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LUCKY POWER PROJECTS CO-OPERATIVE SOCIETY LTD.

TRANHA CHARROLI SMALL HYDRO ELECTRIC PROJECT

(2 X 1.05MW)

HIMACHAL PRADESH

DETAILED PROJECT REPORT

Consultants :-

V.G.ENGINEERS AND CONSULTANT
P.O. MAJRA-173032.
DISTT. SIRMOUR(H.P.)

JULY, 2012

CONTENTS

EXECUTIVE SUMMARY

Govt. of Himachal Pradesh have entrusted to Lucky Power Projects Co-operative Society Ltd., New Shimla for the development of Power potential at Dhar-Chayma (Charroli) in Distt. Shimla of Himachal Pradesh.

It is proposed to develop the small hydro scheme at Dhar-Chayma (Charroli) DPR has been prepared after in-depth study of hydrology, topography, geotechnical investigations and detailed discussions with equipment suppliers.

Project details are summarized below :

- *Available gross head in 214.00 m*
- *Rated discharge is 1.25cumecs*
- *Net head corresponding to the above discharge is 200 m*
- *Total installed capacity is 2.10MW*
- *Horizontal Axis Pelton Turbines having synchronous/ Induction generators directly coupled to the turbin.*
- *Power shall be generated at 3.3 kV, stepped-up to 22 KV and evacuated via the 22 KV outdoor pole mounted step up transformer and switchgear to match the existing 22 KV grid of HPSEB.*
- *Cost parameters are given below:*

-	*Capital cost*	*Rs. 1404.42 lacs*
-	*Project cost (including escalation & interest on loan, Financial charges,LADA)*	*Rs. 1512.62 lacs*
-	*Cost per KW*	*Rs. 72,030/-*
-	*Sellable Units*	*10.26GWh*

Implementation Schedule

-	*Pre-construction activities*	=	*6 months*
-	*Construction period*	=	*24months*

CHECK LIST

NAME OF THE PROJECT	:	Tranha Charroli Small Hydro Electric Project
LOCATION		
i) State	:	Himachal Pradesh
ii) District	:	Shimla
iii) Village	:	Charroli
CATEGORY OF THE PROJECT	:	As per CEA classification, it is a Small Hydel Project.
PLANNING		
Has the overall development of the Stream/canal been prepared and stages of development discussed briefly.	:	Yes
Have the alternative proposals been studied and their merits and demerits Discussed.	:	Yes
Have the detailed topographical surveys been carried out for the following items and drawings prepared as per prescribed Scale.	:	
i) Stream	:	Yes
ii) Head works surveys (weir or diversion	:	Yes

structure)		
iii) Plan site & Camp site	:	Yes
iv) Water Conductor system	:	Yes
v) Power House, Switchyard, tailrace	:	Yes
vi) Penstock	:	Yes
vii) Communication etc.	:	Yes
GEOLOGY		
Have the geological surveys for head work, power house and tail-race etc. Been carried out and report on general Geology of the area and on geology of the sites of principal structures appended?	:	Yes
FOUNDATION INVESTIGATION		
Have the foundation investigations for the major civil structures and of the schemes etc. been carried out ?	:	Yes, Additional investigations by drilling proposed at detailed design stage.
HYDROLOGICAL & METEOROLOGICAL INVESTIGATIONS		
Have the hydrological and meteorological Investigations been carried out, and status of date discussed in report ?	:	Yes
i) Rainfall in the catchment	:	Discussed in chapter 5
ii) Gauge and discharge data of the stream	:	Discussed in chapter 5
HYDROLOGY		

