SAARC ENERGY CENTRE
Energy for Peace & Prosperity

Online training of SAARC Professionals on Small, Mini and Micro Hydro Power Generation
(Sept 13 - 17, 2021)

Technical Consideration in Planning SMMHP

Sept 14, 2021

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Contents

- Planning and Purpose
- Different options
- Selection of sites and layouts

Learning objectives

To provides the need of the planning with different options for optimum layout of SHP Project.

Planning - SHP

For a systematic, time bound, duly shared between Government, Social and Private Sectors, master plan are required.

- It is an inventory of all possible sites.
- Provides priority or ranking for speed development.
- Provides cluster approach.
- Provides financial requirement.
- Provides – grid network strengthening.

Flow chart for project planning

Identification/ allotment of SHP site

Reconnaissance survey
- Assessment of head
- Assessment of discharge
- Assessment of geology
- Environmental aspects

Pre-feasibility study

Not Feasible

Project Dropped

Feasible

Detailed surveys and investigations
- Topographical survey
- Hydrological investigations
- Geological investigations
- Material survey
- Environmental survey
- Load survey
- Socio-economic survey
- Muck disposal survey

Feasibility study/detailed project report

Investment decision for Execution

Master Plan

- Assessment of SHP potential of existing irrigation dams and canals.
- Assessment of potential as run off river schemes
- Assessment of potential sites for rural electrification.
- Compilation of the above mentioned activities with prioritization of identified SHP sites.
- Creating of spatial database using Geographic Information Systems (GIS) for the state incorporating various themes including identified SHP sites.

Sources of Information

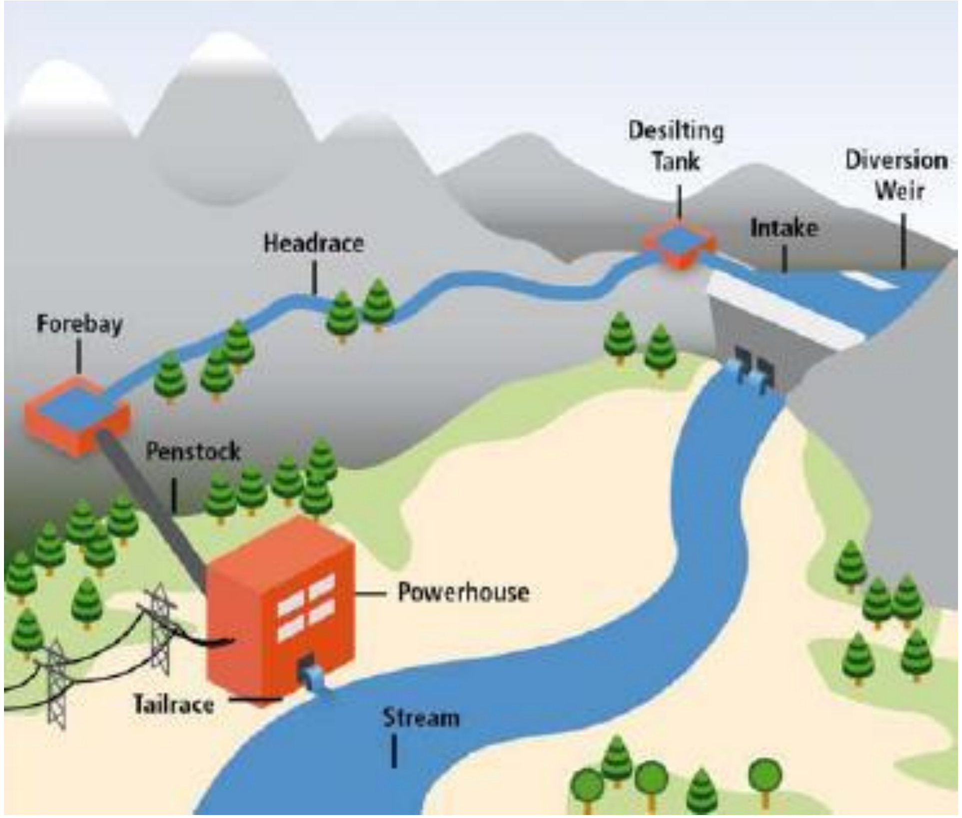
- State Nodal Agencies for renewable energy in states
- State Electricity Boards, Deptt. of Power of states
- Central Government and govt power companies etc
- Individuals having background in such data calculation
- Survey of institutions including Digital Mapping Centre
- Forest Survey institution
- Remote Sensing institution
- NATMO, Calcutta
- Federal govt planning depart and census data

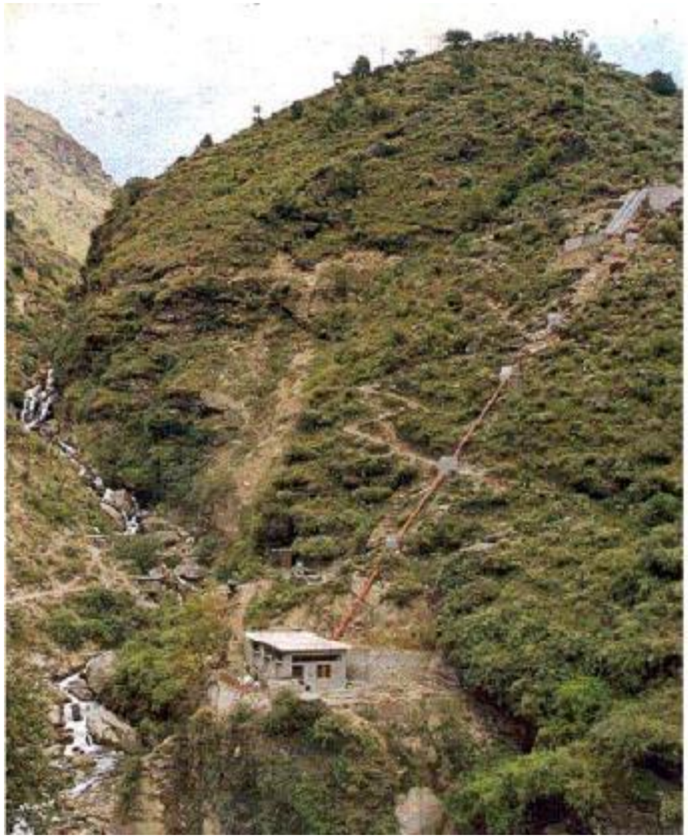
Run-of-River SHP Sites

- Run-of-river (ROR) hydropower implies that there is no (or minimal) storage reservoir.
- The instantaneous flows that are passed through the powerhouse are essentially the flows that occur in the stream at the intake and flows downstream of the powerhouse are virtually identical to pre-development flows.
- Run-of-river facilities use low dams to provide limited storage of water– at most daily pondage.
- In a run-off river SHP scheme, through a diversion structure water is diverted to water conductor system to the powerhouse.

Types of Hydropower

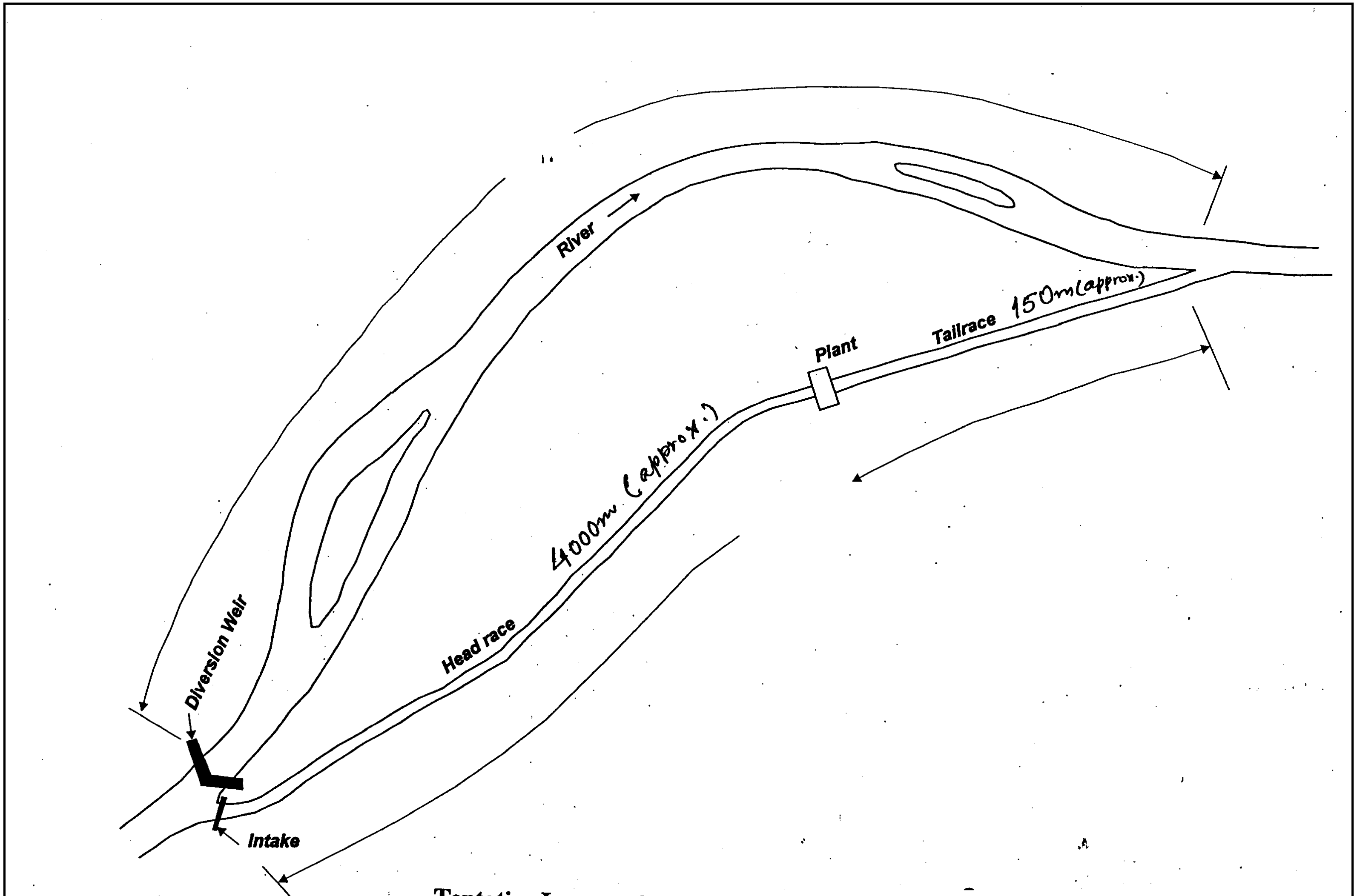
Run of River:





Run of River Hydropower Development

Tentative Layout For RoR Scheme (Rampur SHP)



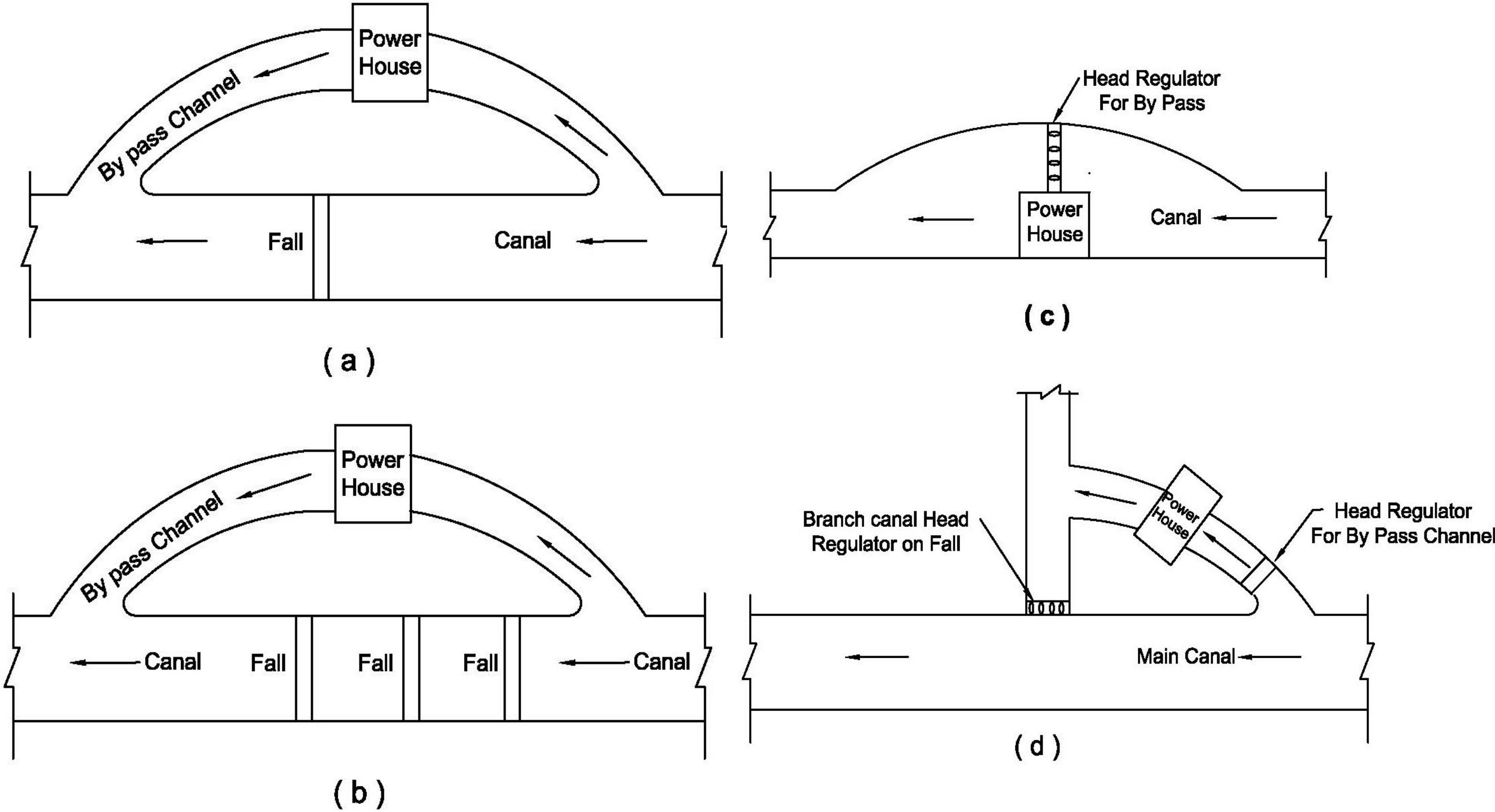
Tentative Layout of Rampur SHP (Right Bank Powerhouse)

Canal Based SHP Sites

- A Canal based scheme utilises the drops on existing/proposed irrigation canals.
- The energy generated by water flowing through the canal fall (located in the canal) is tapped for power generation.
- Powerhouse is located at the main canal or a bye pass canal is constructed where the powerhouse can be located.

