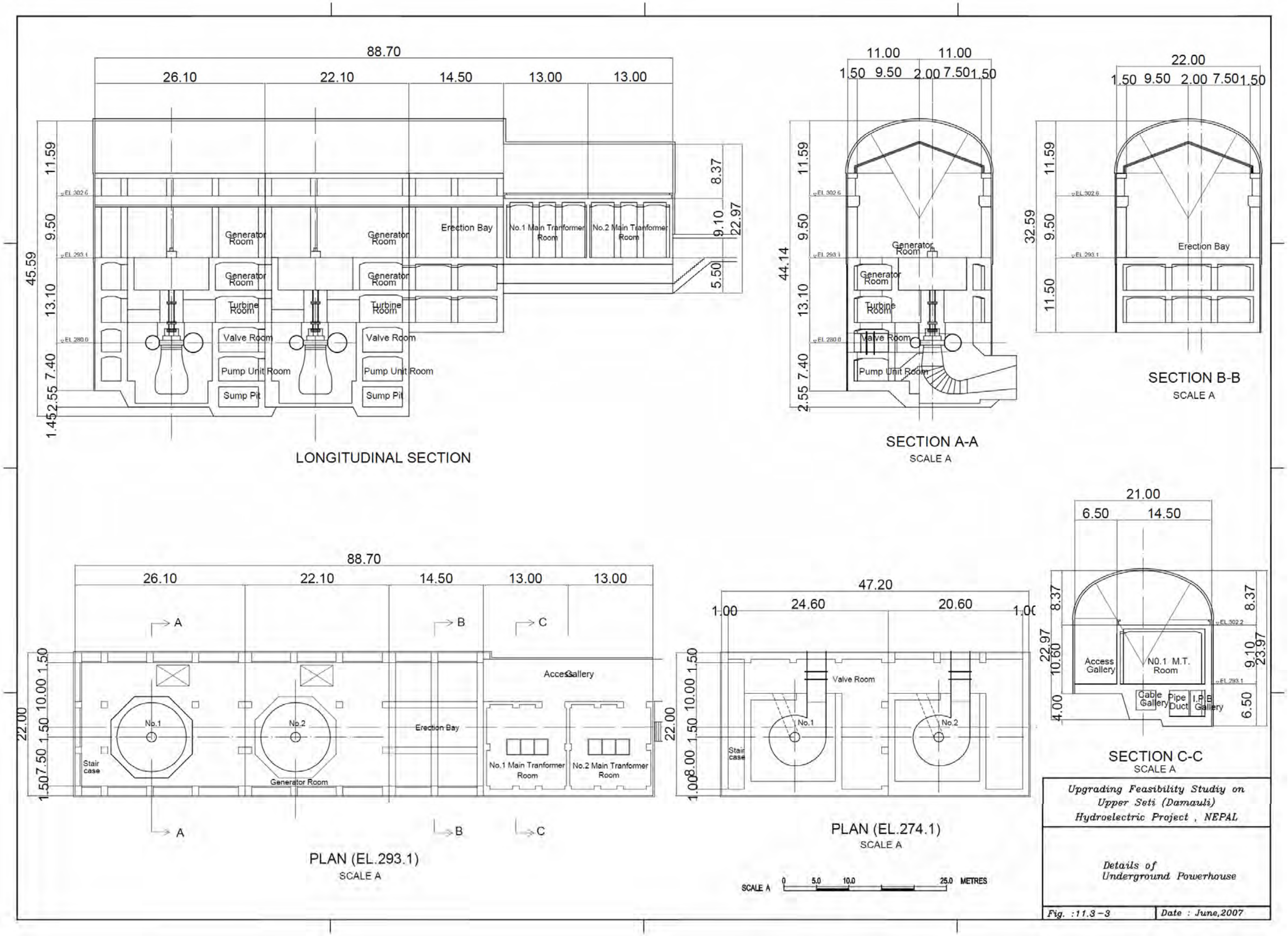
(8) Tailrace Outlet

The tailrace outlet is located at 3 km downstream from the confluence of the Seti River and the Madi River. Tail water level is set at EL.289.2 m from the condition of the Electro-mechanical Equipments. The width of outlet is set at 25 m to secure the required tailwater level. The alignment of the outlet channel is arranged in parallel with the Seti River flow to prevent the debris from entering into the tailrace outlet.