Have hydrological studies been carried out to establish the availability of water for the benefits envisaged, and what is the dependability of the potential ?	:	Yes 90%, 75%, and 50% dependable flows have been computed from long range discharge data.
LAND ACQUISITION & RESETTLEMENT (WHEREVER APPLICABLE)		
Have the provisions for land acquisition and resettlement been considered?	:	Yes
Have the socio-economic problem involved in resettlement been considered?	:	No such problem is anticipated
DESIGN		
Has the layout of the project area, viz. Location of diversion structure, workshop Sheds, offices, camps etc., been finalized ?	:	Yes
Have the preliminary design prepared for the following components ?		
i) Diversion structure of intake etc.	:	Yes
ii) Penstocks and water conductor system etc.	:	Yes
iii) Power House & Switchyard	:	Yes
iv) Power house equipment, LT/HT switching equipment and control and protection	:	Yes

equipment.		
v) Communication facilities	:	Yes
POWER BENEFITS		
Have the following points been discussed?		
i) Total energy production and installed capacity of the grid system.	:	Yes
ii) How does the scheme fit into overall development of power of region? (If applicable).	:	Power generated shall be fed in the existing grid
iii) Energy Generation from the projects firm power, seasonal power and total power	:	Estimated energy generation based on 75% dependable discharge is estimated at 10.26 GWh.
iv) Proposals for transmission and/or connection to the existing system etc. (Wherever applicable)	:	The Generator Transformer shall be connected to the existing 22 kV system of HPSEB via proposed 3 km. long transmission line .
Cost of Project per KW installed per kWh generated as compared to the various micro hydel projects and various services in the region to justiry the, economic viablity of the scheme.	:	Cost of project per KW is working out as Rs. 72030/.

CONSTRUCTION PROGRAM		
Are the major components of work proposed to be done departmentally or through contractor ?	:	Through contractor
Have the year / month-wise quantities of the following items been worked out for various components of the project ?		
i) Excavation-soft and hard strata.	:	Yes
ii) Earth - work in filling (wherever applicable)	:	Yes
iii) Stone for masonary	:	Yes
iv) Coarse aggregate for concrete	:	Yes
v) Steel of various sizes and types of Reinforcement	:	Yes
vi) Cement	:	Yes
vii) Other materials, P.O.L. Electricity	:	Yes
ESTIMATE		
Is the estimated prepared ? Have the analysis of rates for various major items of works for the major components of the project been furnished, with the basis of analysis and the price index at which the estimate is based.	:	Yes the estimate has been prepared based upon the analysed rates and based on market rates for material and skilled / semi-skilled worker's applicable wages in the Project area.

CAMPS AND BUILDINGS		
Has the planning of the camps/buildings been done?	:	Yes
SOIL CONSERVATIONS		
Has the planning of the soil conservation measures in the project been discussed ?	:	Note applicable

SALIENT FEATURES

i)	State	Himachal Pradesh
ii)	District	Shimla
iii)	Location	170 km from Shimla town and located on Haripurdhar –Kupvi road
v)	Geographical coordinates of Project area	
	i) Longitudes	E 77° 9'25" to E77°10'00"
	ii) Latitudes	N31°03'45" to N31°04'40"
2.(a)	RIVER CATCHMENT	
i)	Catchment	Churdhar Tarahn
ii)	Stream	Tarahn
3.	HYDROLOGY	
i)	Catchment area of stream upto power house	34.15 Sq.km
ii)	Catchment area of the diversion site	14.71 Sq.km
iii)	Dependable yield (wherever applicable)	Not applicable
iv)	Climate date	Maximum Minimum
	Atmospheric Temperature (°C)	35°C –3°C
4.	MEDIUM HEAD SCHEME	
(a)	*Diversion Structure*	
i)	Type of Structure	Trench Weir across Tarahn stream
ii)	Length	17.5 m