Using Existing Facilities

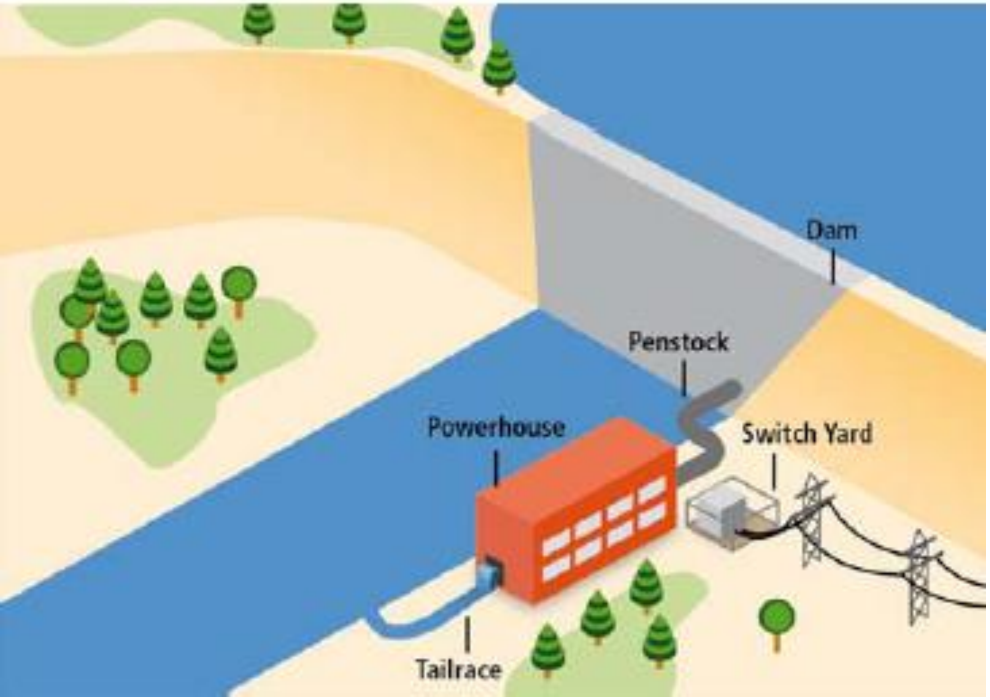
Typical Arrangement of Canal Fall Small Hydropower Development



Typical Alternate Layouts of Canal fall based Power Houses

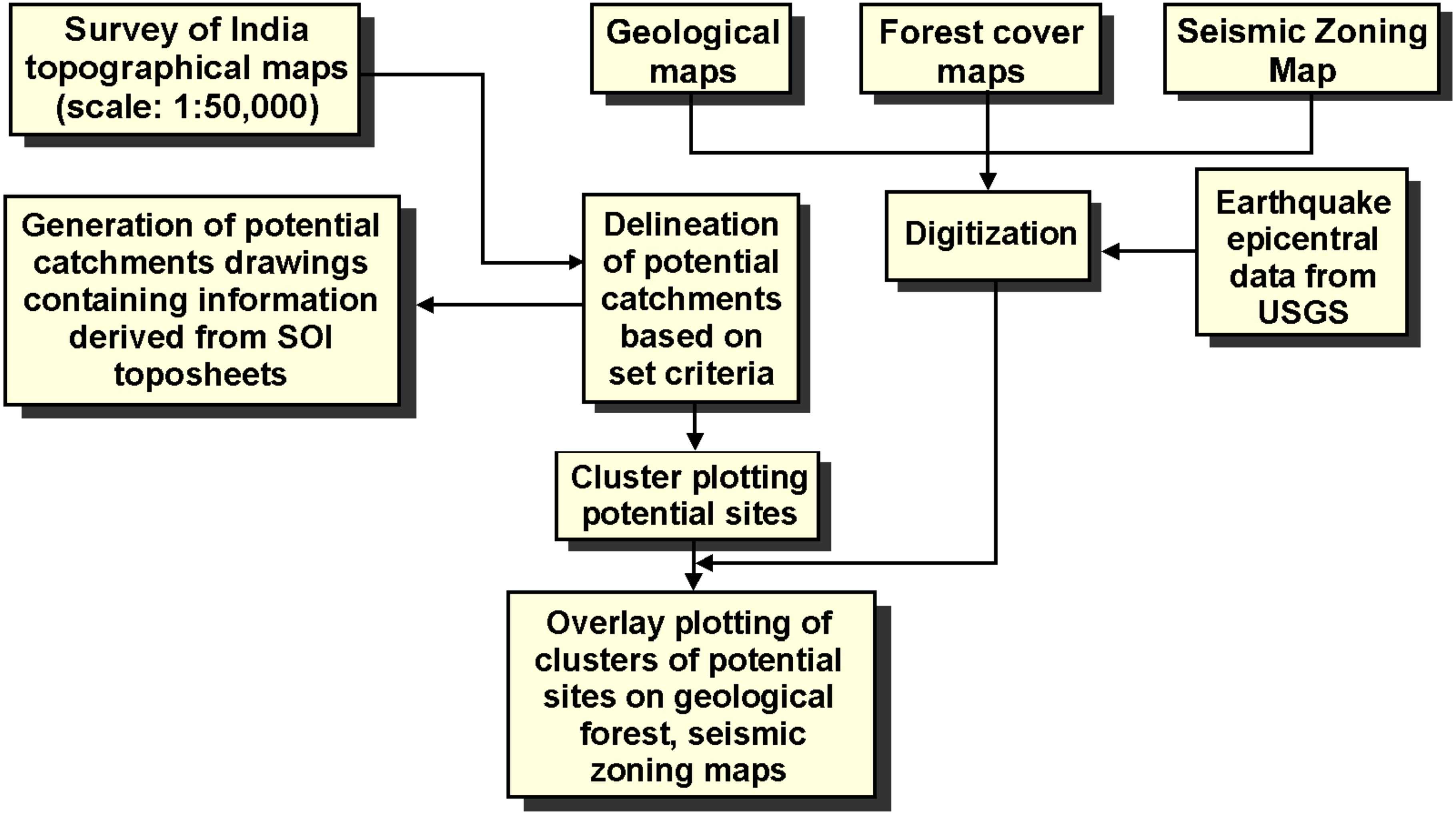
Dam Toe SHP Sites

- The dam provides the means to regulate the flow of water, and can add to the height of the source of water thereby effectively increasing the head (H).
- Reservoir created by the dam may store and regulate stream flows to make them more timely for power production, and to serve other purposes for water resource development.
- Powerhouse is located at the toe of the dam and it utilizes the discharge release through sluice primarily meant for irrigation and the head available (water level difference between upstream and downstream of reservoir) for power generation.

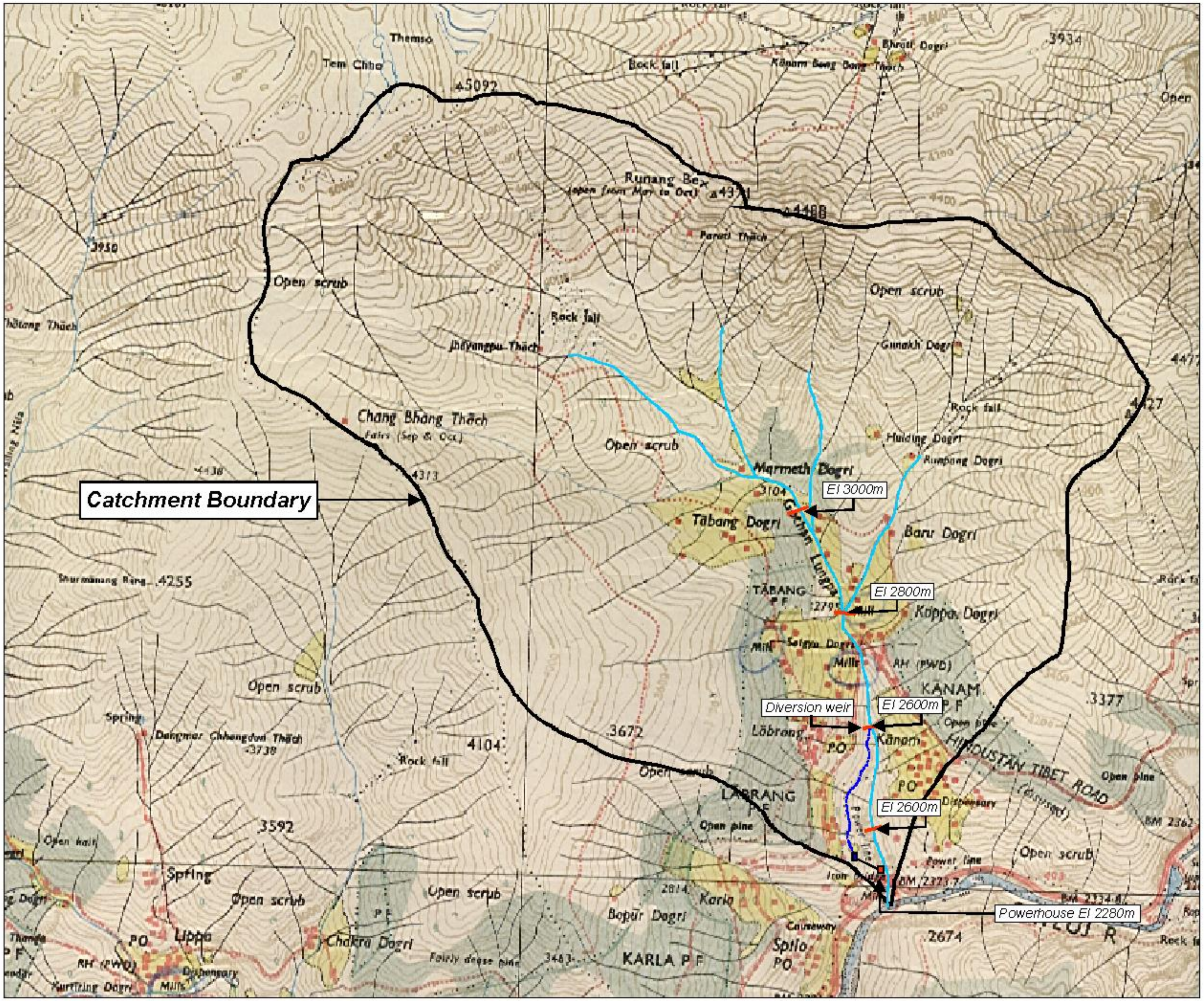


Reservoir Based Hydropower Development

Schematic representation of potential catchment delineation methodology followed in the project.



Shows delineation of potential catchment on Survey of India toposheet (source scale 1:50,000).

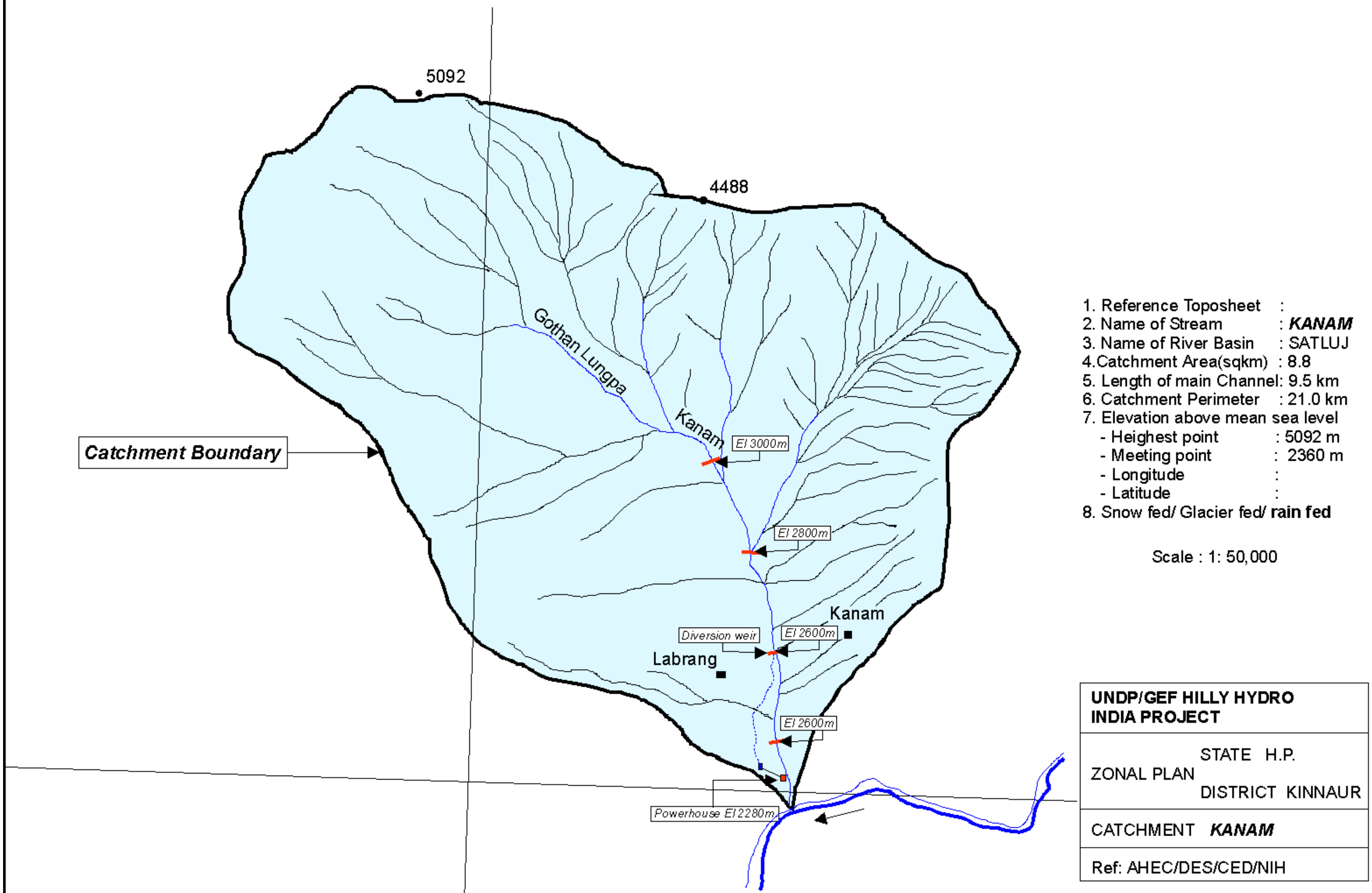


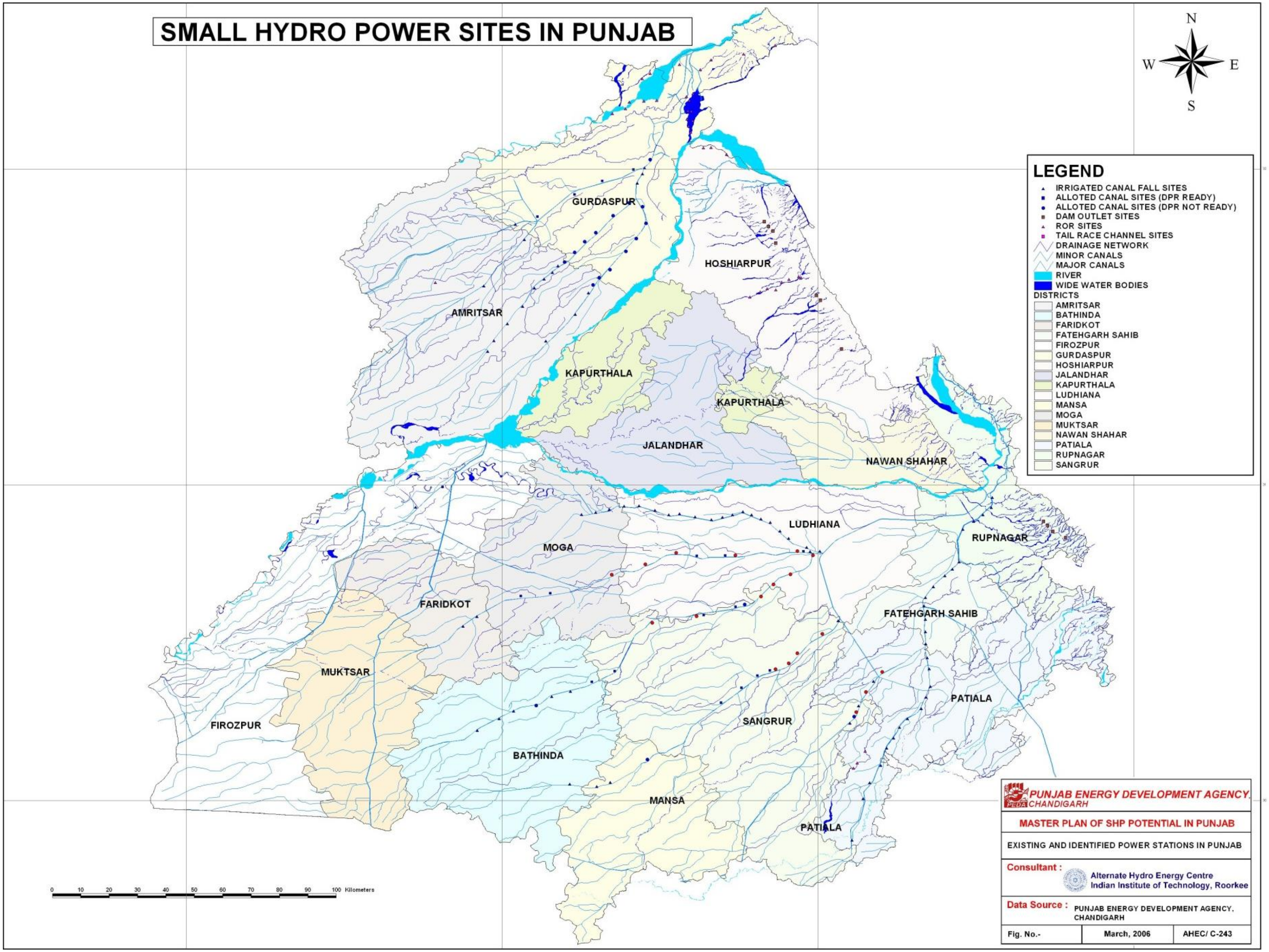
1. Reference Toposheet :
2. Name of Stream : ***KANAM***
3. Name of River Basin : SATLUJ
4. Catchment Area(sqkm) : 8.8
5. Length of main Channel: 9.5 km
6. Catchment Perimeter : 21.0 km
7. Elevation above mean sea level
   - Heighest point : 5092 m
   - Meeting point : 2360 m
   - Longitude :
   - Latitude :
8. Snow fed/ Glacier fed/ **rain fed**