Feasibility design for waterway and powerhouse is as shown in following figures.


Work Adit for Headrace Tunnel
Work Adit for Headrace Surge Tank
Intake
Headrace Tunnel
Headrace Surge Tank
Tailrace Surge Tank
Outlet
Tailrace Tunnel
Penstock
Powerhouse
Plan
SCALE A
Profile
SCALE A
EL. 369.3m
EL. 280.0m
Draft Gate Chamber
FSL. 296.4m
TWL. 289.2m
Headrace Tunnel Support Type A
Headrace Tunnel Support Type B
Headrace Tunnel Support Type C
Typical Section of Penstock Vertical Shaft
Penstock Horizontal Portion
Shotcrete 5cm thick
Shotcrete 10cm thick
Steel Penstock
Steel Support H150 x 150, 1.2m longitudinal spacing
Upgrading Feasibility Studiy on Upper Seti (Damauli) Hydroelectric Project , NEAPL
Waterway Plan, Profile and Section
Fig : 11.3-1
Date : June, 2007


Rock Bolt φ= 25mm, 2.0m Long, 1.5m Sectional Spacing, 1.5m Longitudinal Spacing
Shotcrete 10cm thick
Cable Shaft Typical Section
SCALE B
EL.370.0m
Switch Yard
Cable Tunnel
Access tunnel
EL.320.0m
EL.420.0m
Work Adit for Headrace Surge Tank
Work Adit for Headrace Tunnel
Headrace Surge Tank
Penstock
Powerhouse
Tailrace Surge Tank
Tailrace Tunnel
Outlet
Key Plan
SCALE A
Rock Bolt φ = 25mm, 5.0m Long, 2.0m Sectional Spacing, 2.0m Vertical Spacing
Shotcrete 10cm thick
SECTION A-A
SCALE C
Rock Bolt = 25mm, 3.0m Long, 1.5m Sectional Spacing, 1.5m Longitudinal Spacing
Shotcrete 10cm thick
Access Tunnel Typical Section
SCALE B
Rock Bolt φ= 25mm, 3.0m Long, 1.5m Sectional Spacing, 1.5m Longitudinal Spacing
Shotcrete 10cm thick
Steel Support H150 x 150, 1.2m longitudinal spacing
Access Tunnel Typical Section for Portal Area
SCALE B
Work Adit
USWL EL.423.3m
DSWL EL.382.5m
Flow
Headrace Surgetank Profile
SCALE C
SCALE A 0 60 120 300 METRES
SCALE B 0 2 4 10 METRES
SCALE C 0 4 8 20 METRES
Upgrading Feasibility Studiy on Upper Seti (Damauli) Hydroelectric Project , NEAPL
Arrangement of Powerhouse and Related Tunnels
Fig :11.3-2
Date : June, 2007


LONGITUDINAL SECTION
88.70
26.10
22.10
14.50
13.00
13.00
Generator Room
Turbine Room
Valve Room
Pump Unit Room
Sump Pit
Erection Bay
No.1 Main Tranformer Room
No.2 Main Tranformer Room
SECTION A-A
SCALE A
SECTION B-B
SCALE A
SECTION C-C
SCALE A
Access Gallery
N0.1 M.T. Room
Cable Gallery
Pipe Duct
I.P.B Gallery
PLAN (EL.293.1)
SCALE A
Stair case
No.1
No.2
Generator Room
Access Gallery
PLAN (EL.274.1)
SCALE A
47.20
24.60
20.60
SCALE A
METRES
Upgrading Feasibility Studiy on Upper Seti (Damauli) Hydroelectric Project , NEPAL
Details of Underground Powerhouse
Fig. :11.3-3
Date : June,2007