iii)	Design Discharge	1.25 cumecs
iv)	Gates Number of gates	1 nos. at Intake & 1 no. at Bottom Outlet
	Type of gates	Vertical Lift Gates
	Size of gates	Intake 1.20m x 1.85 m
(b)	*Intake*	
	Length	2.50 m
	Size	1.20m x 2.5m
	Bed Level	El 1819.65m
2.	*Water-Conductor System*	
	RCC Box ,Open Channel/Pipe	
	Type	Box type, Open channel/ circular
	Length	3000m total length
	Size	1.20mx1.40m/ 1.20m dia.
3.	Forebay cum de-silting chamber	
	Size of forebay	14.5 m x 5 m
	Bed Level of forebay	EL 1808.33 m
	Maximum forebay FSL	EL 1813.53 m
	Overflow Structure (escape channel)	
	Crest of spillway escape	EL 1813.53 m
	Length of spill way	3.00 m
	Maximum discharging Capacity	1.25 cumecs
4.	Penstocks	
	Number	1 no.
	Diameter and thickness	700 mm dia, 6 mm to 10 mm thick
	Length	325 m
5.	POWER HOUSE	
i)	Type	Surface
ii)	Head (m):	
	– Gross	214.00 m
	– Design	200.00 m
iii)	Size of power house	
	a) Length (m)	24.50 m

	b) Width (m)	18 m
	c) Height (m)(Truss Level)	9 m
	d) Machine Center line level	EL. 1608.00 m
iv)	Installed capacity	2.10 MW
v)	Turbine	
	– Type	Horizontal Pelton
	– Number	2 no.
	– Capacity	1.05 MW (each)
vi)	Type of Generator	Synchronous/ Induction
vii)	Power house crane / lifting tackle capacity	HOT Crane, 20/5 T capacity
7.	TAILRACE	
i)	Shape	Rectangular RCC duct emanating from unit
ii)	Length from centre line of unit	60 m
8.	POWER	
i)	Installed capacity	2.10 MW
ii)	Seasonal (max.) power	2.31 MW
iii)	Total Annual energy	
	– 50% Dependable Year	13.039 GWh
	– 75% Dependable Year	11.142 GWh
	– 90% Dependable Year	9.768 GWh
9.	SWITCHYARD	
i)	Voltage level	22 kV
iii)	Type	Pole mounted with 22 kV switch gear

CHAPTER-1

INTRODUCTION

1.1 GENERAL

Small hydro power has generated a great deal of interest because they are easily available source of energy and as a moderate investment method for providing electricity to far flung areas in the hilly regions. Generation of electricity through small hydro electric projects is environmental friendly as compared to most other plants run by fossil fuels and therefore it can play an important role in protection of environment and in maintenance of ecological balance specially far the isolated hilly areas.

Himachal Pradesh has been endowed with numerous perennial rivers viz. Satluj , Yamuna , Chenab , Beas , Ravi with consistent flows. These perennial rivers are both snow and rainfed and are protected by fairly extensive cover of natural vegetation. The steep slopes of their courses and series of loops and bends on the way, offer potential sites for development of hydropower. The present report deals with

'Tranha Charroli' Small Hydro Electric Project in Shimla of Himachal Pradesh.

1.2 POWER POTENTIAL

At present, 185 small hydro power plants up to 3 MW capacity exist in India with a total installed capacity of 133.46 MW while additional plants having cumulative capacity of 246.69 MW are presently under construction. Out of these, about 75 existing plants are located in the northern hilly region having total installed capacity of 50 MW.

In Himachal Pradesh, there is an estimated potential of about 1200 MW in the small hydropower sector. Under the UNDP-GEF Hilly Hydro Project, Alternate Hydro Energy Centre, IIT, Roorkee, has so far identified hydro project – Master plan, having 458 sites (upto 5 MW capacity) with cumulative installed capacity of 764 MW capacity with 75% dependability. HP State Electricity Board has also prepared a Master Plan in 1994 identifying 147 project sites in the state. Tranha Charroli Small Hydro

Electric project is envisaged on Tarahn Stream, a tributary to Sainj khad.

1.3 PROJECT SPONSOR

State Govt. of Himachal Pradesh has entrusted the task of development of small hydropower schemes up to 5 MW capacities to HIMURJA (Himachal Pradesh Govt. Energy Development Agency) and has appointed it as a nodal agency for this purpose.