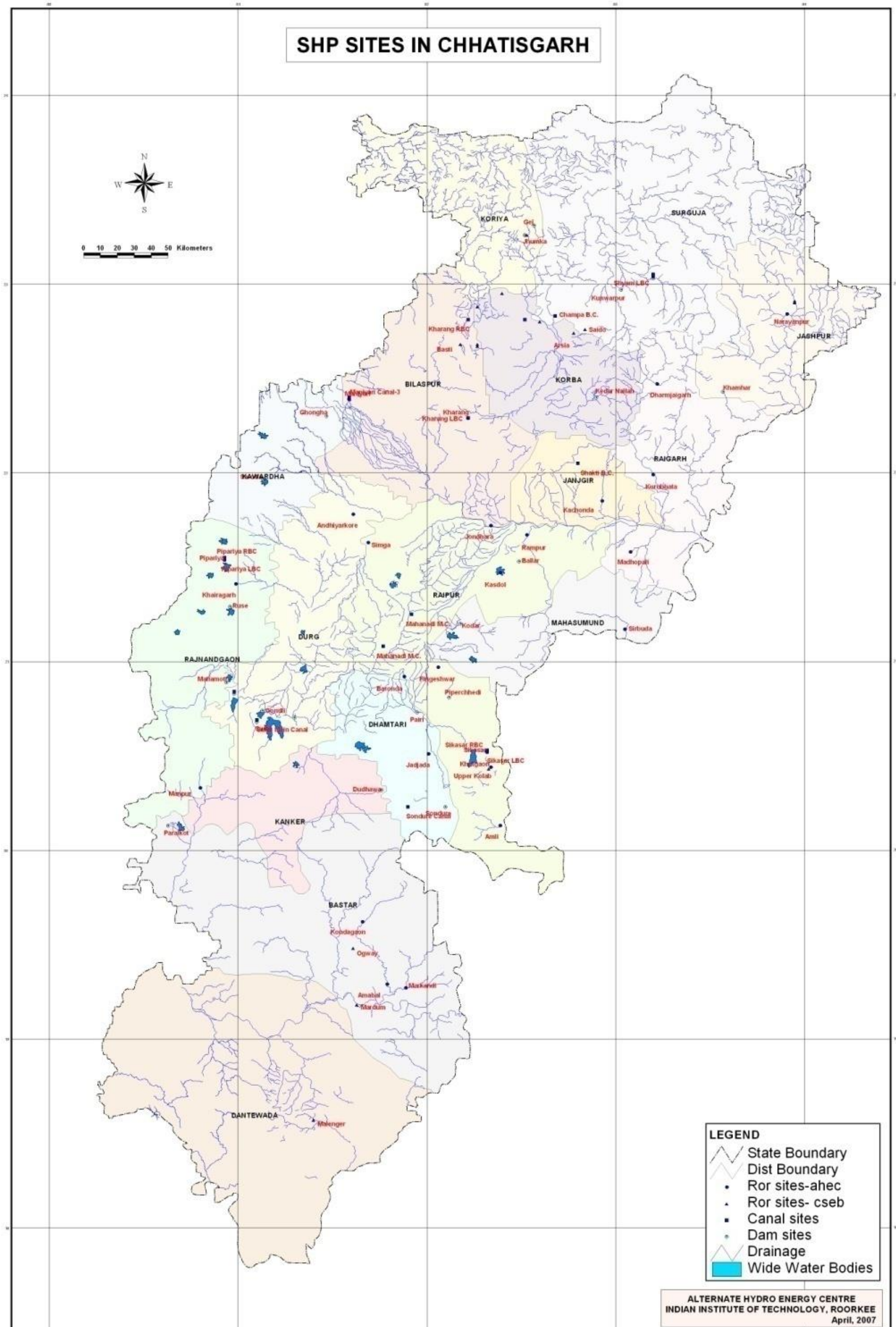
Scale : 1: 50,000

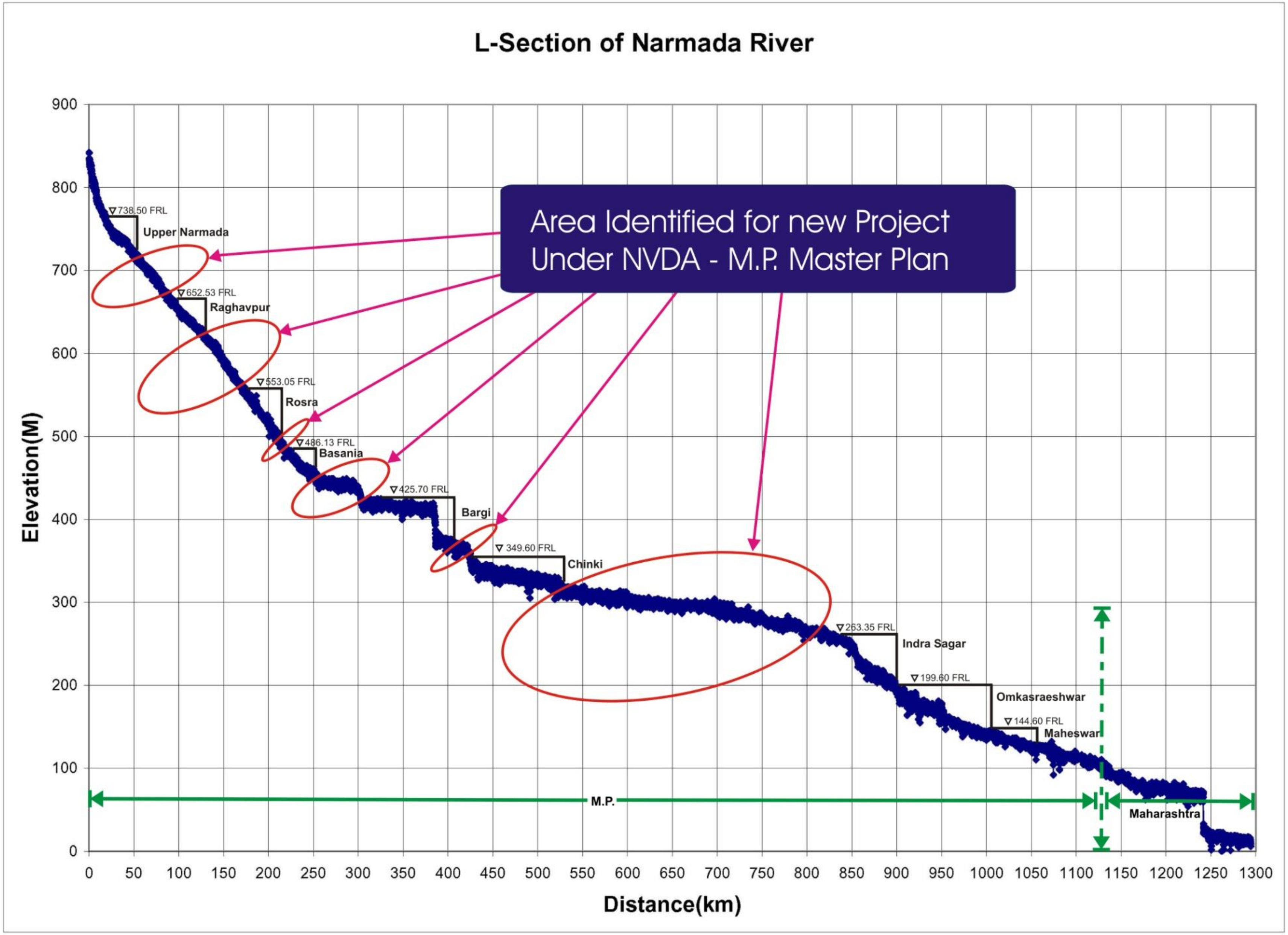
UNDP/GEF HILLY HYDRO INDIA PROJECT	
ZONAL PLAN	STATE H.P. DISTRICT KINNAUR
CATCHMENT ***KANAM***	
Ref: AHEC/DES/CED/NIH	

Illustrates potential delineated catchment and other relevant information derived from Survey of India toposheet.

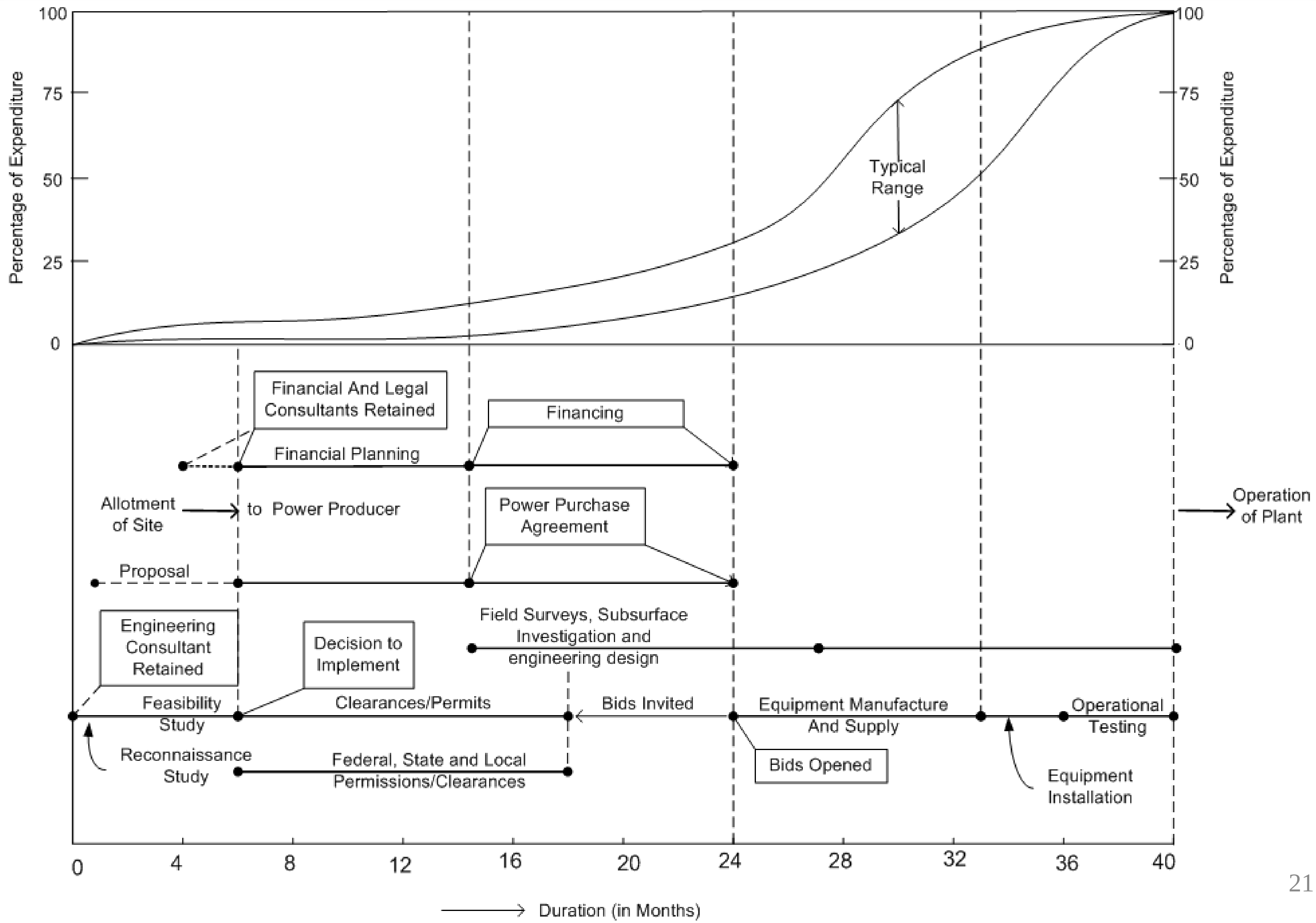



SMALL HYDRO POWER SITES IN PUNJAB
N
W
E
S
LEGEND
IRRIGATED CANAL FALL SITES
ALLOTED CANAL SITES (DPR READY)
ALLOTED CANAL SITES (DPR NOT READY)
DAM OUTLET SITES
ROR SITES
TAIL RACE CHANNEL SITES
DRAINAGE NETWORK
MINOR CANALS
MAJOR CANALS
RIVER
WIDE WATER BODIES
DISTRICTS
AMRITSAR
BATHINDA
FARIDKOT
FATEHGARH SAHIB
FIROZPUR
GURDASPUR
HOSHIARPUR
JALANDHAR
KAPURTHALA
LUDHIANA
MANSA
MOGA
MUKTSAR
NAWAN SHAHAR
PATIALA
RUPNAGAR
SANGRUR
GURDASPUR
HOSHIARPUR
AMRITSAR
KAPURTHALA
KAPURTHALA
JALANDHAR
NAWAN SHAHAR
LUDHIANA
RUPNAGAR
MOGA
FARIDKOT
FATEHGARH SAHIB
MUKTSAR
PATIALA
FIROZPUR
SANGRUR
BATHINDA
MANSA
PATIALA
0 10 20 30 40 50 60 70 80 90 100 Kilometers
PUNJAB ENERGY DEVELOPMENT AGENCY
CHANDIGARH
MASTER PLAN OF SHP POTENTIAL IN PUNJAB
EXISTING AND IDENTIFIED POWER STATIONS IN PUNJAB
Consultant :
Alternate Hydro Energy Centre
Indian Institute of Technology, Roorkee
Data Source :
PUNJAB ENERGY DEVELOPMENT AGENCY, CHANDIGARH
Fig. No.-
March, 2006
AHEC/ C-243


SHP SITES IN CHHATISGARH
N
W
E
S
0 10 20 30 40 50 Kilometers
KORIYA
SURGUJA
JASHPUR
BILASPUR
KORBA
RAIGARH
JANJGIR
KAWARDHA
RAIPUR
MAHASUMUND
DURG
RAJNANDGAON
DHAMTARI
KANKER
BASTAR
DANTEWADA
LEGEND
State Boundary
Dist Boundary
Ror sites-ahec
Ror sites- cseb
Canal sites
Dam sites
Drainage
Wide Water Bodies
ALTERNATE HYDRO ENERGY CENTRE
INDIAN INSTITUTE OF TECHNOLOGY, ROORKEE
April, 2007


L-Section of Narmada River
Area Identified for new Project Under NVDA - M.P. Master Plan
738.50 FRL
Upper Narmada
652.53 FRL
Raghavpur
553.05 FRL
Rosra
486.13 FRL
Basania
425.70 FRL
Bargi
349.60 FRL
Chinki
263.35 FRL
Indra Sagar
199.60 FRL
Omkasraeshwar
144.60 FRL
Maheswar
M.P.
Maharashtra
Elevation(M)
Distance(km)

Typical Project Implementation Schedule and Expenditure pattern



Feasibility/Detailed Project Report- Investigations

- Hydrological survey
- Topographical survey
- Geological survey
- Power load demand assessment
- Socio- economic survey
- Meteorological survey
- Environmental survey
- Survey for construction material
- Power Evacuation Line Survey
- Muck Disposal area Survey

Development

Reports

- Reconnaissance level/ Pre feasibility
- Detailed surveys and investigations
- Feasibility/Detailed project Report
- Engineering and construction
- As built report

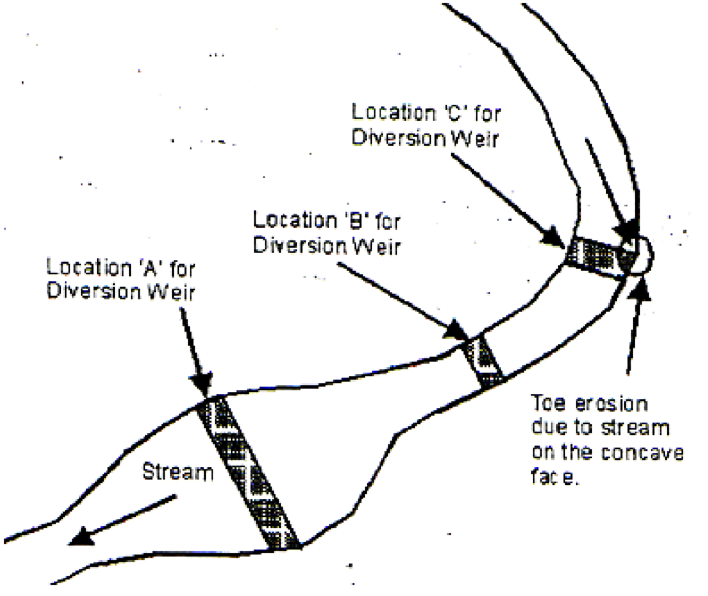
Risks - SHP Development

Risk	Reasons
Hydrological Risk	• No Long time series data
Geological Risk	• Lesser Detailed investigations
Constructions Risk	• Lesser availability of Insurance • Non availability of Liquidated damages on non-performance • Being expensive engineering design people hire cheaper and inexperience manpower • Inadequate construction experience with the local contractors
Performance Risk	• Lesser availability of Insurance
Power evacuation risk	• Being on the low voltage line (33/11 kV) as distribution feeders, high disruptions in the grid resulting in losses
Financial Risk	• Non availability of Long term financing • Lesser understanding by FIs
Delayed disbursement, Delayed receipts from sale	

SITE SELECTION

Diversion Weir and Intake Site

- Should be at narrow valley.
- Bends should be avoided.
- Banks should be stable.
- No land slides.
- Minimum turbulence in flow



DESILTING TANK AND CHANNEL

- Flatter land.
- Free from cross drainages.
- No active slide zone.
- Slopes should be stable

FOREBAY AND SPILLWAY

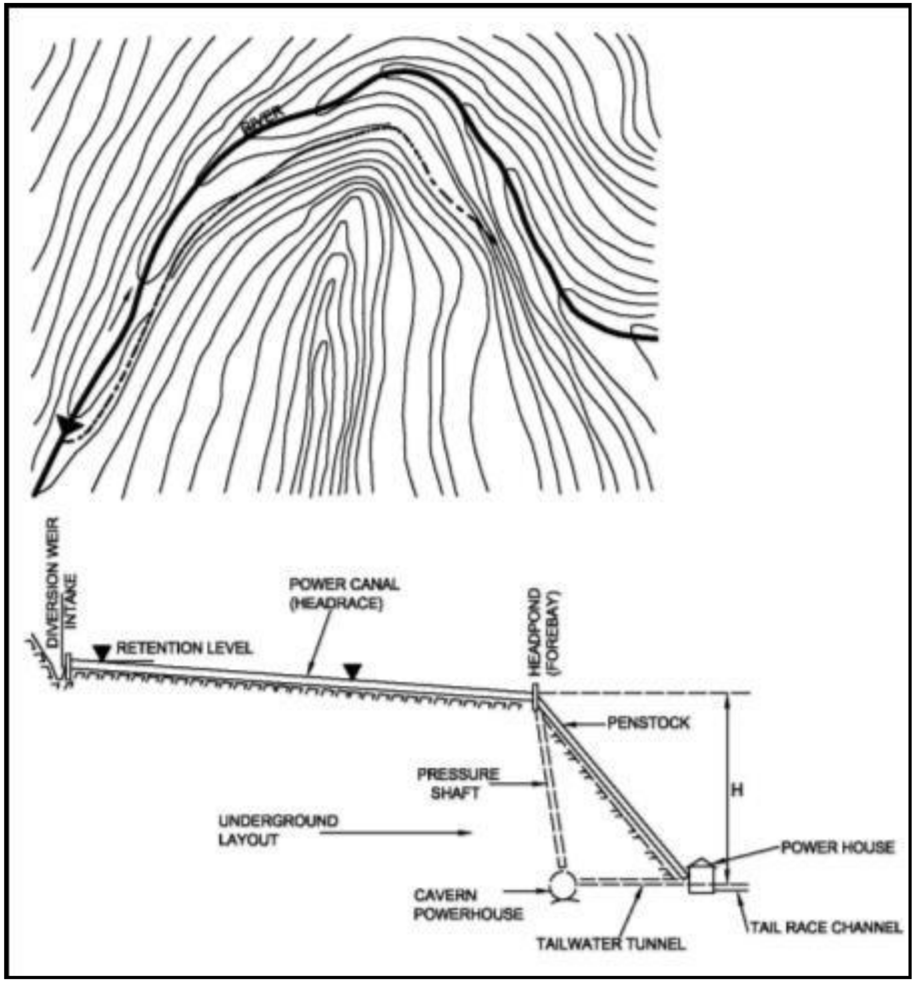
- Flatter land.
- Filling of land should be avoided.
- Slopes should be stable.
- Natural stream should be nearby for spill water

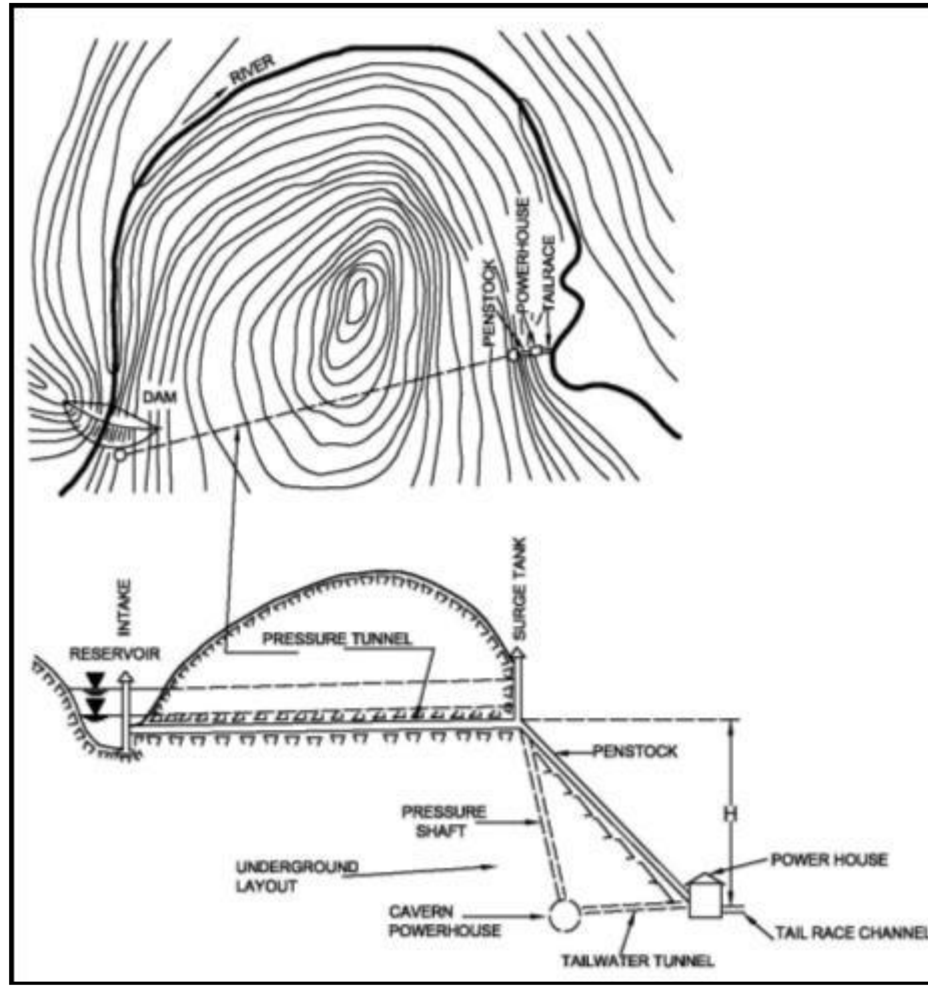
PENSTOCK

- Alignment should be along the ridge.
- Shortest length.
- Minimum bends.

POWER HOUSE

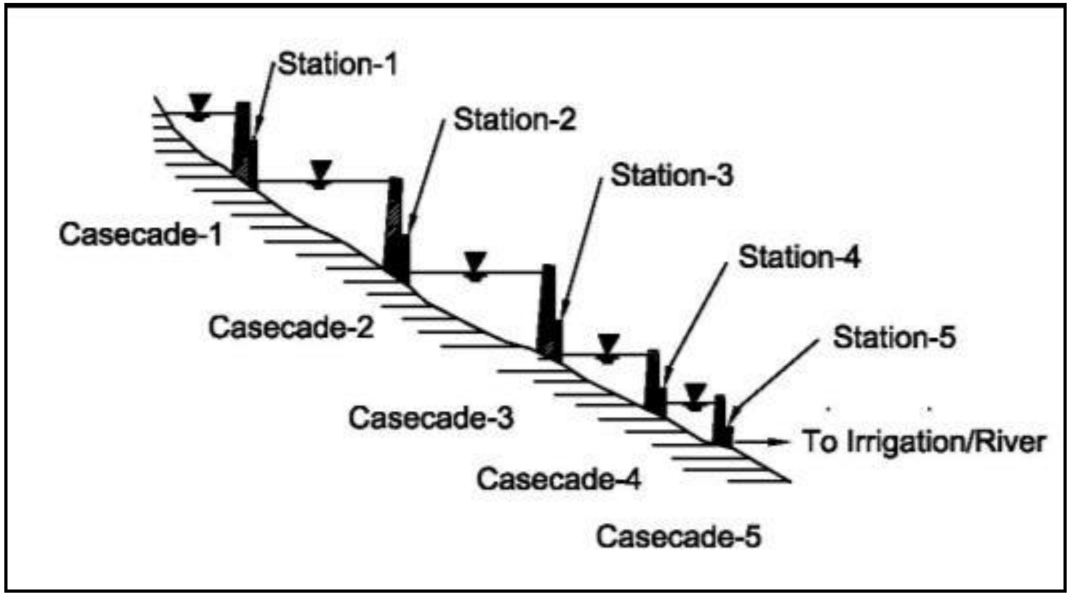
- Easy accessibility.
- Flatter ground.
- Above high flood level.
- Stable slope.



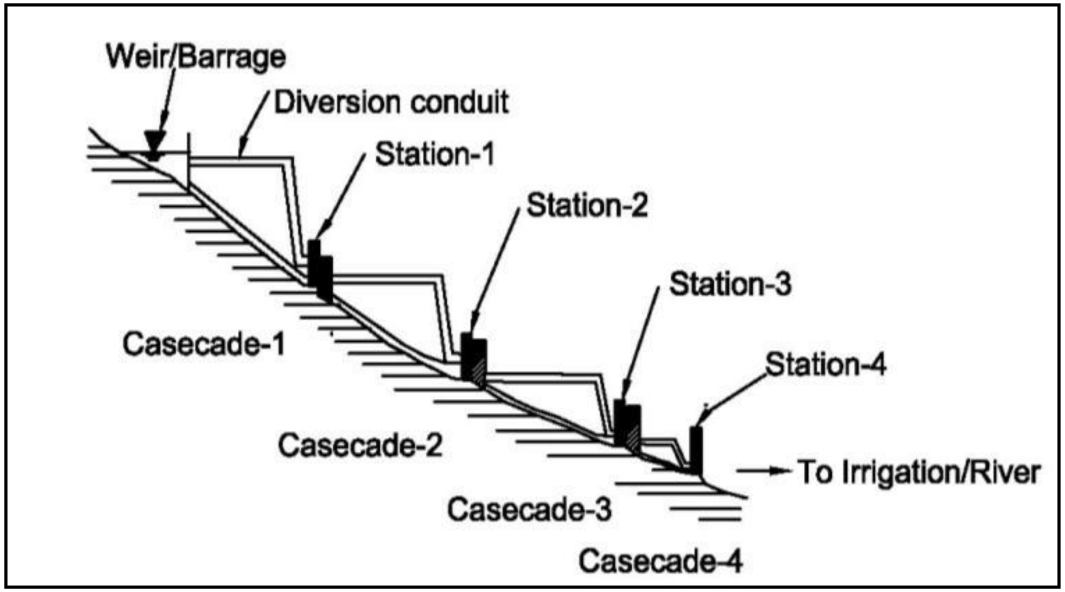


Mosonyi, High Head Power Plant, Vol. II, 2009

Typical Alternate Layouts for Water Conductor System for Run of River Schemes



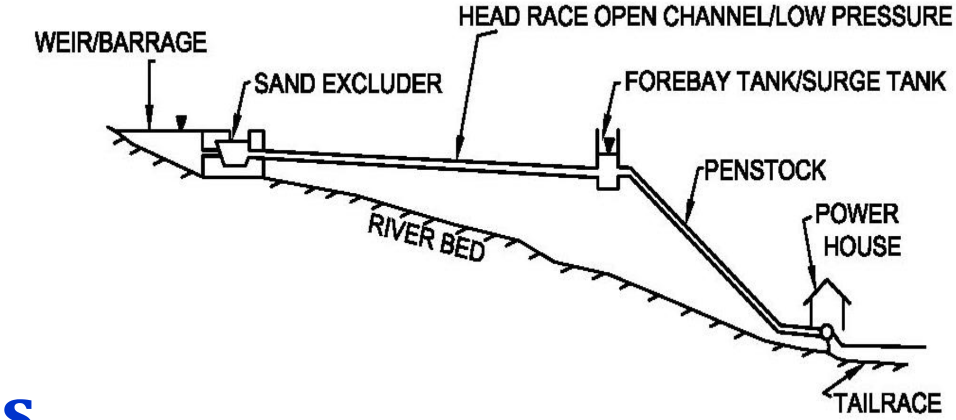
Cascade Development With Storage Schemes

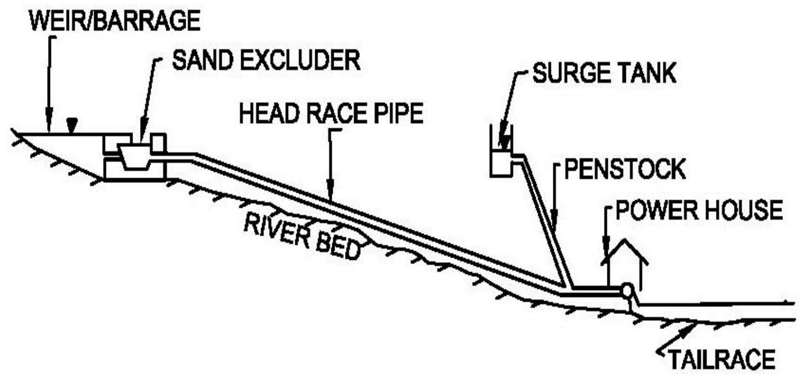


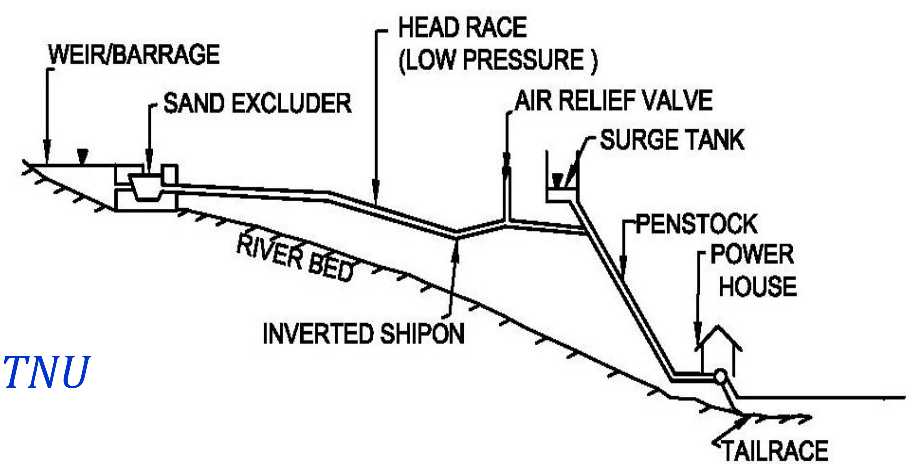
Mosonyi, High Head Power Plant, Vol. II, 2009