HIMURJA has allotted 262 small hydro projects to various private investors in different phases. The total installed capacity of these projects estimated as 759.51 MW. The Tranha Charroli small hydro electric project has been awarded to M/S Lucky Power Projects Co-operative Society Ltd.New Shimla, for development on Build, Own, Operate and Maintain (BOOM) basis for which purpose a Memorandum of Understanding (MOU) was signed between HP Govt. and M/s Lucky Power Projects Co-operative Society Ltd. New Shimla on 11th June, 2009 conveyed vide letter

No.HIMURJA/SHP-Tranh Charroli(Lucky power)/2009-5417 Dated 11th June, 2009.

M/s Lucky Power Projects Co-operative Society Ltd. New Shimla has appointed M/S V.G. Engineers and Consultant Majra, Distt. Sirmour as consultant. for carrying out the relevant studies and preparation of Detailed Project Reports (DPR) for Tranha Charroli small hydro electric project

1.4 GOVERNMENT OF INDIA POLICY

Keeping in view the Government overall thrust on liberalization and private sector participation in power development, various fiscal incentives are available for small hydro sector :

1. Schemes involving capital investment upto Rs. 2500 million needs no prior clearance from CEA, even though under MOU route.
2. A scheme involving capital investment up to Rs. 500 million needs no environment clearance.
3. Income – Tax holiday for ten years.

4. Terms loans at concessional rate through IREDA

5. Concessional customs duty.

MINISTRY OF NEW AND RENEWABLE ENERGY(MNRE)

Government of India had entrusted the with the Ministry of New & renewable Energy the of overseeing the development of small hydropower up to an installed capacity of 5 MW that signifies the thrust attached to this activity by the Government. Following incentives schemes have been announced in respect of Small Hydro Projects in Private Sector.

Promotional Incentive to carry out DSI works and preparation of DPR

Supports towards the cost of survey and investigations limited to Rs. 1.75 Lac up to 1 MW capacity projects, Rs.3.00 lac for project with in range of 1.00 to 3.00 MW capacity and Rs. 5.00 lac for project having capacity of 10 to 25 MW is being allowed by MNES after completion of stipulated codal formalities.

Capital Subsidy

As per Hydro Policy Document 2006 released by Govt. of HP, MNRE is allowing capital subsidy for setting up of commercial small hydro power projects as under: –

- Up to 100 kW, 45% of project cost limited to Rs. 80,000 per kW.
- From 101 kW to 999kW, 45% of project cost limited to Rs. 30.00 lac plus Rs. 21625 per kW.
- From 1.00 MW to 25 MW, 45% of project cost limited to Rs. 2.00 crore plus Rs. 30.00 Lac per MW.

Incentives by the H. P. Government

The following are the terms and conditions stipulated by the Himachal Pradesh Government:

i) H.P. State Electricity Board shall purchase power from Private Investors and Joint Sector companies setting up small hydro power station @ Rs. 2.95 per unit.

ii) H.P. State Electricity board will allow Wheeling for captive use at a fee of 2% (including system losses) within the state boundary whereas the same shall be 10%

(including system losses) in case of sale/ captive use of power out side the state.

iii) H.P. State Electricity Board will also allow banking of energy as per prevailing rules and regulations.

iv) Third party sale of power with in the state shall not be allowed.

v) Royalty on water usage in shape of free power to the State shall be charged as follows:

- 6% royalty for a period of first twelve years reckoned after 30 months from signing of IA of the project .
- Beyond 12 years, the royalty will be 15% for next 18 years and beyond that it will be @ 24%.

vi) The developer shall be permitted to Build, Own, Operate and Maintain the project for 40 years and the date shall be reckoned after 30 months from the signing of IA. Thereafter the project shall be reverted to the state govt. free of cost and free from all encumbrances.

vii) Interfacing including transformers, panels, kiosks, protection, metering HT Lines from the point of generation to the Board's nearest HT

substation as well as maintenance will be undertaken by the developer as per the specifications and requirements of the Board for which he will bear the entire cost. Alternatively, these works and their maintenance could be undertaken by the Board, at charges to be decided by the Board and payable by the developer.