Cascade Development With Run of River Schemes

Typical Layouts for Run of River Schemes

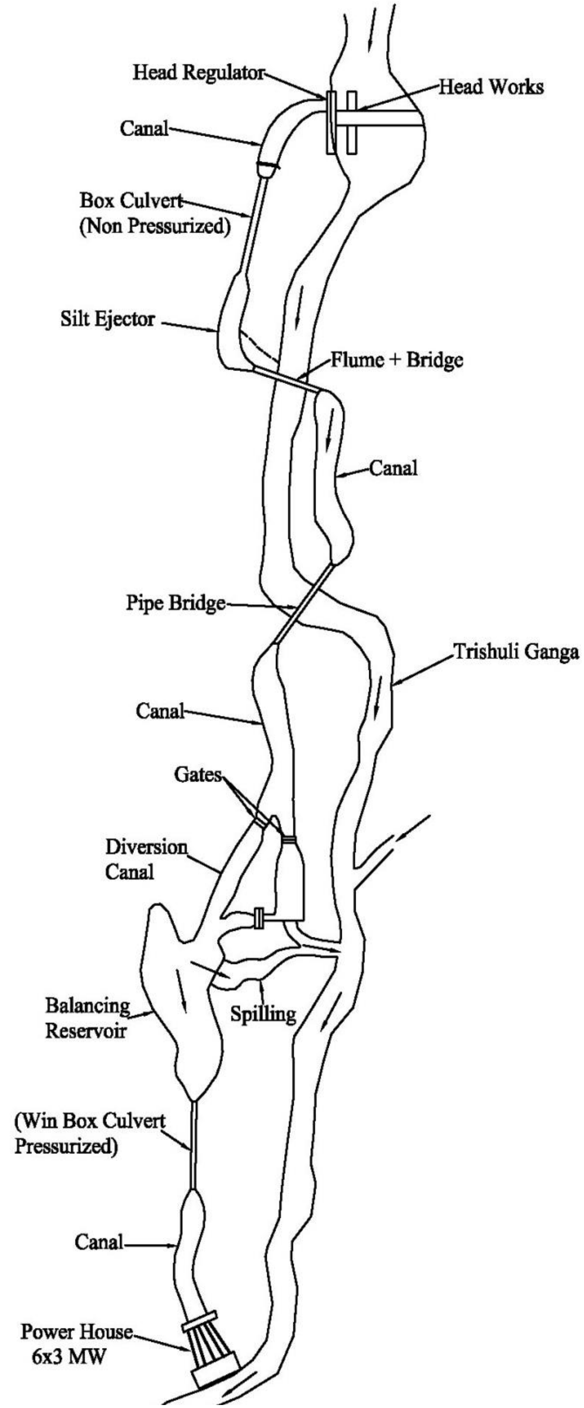


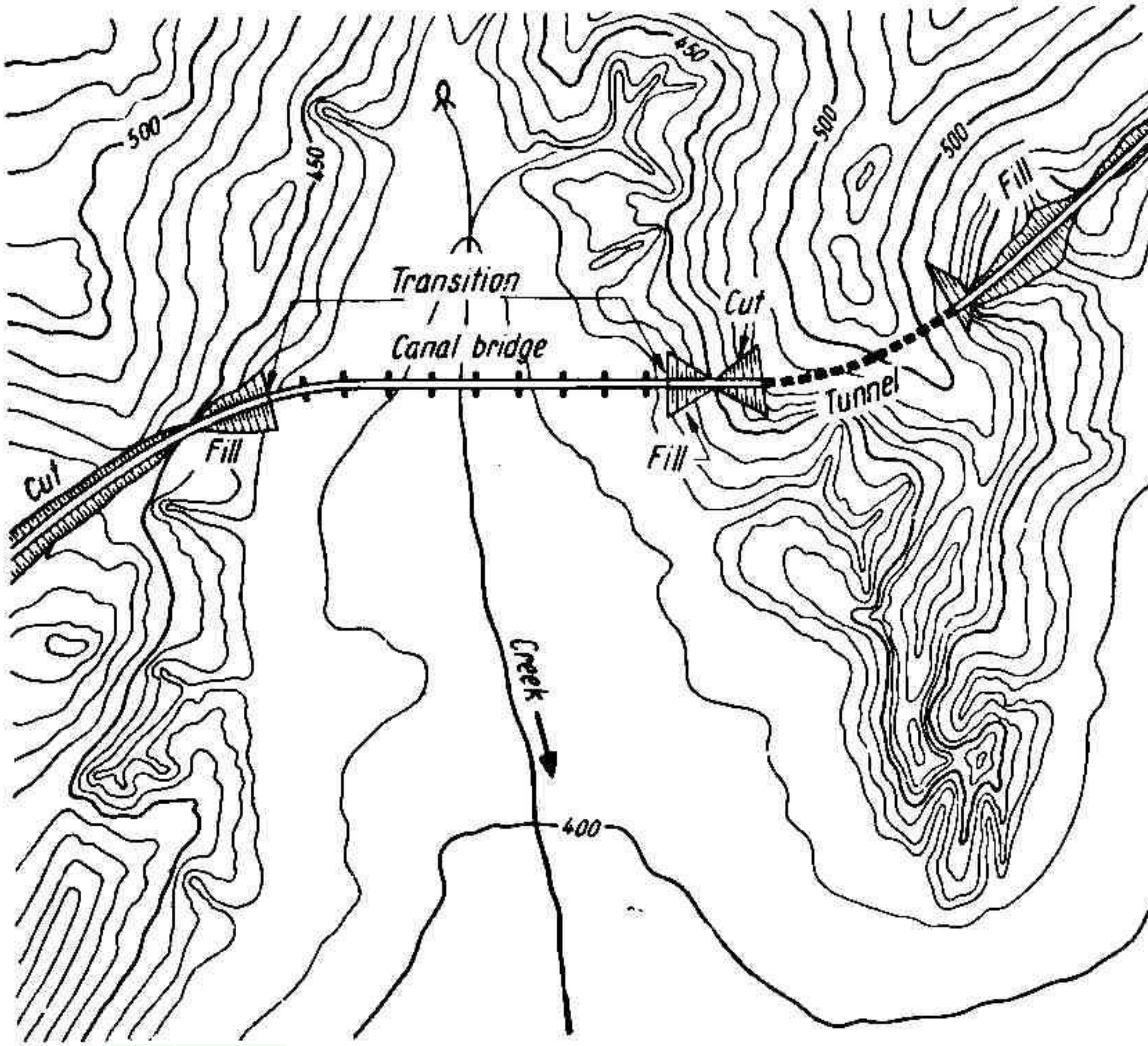




Lysne, Planning and Guidelines, NTNU

Typical Layout Run of River Scheme With under Water Conductor Shift from One Bank to Other





Location of the power canal over rugged terrain

Mosonyi, High Head Power Plant, Vol. II, 2009

CANAL BASED SHP SCHEME

- Power house may be located in diversion channel on either bank
- Power house may be located in the canal itself.
- Location of spillway
- Proximity of substation for power evacuation
- Accessibility
- Land availability

DAM BASED SHP SCHEME

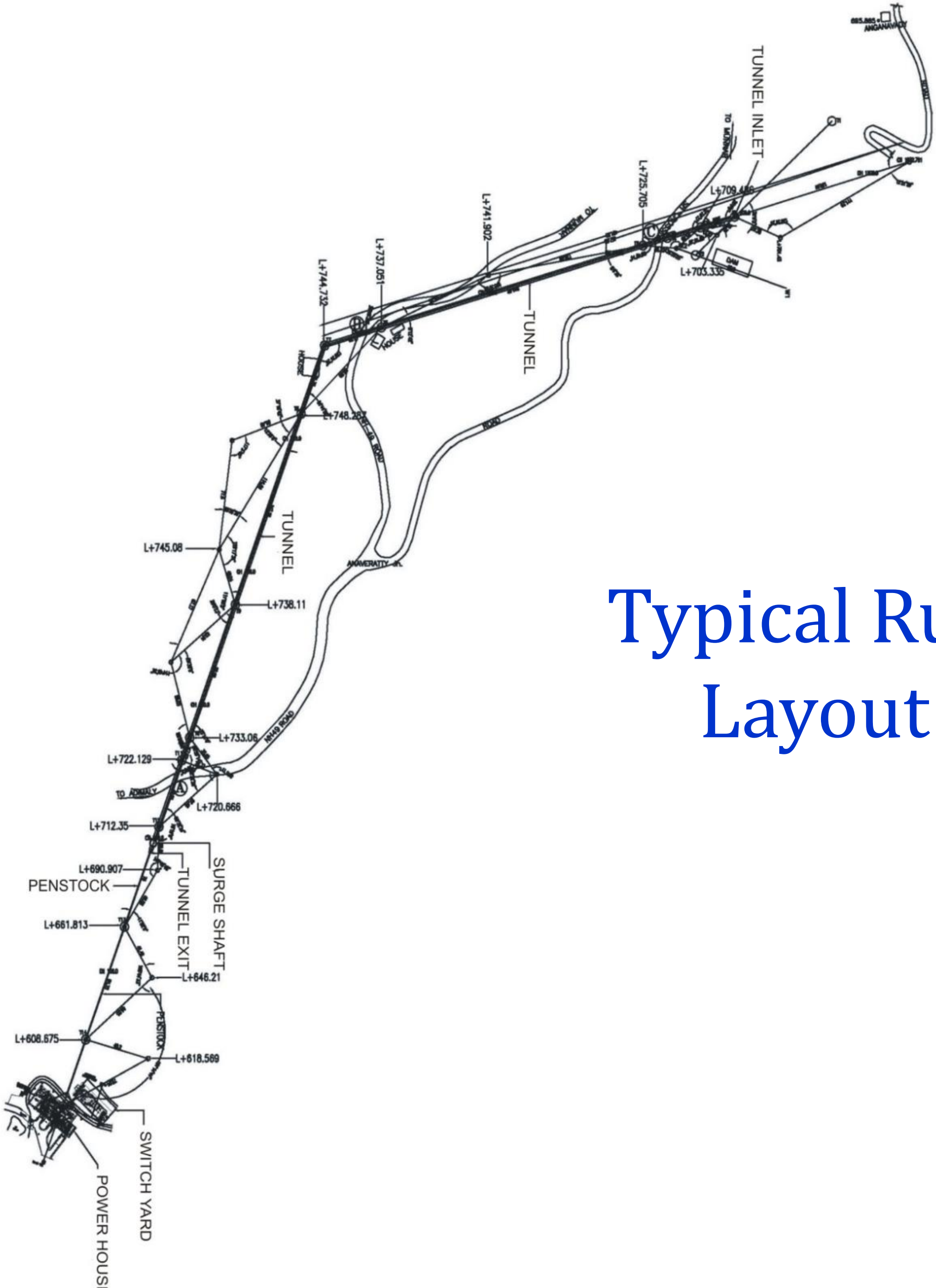
- For dam based, same as ROR scheme
- For dam toe, Proximity of substation, land availability and
- Accessibility

PUMP STORAGE BASED SHP SCHEME

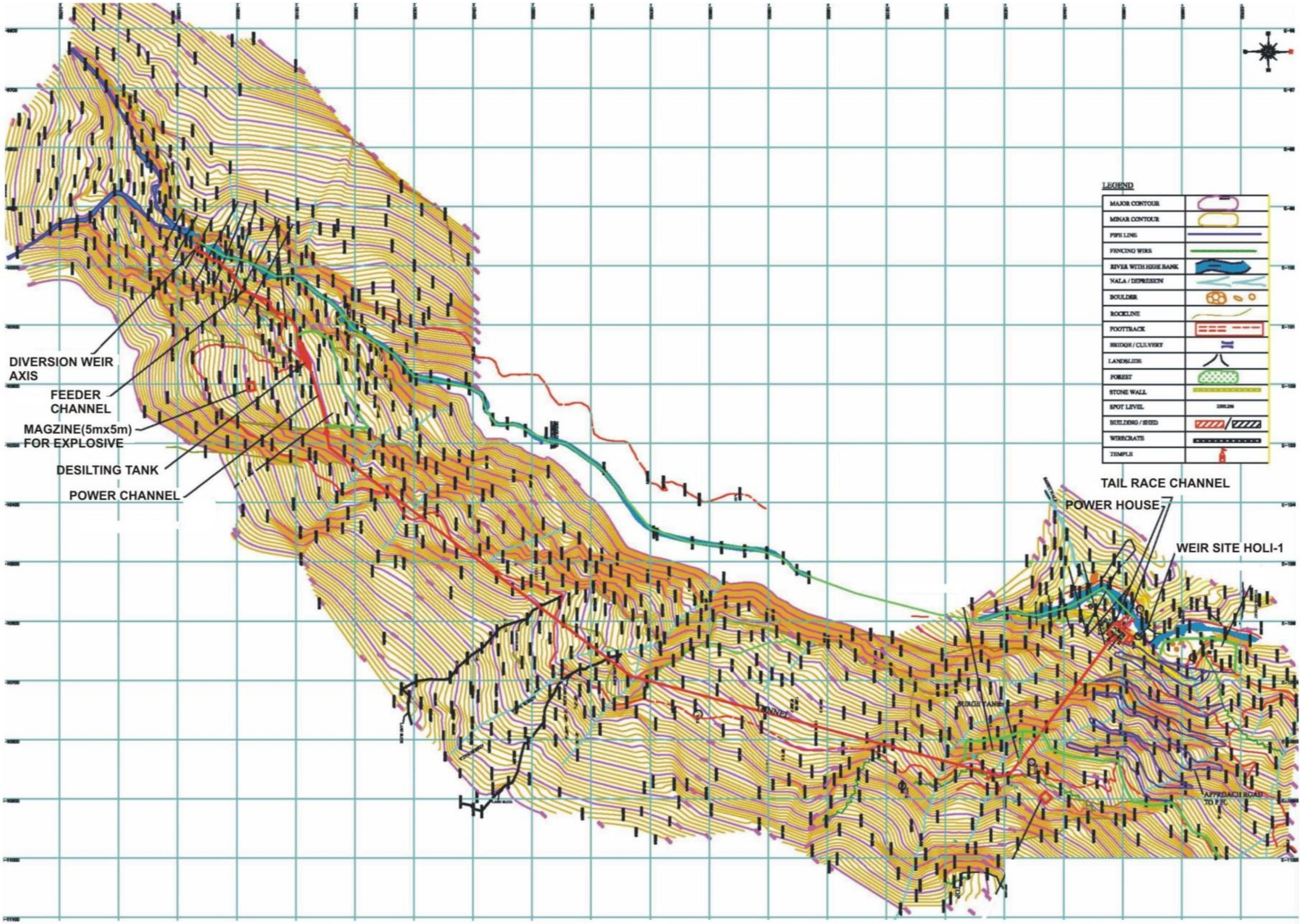
- Suitable site for upper and lower reservoir
- Suitable site for location of power house
- Alignment of penstock

OTHER POSSIBLE LOCATIONS FOR SHP

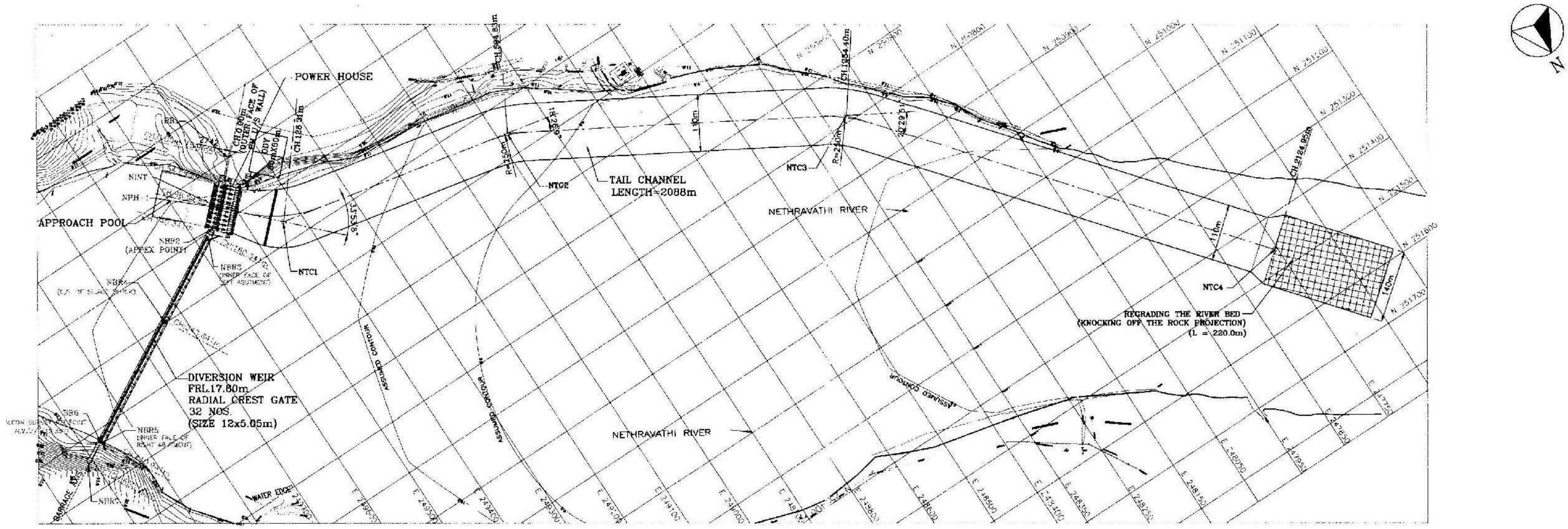
- Cooling water return channel
- Velocity head or kinetic energy
- Very low head



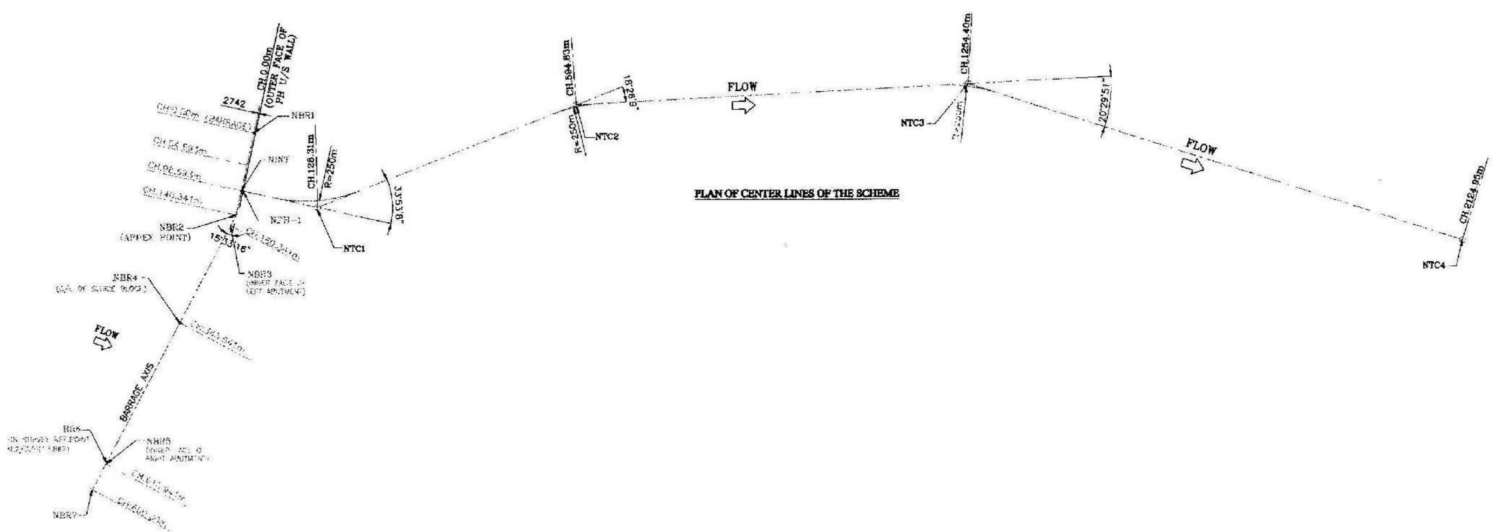
Typical Run of River Scheme Layout With Tunnel - 1