viii) If augmentation of the capacity of sub-station is required only to feed power generated by the Private Investor into the grid, the expenditure for such an augmentation shall be borne by the Private Investor. However, cost of increasing line capacity beyond the sub-station will be borne by HP State Electricity Board and preference will be given by the HP State Electricity Board to Mini Hydel Power Projects for using the existing capacity of both the sub-station and transmission lines, over other bigger power projects in private/ joint sector.

ix) Any industrial unit which is a consumer of HP State Electricity Board and which establishes a power generating unit from non- conventional energy sources will be given exemption from the demand charges for its own use to the extent

of 30% of the installed capacity of Mini Hyde Project.

x) If the applicant does not take the effective steps to undertake the DSI works within a period of three months from the date of signing of MOU, the MOU shall be automatically terminated and the site shall be handed over to some other agency.

xi) The Implementation agreement will be signed within 30 months from the date of signing the MOU.

xii) Income accruing from the Mini-hydel power project shall be exempted from income tax for ten years (30 % exemption for five years thereafter) for all projects set up to 31.03.2003.

xiii) Applications shall be disposed of within a period of 45 days from the date of application (which should be complete in all respects with full information required by the Screening committee). If the Screening committee clears the application, a MOU will be entered into with the entrepreneur within a period of one month from the date of clearance of application.

xiv) Escort services shall be provided by HP State Electricity Board or HIMURJA as the case may be.

xv) H.P. State Electricity Board will clear all dues of a private party on account of purchase of power within one months from the receipt of bill, failing which penalty at the rates of 1.5% per month will be payable by HP State Electricity Board.

1.5 COST

Estimate of cost have been made for civil works of the project including penstock and for generating plant and related equipment of the power house as also the cost of transmission. In case of hydro electric projects, even small ones, a considerable quantum of civil work is involved forming nearly 60% of the total cost estimate. Cost of various components of civil works have been assessed based on DPR level designs of the works and the prevailing rates. Estimates of cost of generating plant and transmission lines and the allied equipment are based on enquiries from Indian suppliers and prevailing rates for other items. Details are given in Chapter 13 - Estimates of cost. The

financial analysis/ evaluation has been carried out in Chapter 14.

1.6 JUSTIFICATION FOR PROJECT

Small hydro electric power project is a greatly favoured renewable energy source with negligible environment impact and minimum disturbance to population and other related factors, while helping reduction of fossil fuel consumption for electricity generation. The magnitude of power generation at any individual small hydro electric project is quite small and presents no difficulty in easy absorption either locally or in the state grid. The expected peak demand of Himachal Pradesh in the year 2010-2011 is estimated in the 17th Electric Power Survey (EPS) as 1451 MW, which at end of 11th plan would rise to 1611 MW. Small hydro electric power projects of the nature of the proposed Tranha Charroli small hydro project will contribute to a small extent in improving the power supply conditions of the surrounding areas of the project and will ensure reliable and quality power to these consumers.

CHAPTER-2

NEED OF THE PROJECT

2.0 INTRODUCTION

Tranha Charroli Small Hydro Electric Project is an run of-the-river development harnessing water of Tarahn stream in Shimla distt. of H.P. The project will feed power in the Northern region which comprises the states of Uttranchal, U.P., Rajasthan, Haryana, Punjab, H.P., Delhi.

2.1 Hydro Power Potential of H.P.

H.P.is endowed with a sizeable hydro power potential of the order of 21000 MW . As per CEA the total identified hydro potential of H.P. is 11578 MW at 60% load factor.

The present installed capacity in the medium and major projects in H.P. is 6045 MW .Break-up of the total hydro potential that has either been harnessed already, or is under execution, or for which detailed project reports are ready or those which are under investigation is as under—

Harnessed so far	6045 MW
Under Execution	3442.50 MW

For which DPR ready	267.50 MW
Under investigation	2094.5 MW
Himurja	750.00 MW
Total	20786.50 MW

Himachal Pradesh, blessed with vast hydro power potential has a significant role to play in mitigating power shortages in Northern grid.