Typical Run of River Scheme Layout With Tunnel – 2

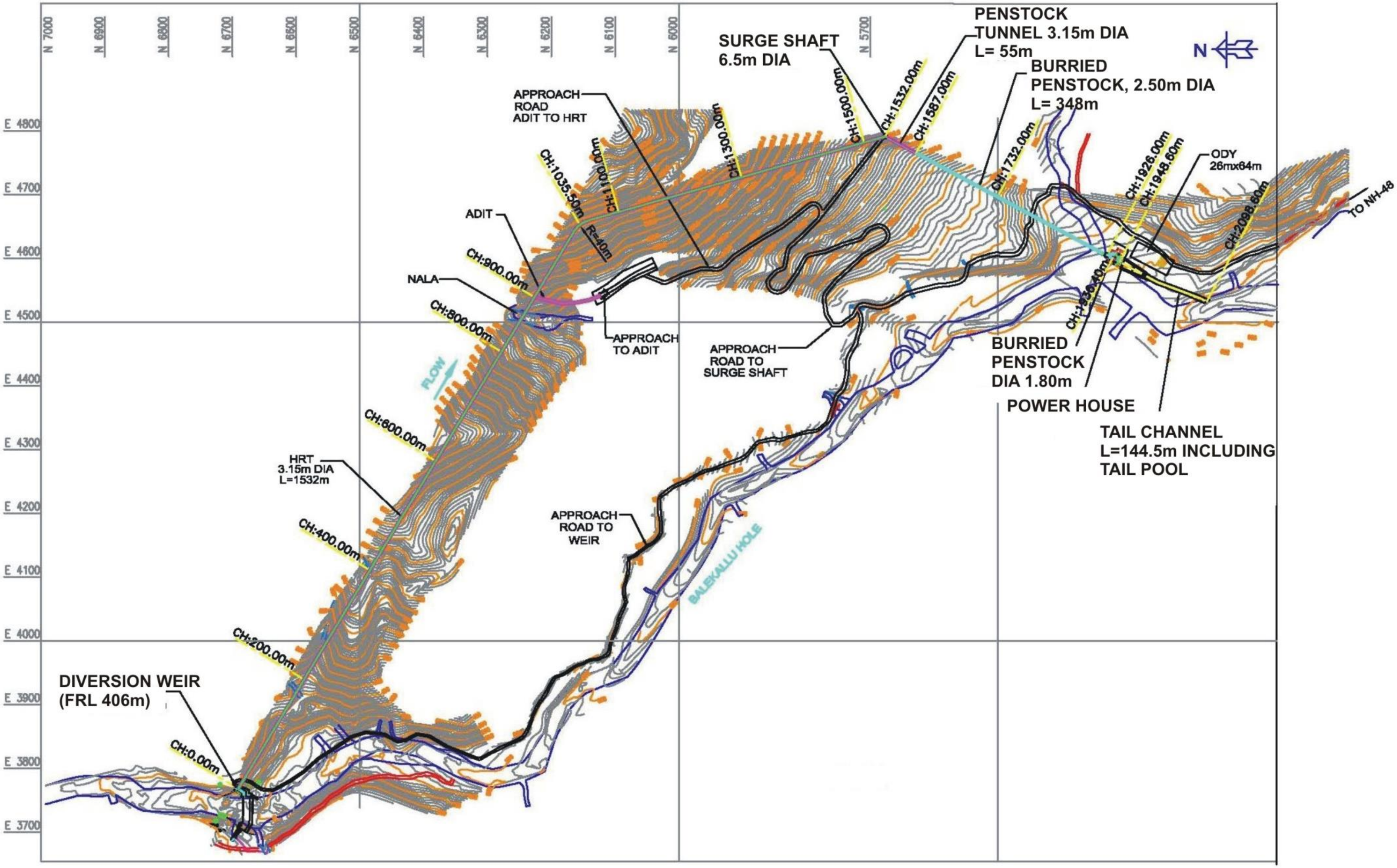


PLAN OF THE SCHEME

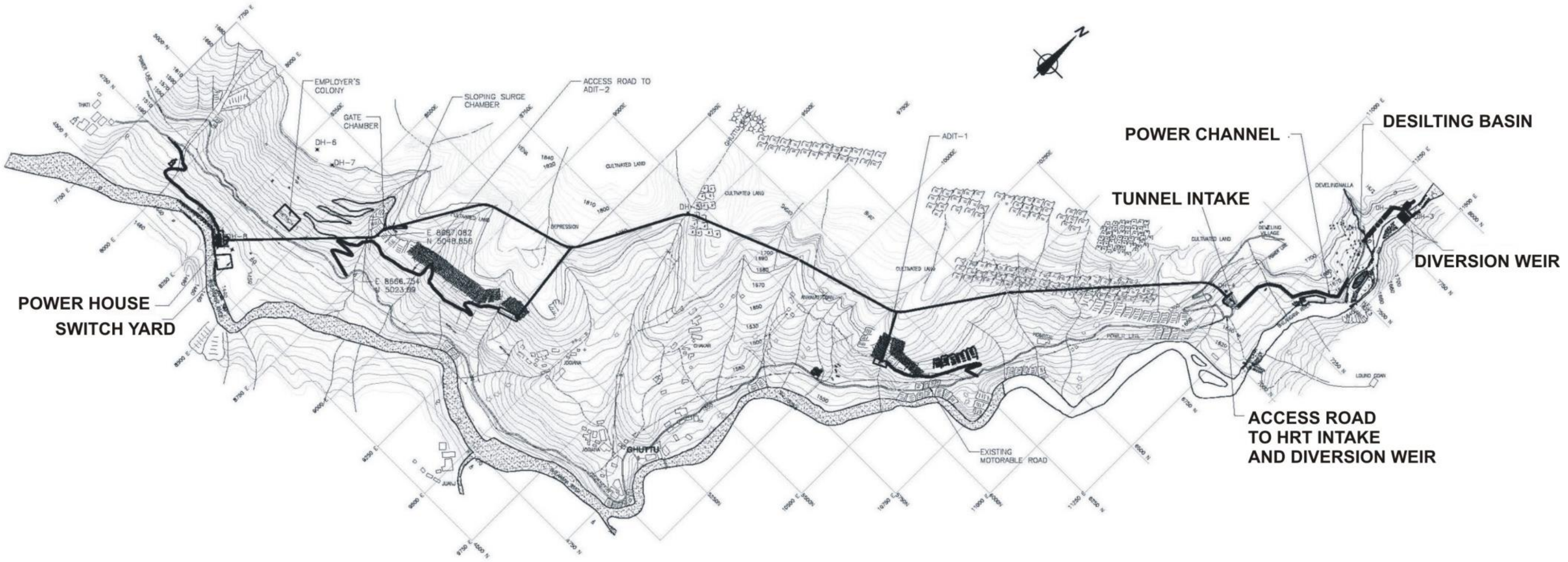


PLAN OF CENTER LINES OF THE SCHEME

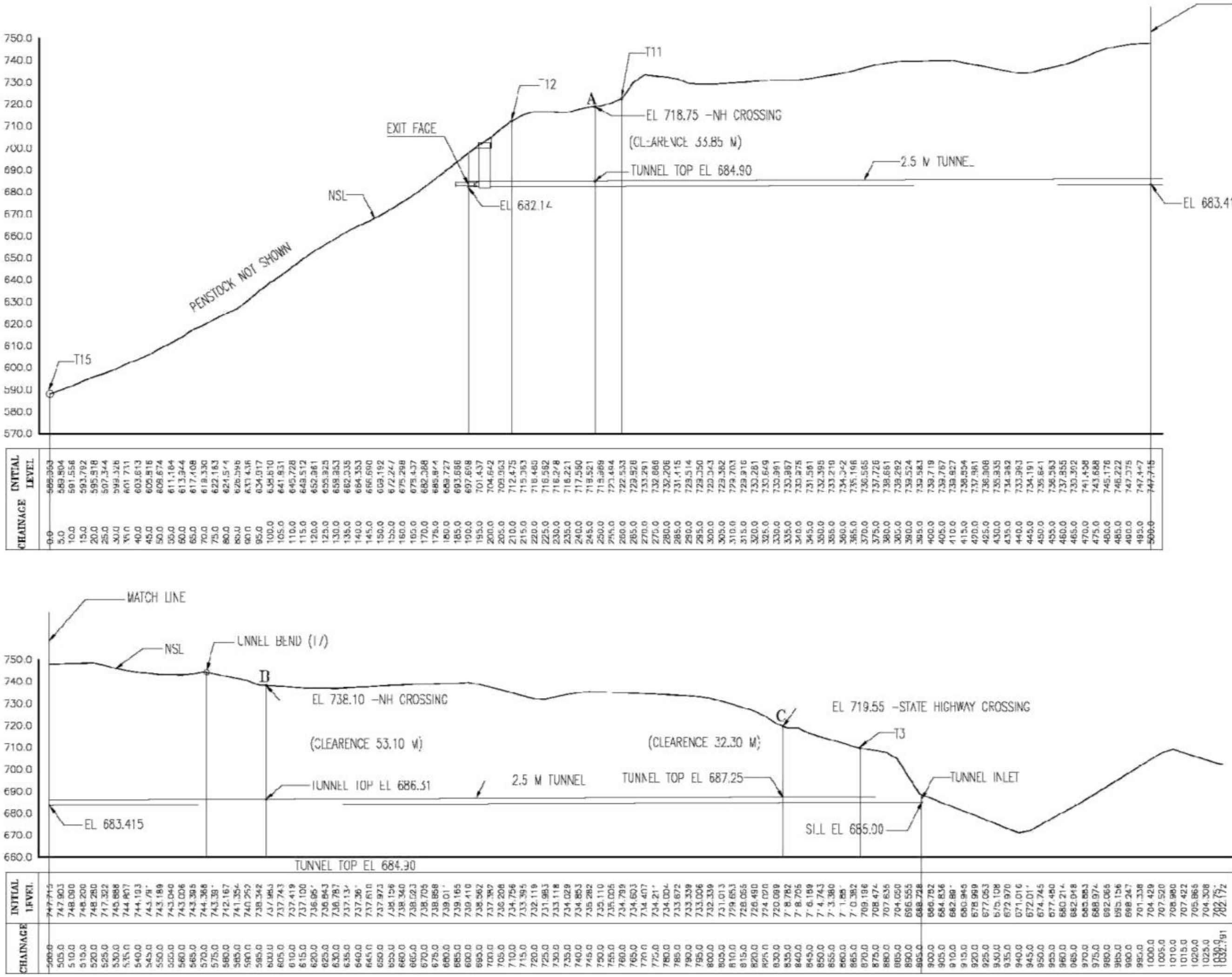
Typical Run of River Scheme Layout with Short Approach And Long Tail Race Channel



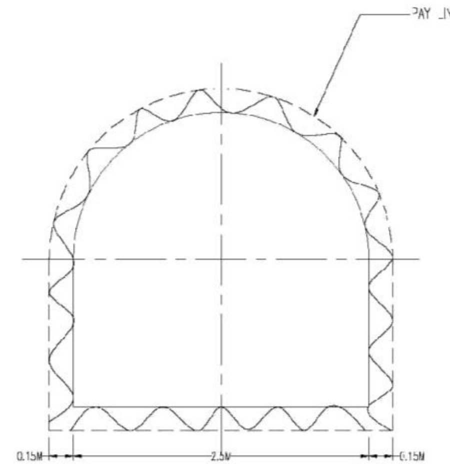
Typical run of river scheme layout with longer tunnel compared to river length for providing adequate cover over tunnel



Typical Run of River Scheme Layout Having Several Bends in the Tunnel Alignment



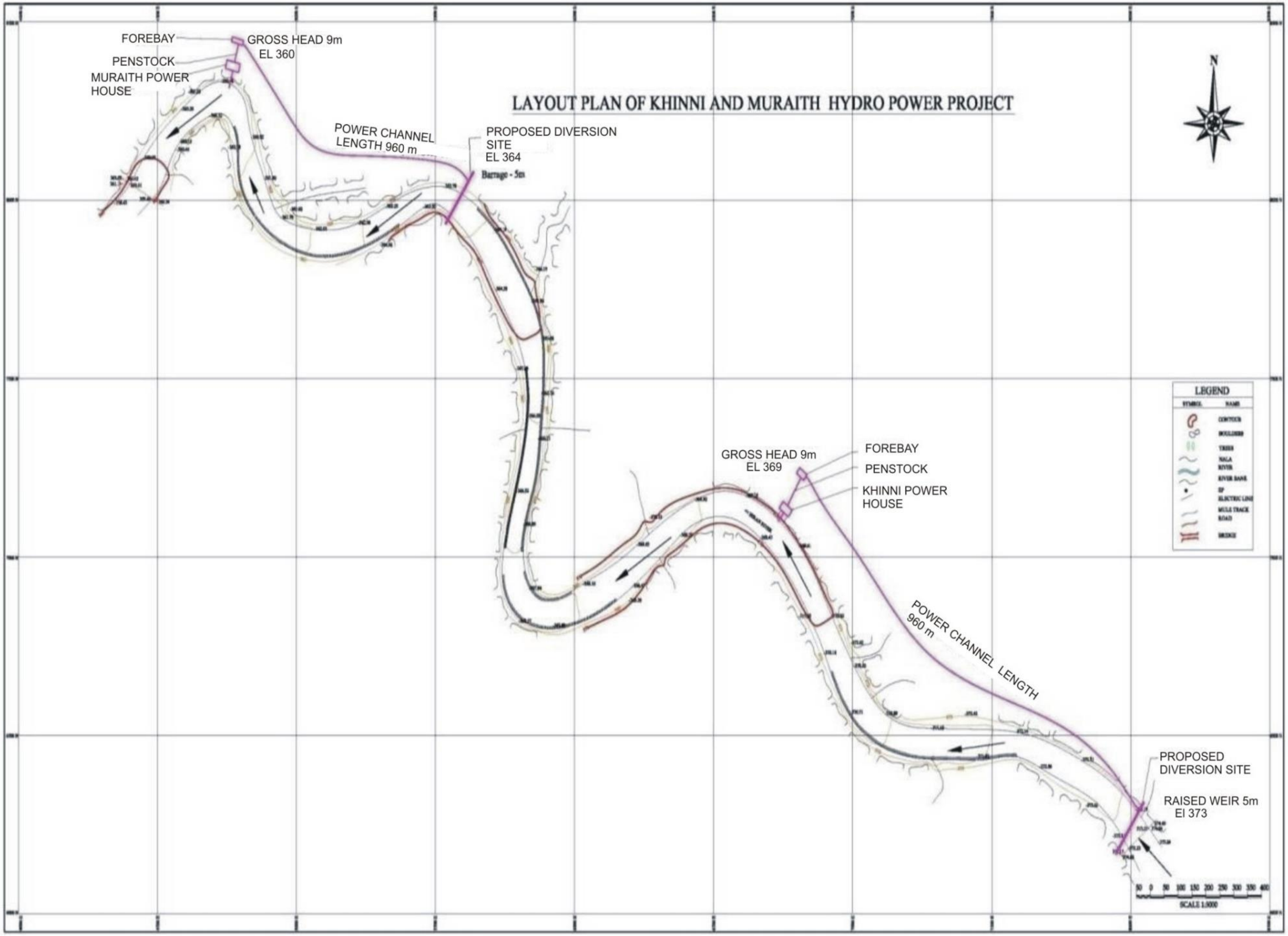
L SECTION OF TUNNEL



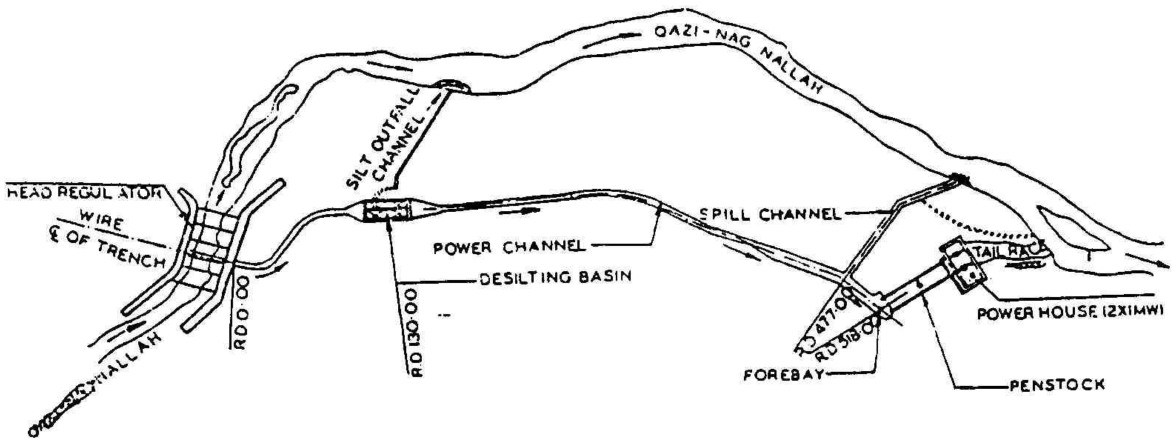
TYPICAL TUNNEL CROSS SECTION

(NTS)