2.2 Development of Hydro Power Demand in Northern Region.

2.2.1 Present Status

The Northern Region, already under severe power deficit, is likely to continue to face power shortage even after counting the benefits from the ongoing projects and also from other schemes cleared by CEA most of the states in the Northern Region have been experiencing energy shortage of Peak Power of varying degrees. Actual power supply position in the Northern Region during the year 2004-05 has been as under--

STATE	PEAK DEMAND	PEAK MET
Chandigarh	210	220
Haryana	3460	2850
Punjab	5740	4660
U.P.	6500	5300

2.2.2 Future Forecast

During the 10th plan period i.e. up to the year 2006 07, 31 projects with an aggregate installed capacity of 13280 MW are scheduled to be implemented in the Northern Region.

Further, as per the 16th Electric Power Survey published by CEA, the electricity demand of in the country is likely to grow at the rate of 6.41%.

The Power supply and demand scenario during the period 2011 to 2012 for the Northern Region and country as a whole considering the benefits

arising out of the ongoing schemes would be as follows source (17th Electric Power Survey)

Description	India	Northern region	
	2004-05	2004-05	2011-12
Energy Demand(MU)	602787	181203	294841
Energy Demand(MU)	559884	165350	249731
Surplus/Deficit(MU)	-92476	-39352	-58797
Surplus/Deficit %	-12.9%	-17.30%	-19.05%
Peak Demand(MW)	90221	27759	48137
Peak Avai.(MW)	80189	25050	35073
Deficit in MW	-14178	-5873	-1460
Surplus/Deficit %	-12.3%	-17%	-29.4%

2.3 Necessity and Justification for implementing the Project

Comparing the projected growth of peak demand and anticipated increase of new projects proposed and/or under construction/consideration during 10th and 11th Five year plans, it is evident that there is a dire need to provide additional power to the Northern Grid to meet the increasing

demand of power. New schemes have to be taken up immediately and implemented to derive timely benefits. The most important source of power development in the Northern Region is Hydro Electric Project located in H.P., Uttaranchal and Jammu and Kashmir. Thus, implementing the Tranha Charroli small hydro electric project is clearly justified. Power from the project is expected to be fully absorbed in the power starved Northern Grid.

2.4 ECONOMIC SCENE OF HIMACHAL PRADESH

The per capita consumption of electricity in Himachal Pradesh is low and is far below the national average of 612 KWh. The standard of living of people and status of industrialization of the state largely depends upon the extent of the usage of electricity. In order to achieve higher per capita consumption of electricity, concerted efforts are being made by the Government of Himachal Pradesh for enhancing substantially the power generation both in medium and large size hydro schemes as well as in several small size hydro schemes. The primary objective of especially the small hydro projects up to 5 MW

was to meet the demand of electricity of the remote and far flung households and villages. With the availability of more funds for various development works in the backward and hilly regions in the state, there has been gradual increase in the use of electricity for various purposes including starting of cottage industries based on local produce and such other industries which have special significance considering the climatic conditions and availability of labour at economical rates.

2.5 PLANNING FOR INCREASED POWER POTENTIAL

It is estimated that by the end of the 11th Five Year Plan, the State's requirement will be as follow in different years.

YEAR	PEAK LOAD (GW)	ENERGYREQUIREMENT (TWh)
2008–2009	1.176	6.909
2009–2010	1.306	7.684
2010–2011	1.451	8.545
2011–2012	1.611	9.504

The above shows that the state has to go a long way in harnessing the available hydro-potential in its major and minor rivers and streams. With the increased emphasis by State Government in harnessing the available potential in small streams , khads, nallas through private participation, the contribution from a large number of small schemes is expected to be substantial . Tranha Charroli small hydro electric scheme is one such scheme.

2.6 OBJECTIVES OF THE SCHEME

The central focus of the state planning is to ensure that the needs of the ordinary people are met and the quality of their life , specially in the rural areas , is improved. The state plan seeks to promote rapid overall development and diversification of the economy and also to strengthen the infrastructure base specially in the hilly region and far flung areas where the pace of development has been very slow. Implementation of Tranha Charroli small hydro electric project will help to improve the infrastructure facilities and as a result ,the local

economy will get the much needed boost, thereby improving the quality of life . Significantly, this scheme will have negligible environment impact and minimum disturbance to population and other related factors.

CHAPTER 3

INFRASTRUCTURE FACILITIES

3.1 LOCATION OF THE PROJECT

Tranha Charroli project a small hydro electric project is planned on Tarahn stream. The scheme is fall under the Survey of India Toposheet No.53F/9 (SW Quadrant) and is located in between the co-ordinates, Longitude 77^0 09' 25" to 77^0 10' 00" E and latitude 31^0 03' 45" to 31^0 04' 40" N. The proposed site is about 170 Km from the Shimla located on Shimla - Solan -- Haripurdhar - Kupvi road .

3.2 ACCESS

The scheme is located near Dhar-Chayma (Charroli) village in Chopal Tehsil of Distt. Shimla in Himachal Pradesh and is approachable by on all weather road. Solan is a narrow gauge railway (Northan Railway) station which is connected with all weather road & rail line with the rest of the country. From project site, Solan is at a distance of 125 Km.

3.3 ROADS IN WORK AREA

The scheme is approachable through out the year through all weather motorable road. For approach to diversion weir & power house about 900m and 700m of a path will have to be constructed taking off from the existing metalled road

The water conductor system will require development of mule path of suitable width for transportation of men & materials along the proposed alignment of the channel up to forebey location .

3.4 AVAILABILITY OF LABOUR

Only unskilled labour is available in the nearby villages. Suitable skilled workmen and technicians for various important works at the diversion weir, intake, forebay cum desilting tank, penstock, power house etc. are not likely to be available in project area and may have to be brought from neighbouring areas such as of Haryana / Punjab. etc.

3.5 AVAILABILITY OF ACCOMMODATION

At Kupvi the availability of accommodation for the various categories of staff/supervisory personnel is not adequate. Some rented accommodation is likely to be available at Kupvi about 3km away from the project location. The project executing agency will have to make their own arrangement for tentage and tin shed accommodation for their staff to be engaged for construction and operation of the various works of Tranha Charroli project. The accommodation required for the skeleton O&M staff may be constructed at Dhar-Chayama (Charroli) village from where daily commuting by the staff may be possible.

3.6 AVAILABILITY OF ELECTRICITY

Power lines of HPSEB are running in the vicinity of the project component works and electric power can be taken from HPSEB for lighting, welding, dewatering and various other construction works of the scheme viz. fabrication of steel penstock and steel gates etc. required for conveyance and regulation of water for generation of power.

3.7 COMMUNICATION FACILITIES

No telephone facility is available at the project location. The nearest telephone exchange is located at Haripurdhar town which is about 20km from the project site.

3.8 OTHER SERVICES AND FACILITIES

The nearest town of Haripurdhar lacated at a distance of about 20km from the project location has market, hospital, schooling and other facilities. There are bank and post office available in Haripurdhar town.

CHAPTER-4

SURVEYS AND INVESTIGATIONS

4.1 GENERAL

M/S Lucky Power Projects Co-operative Society Ltd. New Shimla have done preliminary identification of layout at site in association with Engineers of their consultants, M/s V.G Engineers and Consultant. The components of the project viz. diversion weirs, intake, water conductor systems, forebay cum desilting tank, penstock alignment and power house site have been carefully selected. Subsequently, various visits were conducted for carrying out hydro-meteorological, topographical surveys and to freeze the layout at site and establish the feasibility of the project.