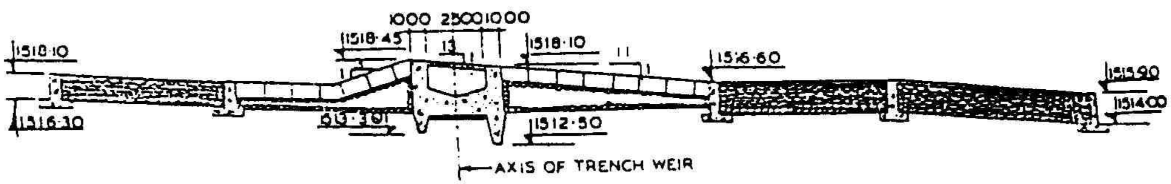
Typical Longitudinal and Cross section of Tunnel



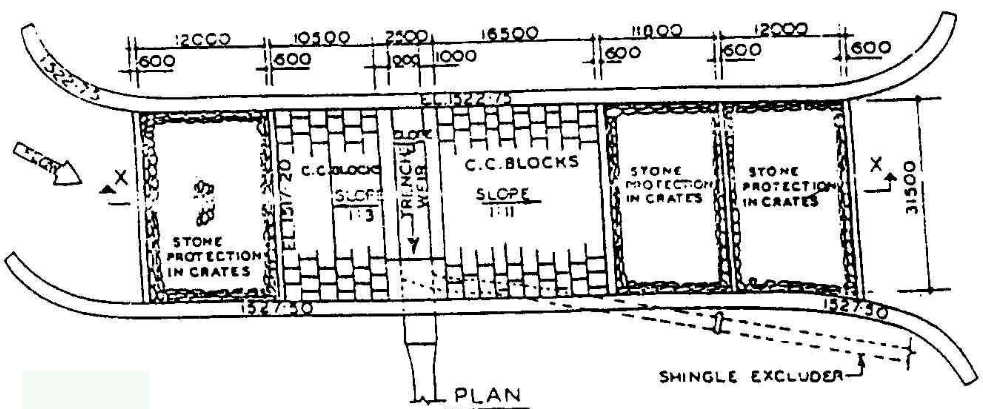
Typical Layout Cascade RoR Schemes with Gaps Between Two Schemes



KARNAH H.E. PROJECT–LAYOUT PLAN

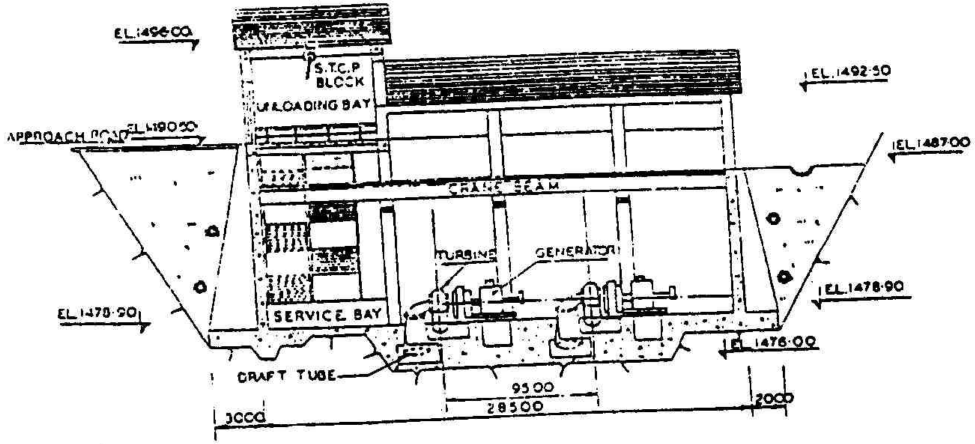


SECTION X - X

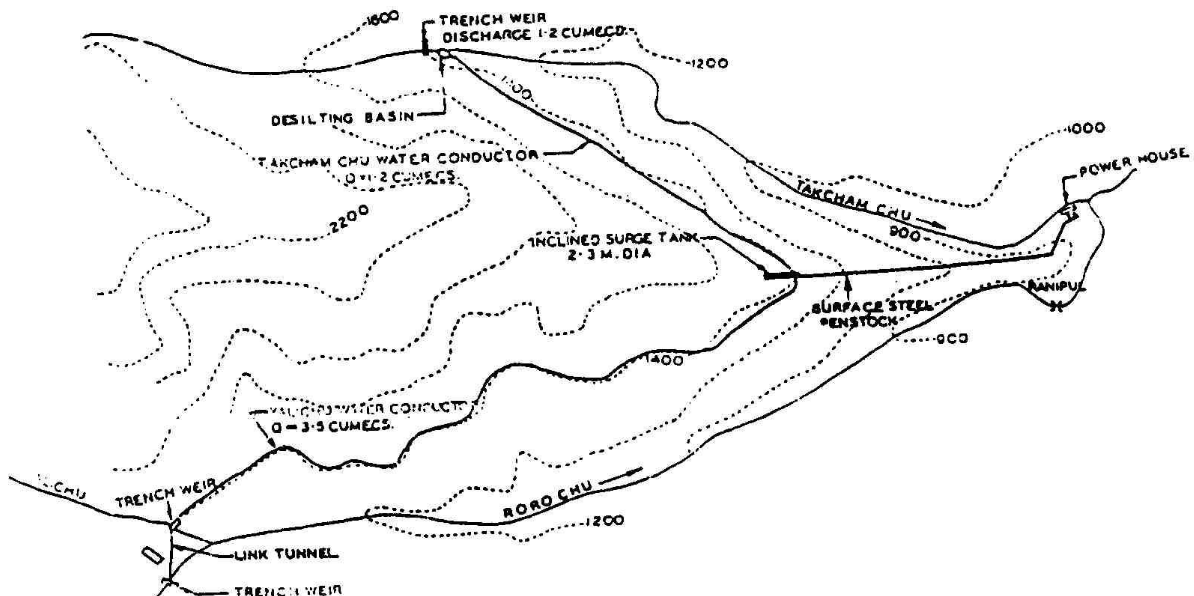


PLAN

KARNAH H.E. PROJECT–PLAN AND SECTION OF TRENCH WEIR



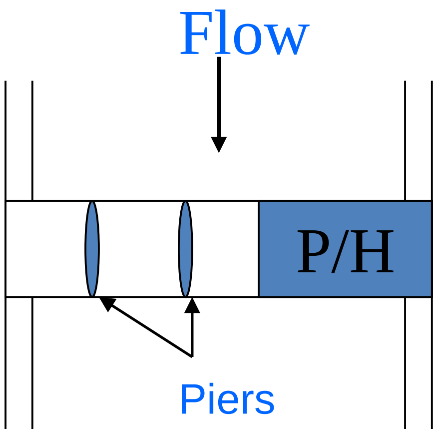
KARNAH H.E. PROJECT– POWER HOUSE L– SECTION



LOWER LAGYAP H.E. PROJECT– GENERAL LAYOUT

Block Power Station

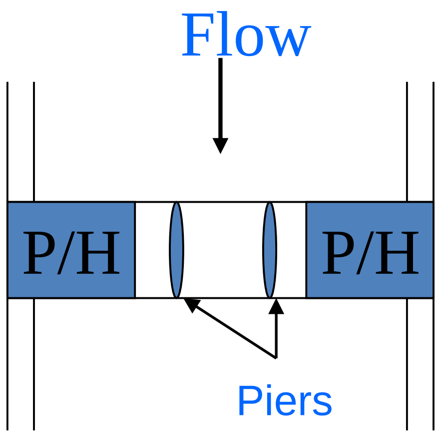
- Most widely used.
- Convectional low/head turbines (Kaplan)
- Widening of the width of river may be required
- One-side bay may give rise to curvilinear flow and may adversely affect the efficiency of the turbines, trash rack losses
- Plant should be provided on the left concave side of the river bend.
- Large number of such type of power houses in Switzerland, Germany, Austria and Sweden.



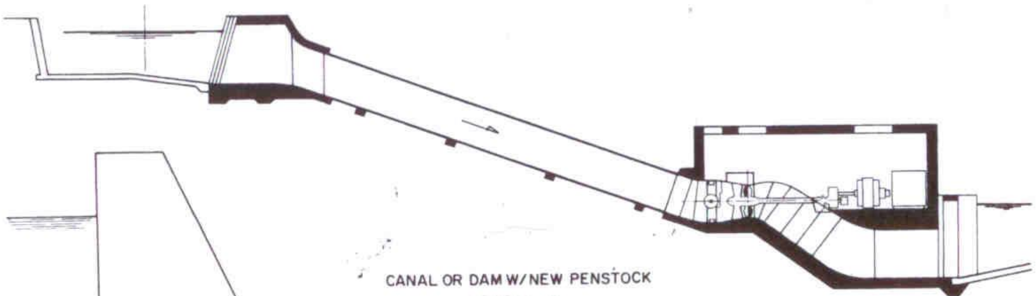
Block Power Plants

Twin Power Station

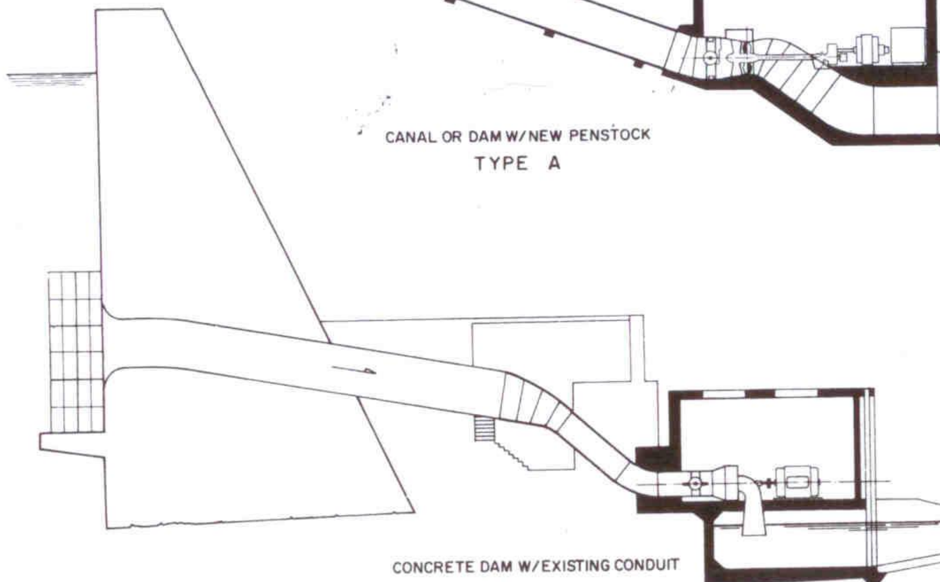
- If the plant discharge capacity is large at a low head, it is desirable to prefer twin power house.
- High investment cost.



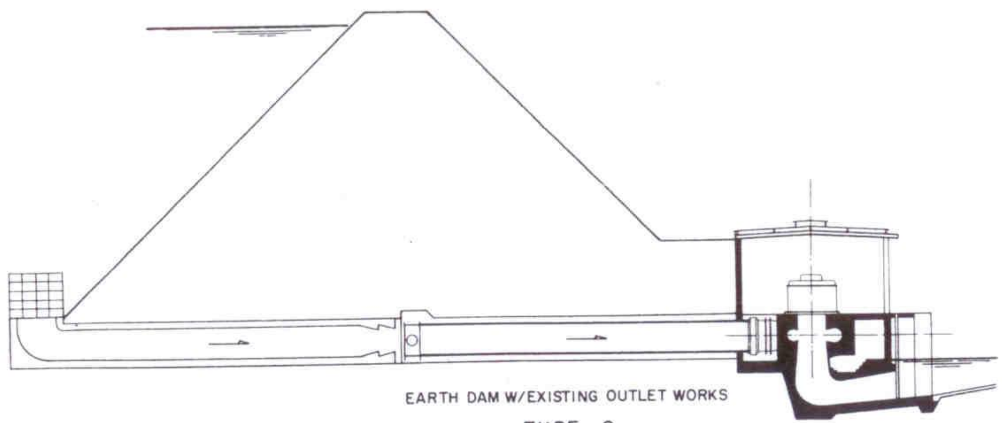
Twin Power Plants



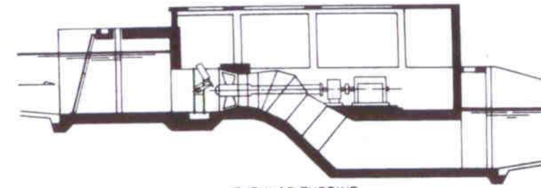
CANAL OR DAM W/NEW PENSTOCK
TYPE A



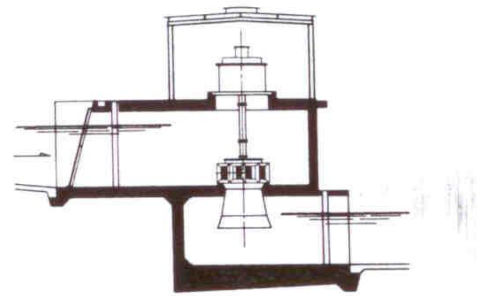
CONCRETE DAM W/EXISTING CONDUIT
TYPE B



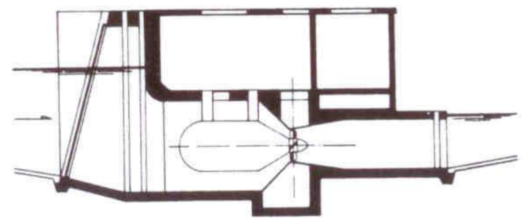
EARTH DAM W/EXISTING OUTLET WORKS
TYPE C



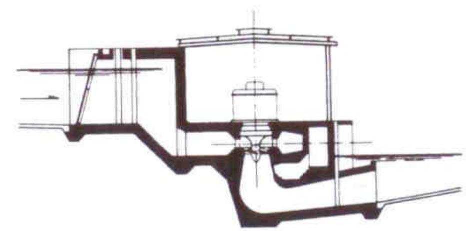
TUBULAR TURBINE



OPEN FLUME TURBINE

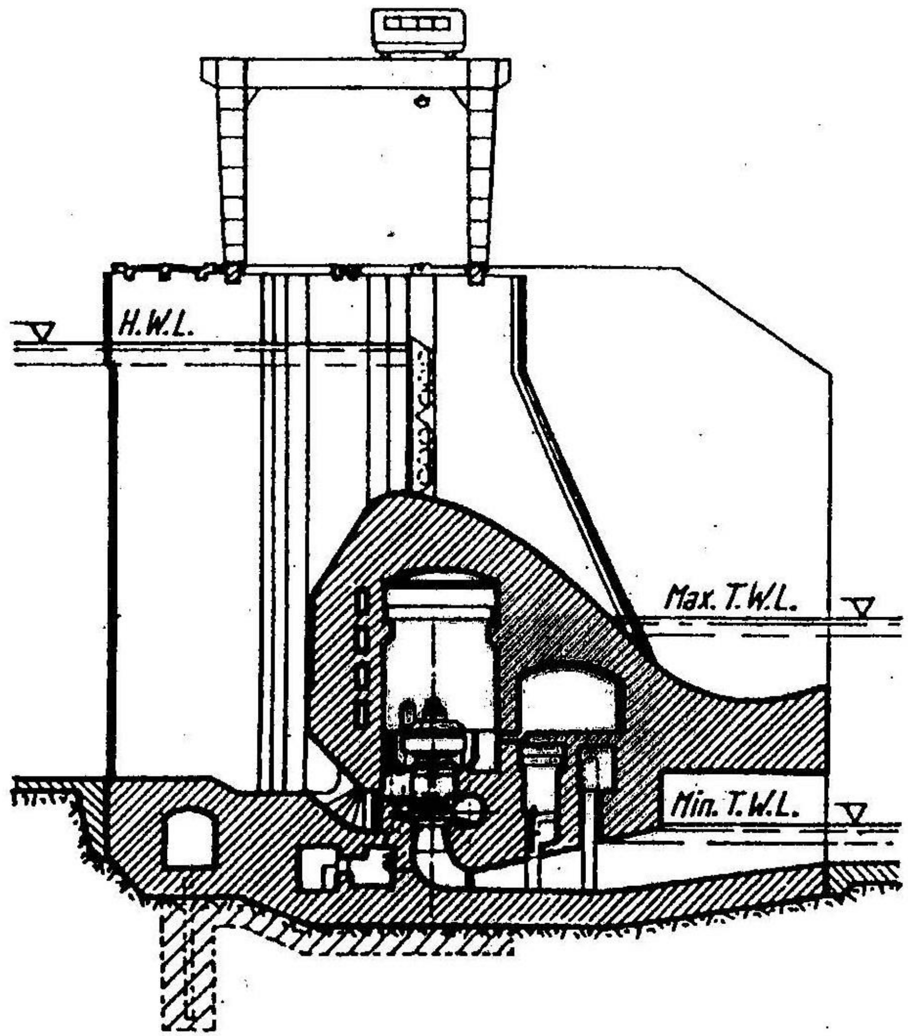


BULB TURBINE

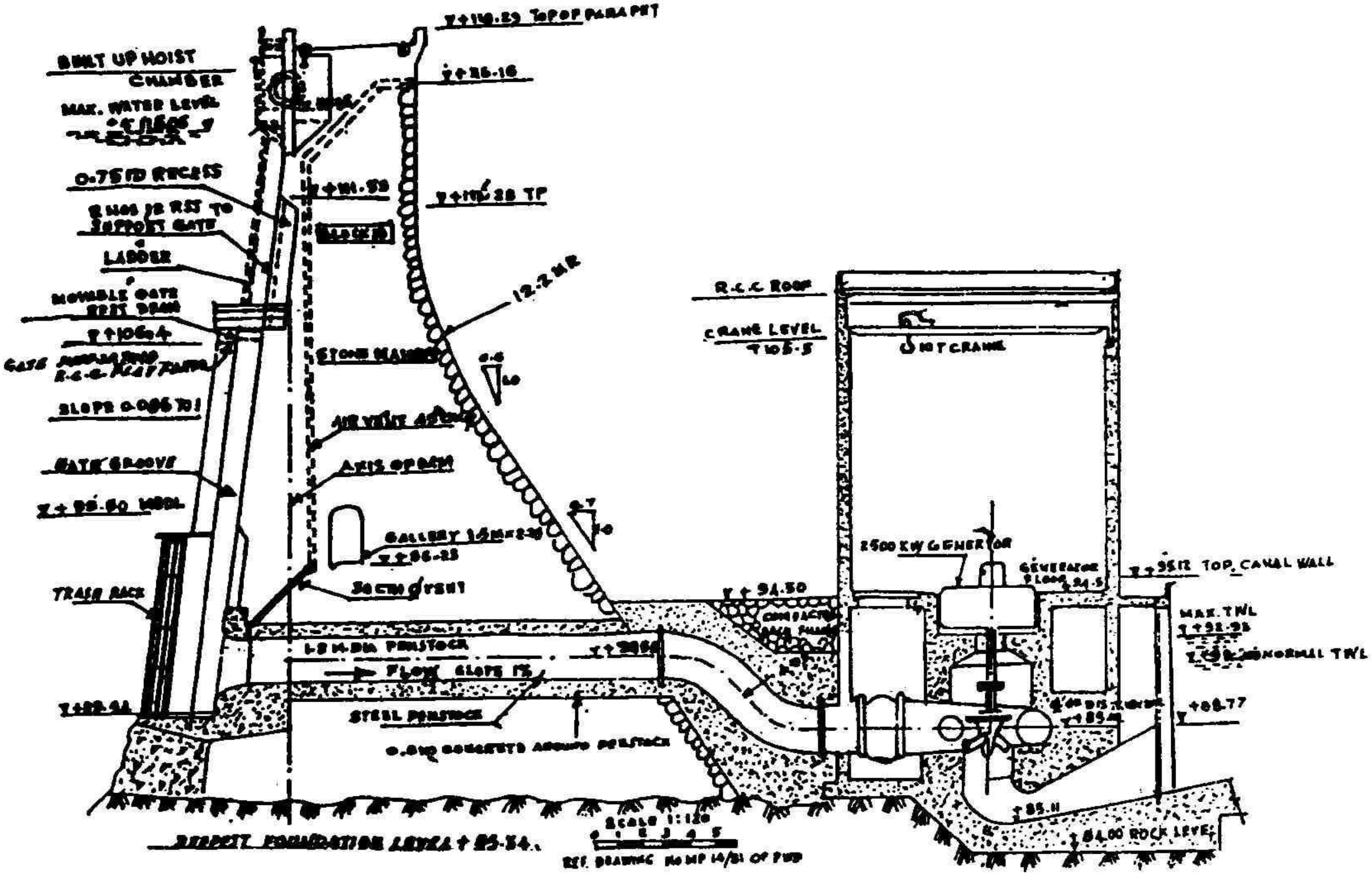


PROPELLER TURBINE

POWER PLANTS BUILT AS DAMS
TYPE D



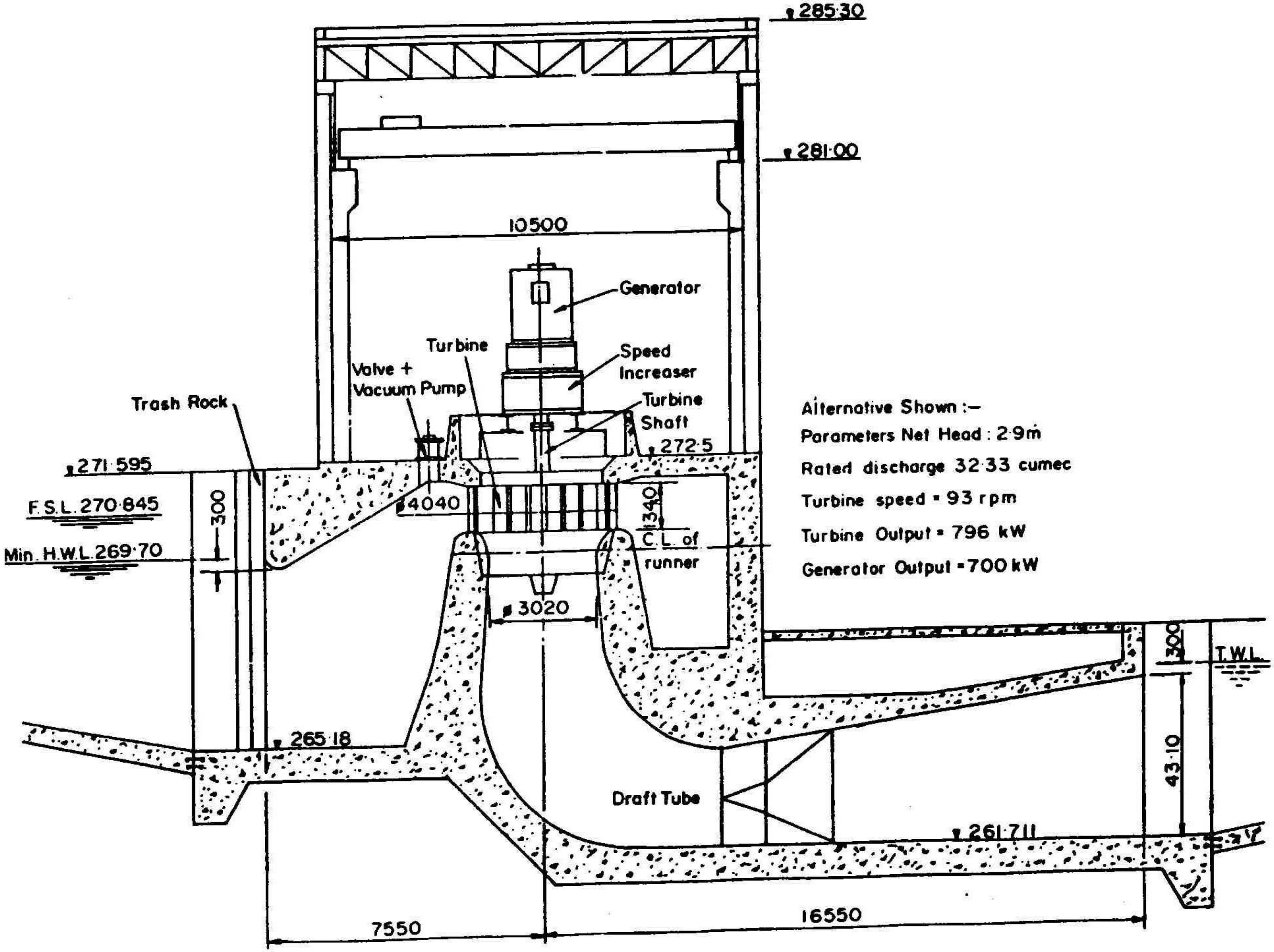
Submersible station with conventional Kaplan units located within the weir body; Pavlovsk, USSR.[46]



KERALA STATE ELECTRICITY BOARD

POWER GENERATION SCHEME UNDER
MALAMPUZHA IRRIGATION PROJECT

SECTIONAL ELEVATION-DAM, PENSTOCK AND POWER HOUSE

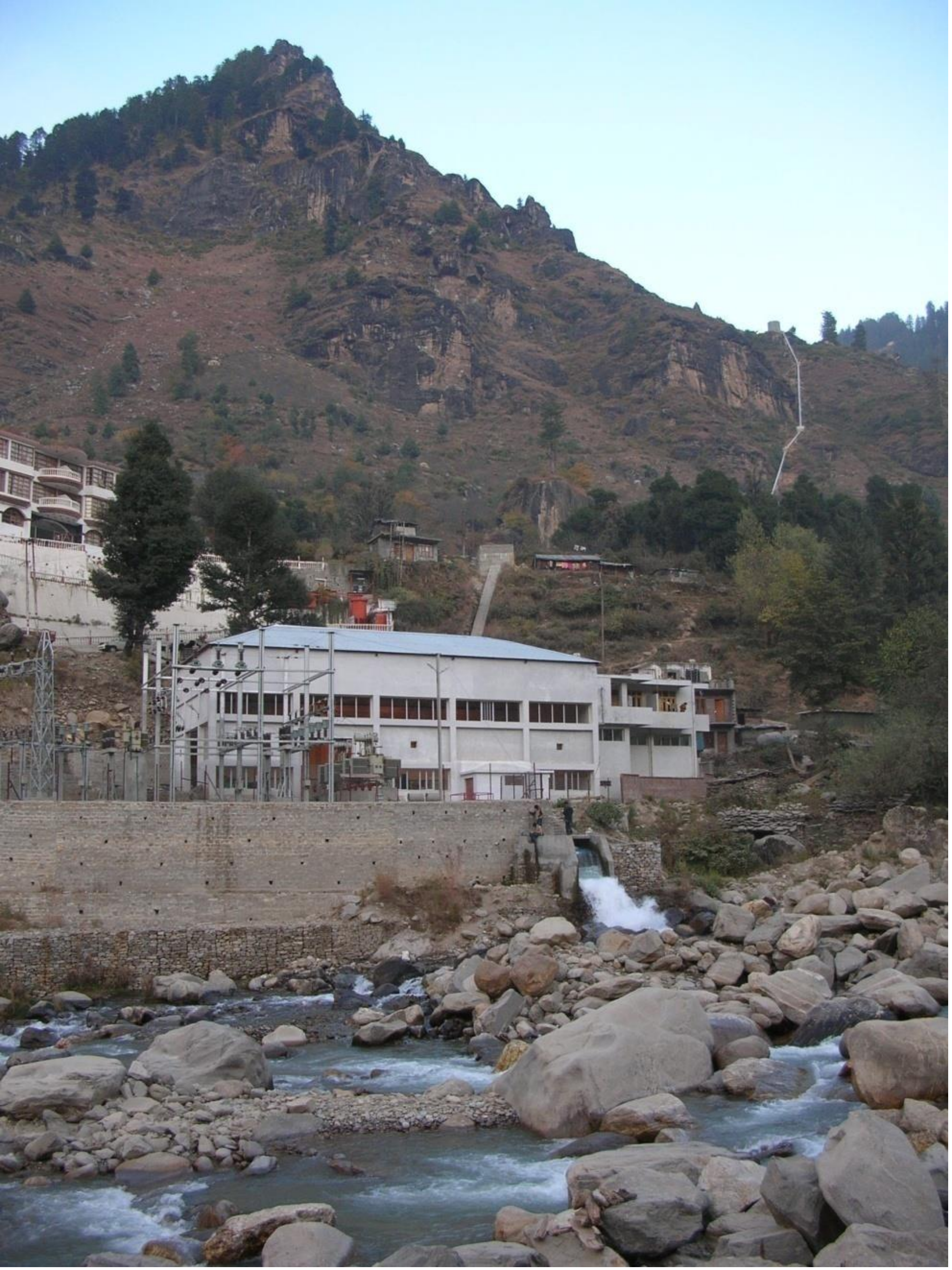


Syphon Intake

Canal Falls

Canal Falls

Waya Dam Based
150 kW shp
Bauchi state ,Nigeria




BRAHMGANGA HYDRO ELECTRIC PROJECT


27.05.2008 15:43

17.04.2008 13:12

Cost Effective Diversion Intake in Himalayan SHP


03.08.2008 11:08


15.03.2008 15:08

Client: GLOBAL ENERGIA

Country: Brazil

Type: Horizontal Kaplan
3 x 6.000 kW

Year: 2001

Client: Companhia Força e Luz Cataguazes-Leopoldina

Country: Brazil

Type: Francis
1 x 9.400 kW

Year: 2000

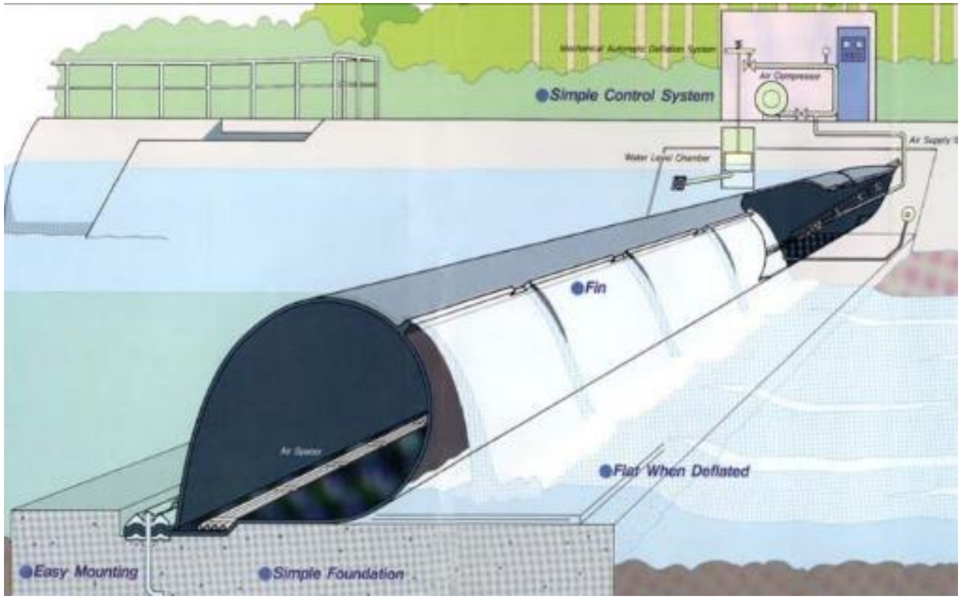
Client: Empresa Eléctrica Valle Hermoso S.A.

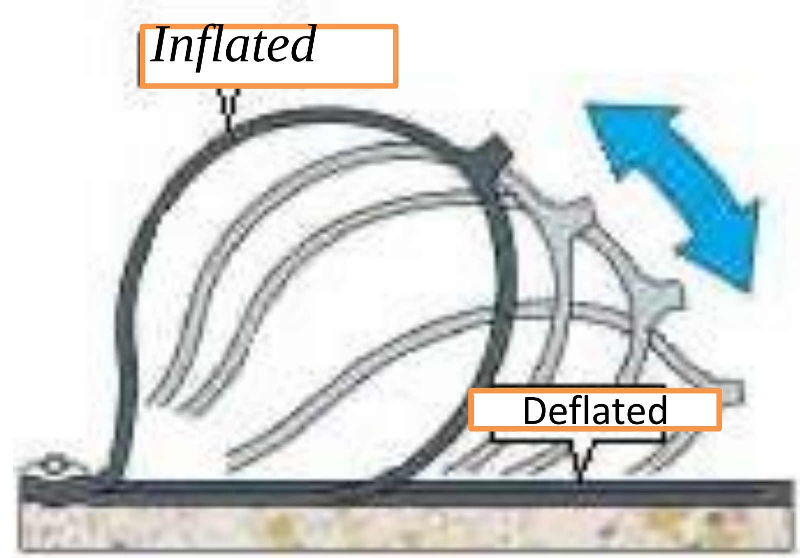
Country: Bolivia

Type: Francis
1 x 3.350 kW

Year: 1999

TYPICAL RUBBER DAM





Compactness

Merging with Environment – Gale, Sri Lanka

Cleanliness - Minar, Brazil

Good Example – Iran 1990

Good Example

Bad Examples

Good Example

HUMAN RESOURCE DEVELOPMENT

- Small hydropower involves a multi-disciplinary for planning, design, execution and operation & maintenance.
- Civil, electrical, mechanical, electronic engineering and socio-economy are the disciplines for hydropower
- Being small it may not afford of having persons specialist in each discipline.
- Small hydropower may need personnel having fairly good background in each of these fields.

Availability of Manpower for SHP Development

Due to rather difficult conditions in the areas where hydropower source exist the volunteers to take up hydropower as their field of expertise, are not easily available.

- One needed to motivate the person, may be by training local people only specially at energy diploma & technician level.
- The multi disciplinary specialist course(s) at different level to match the requirement is required.

Thank you