4.2 DETAILED TOPOGRAPHICAL SURVEYS

Topographical surveys for the scheme were carried out by engaging "M/s Northern Survey Agency Chandigarh", a well known Surveyors engaged with topographical and geotechnical

surveys of hydro power projects in and around H.P. There team of surveyors and helpers under the supervision of consultants carried out the surveys by total station for horizontal and vertical control. The surveys were carried out between upstream of the proposed diversion sites and the downstream of powerhouse site. The surveys were carried out in three stages. In first stage control survey was done to fix horizontal and vertical control. In second stage detailed topographical surveys were carried out for various structures. The third stage surveys contemplated the geotechnical appraisal of the scheme. The field surveys in all the stages took about thirty days for completion.

The topographical surveys for all project components were carried out in accordance with guidelines and practices generally followed for small hydroelectric projects. The project was mapped on a scale of 1:5000 with 1m to 5m contour interval. The detailed topographical surveys for intake areas, forebay cum desilting tank, penstock and power house area were carried out on scale of 1:500 and contour interval of 1m to 5m. Detailed topographical

surveys were carried out and following maps were prepared:

- General layout map of the project area on scale 1: 5000.
- Intake area on a scale of 1:500 with 1m contour interval.
- Water Conductor System survey on the scale of 1:500 with 1m to 5m contour interval.
- Project survey of Diversion ,Forebay cum desilting tank, Penstock and power House on the scale of 1:500 and contour interval 1m to 5m.
- Strip survey for forebay cum desilting tank and penstock on a scale of 1:500 with 1 m. contour interval.
- Powerhouse area on a scale of 1:200 with 1 m. contour interval.
- L-section of penstock alignment on a scale of 1:500
- L-section of Tranha Charroli stream on a scale of 1:5000
- X-section of intake area on a scale of 1:200.

4.3 HYDROLOGICAL SURVEYS

M/s Lucky Power Projects Co-operative Society Ltd. New Shimla the developer, has established a discharge-measurement site down stream of the proposed diversion site. A flat reach of the stream was identified near the diversion site to have laminar flows throughout the year. A rectangular weir was constructed at this site by placing wire crates along both banks of the stream. A gauge-discharge relationship has been established for measuring the flows. The site had evenly distributed stream flow in the entire width. The measurement was done by float method. Discharge observations have been made from January, 2008 to March, 2011, i.e. for two lean seasons as per codal requirement of Himurja/MNES. The discharge observations are being continued to confirm the derived flow series.

The gauge was observed once a day in the morning at 10.00 hrs.

4.4 METEOROLOGICAL SURVEYS

There is no rain gauge station located in the catchment area of the project site. Distribution of rainfall in the close vicinity of the project area indicates that most of the rainfall occurs during the months of July to September whereas a little rainfall, accompanied with snowfall, occurs during the winter months of October to February.

4.5 GEOTECHNICAL SURVEYS

Geological appraisal were conducted by "Geological Wing of the Directorate of Industries, Udyog Bhawan, Bemole, Shimla". The project area has moderate relief and rugged topography. Geological investigations including geological mapping of the project has been carried out and geological sections were developed for the proposed engineering structures. No trial pits and exploratory trenches were undertaken at this stage. However, adequate geological explorations, as per actual requirement, will be carried out during pre-construction stage to establish the design parameters.

4.6 CONSTRUCTION MATERIALS

The principal construction materials required for the project are:

- Coarse and fine aggregates for concrete.
- Stone/boulders for masonry works and pitching.
- Cement for concrete and masonry.
- Steel for reinforcement, water conductor system, gates, penstock etc.
- Explosives, detonators etc., for rock excavation.

Since coarse and fine aggregate are not available, same has to be procured from crushers at Renukaji about 65 km away, to cater the actual demands. The other materials like steel, CGI sheets are available in the market at Kala Amb or factories and will be transported to the site.

4.7 LOAD SURVEY

Load Survey for assessing the exiting load and future load projections was carried out in the villages surrounding the project area. The load

demand is assessed to be around 600KW during the peak hours. The expected increase in load demand during peak hours in next five years is expected to 1000kw. There is no industry in the area. Therefore, the power station cannot work in isolation to cater to local load.

4.8 POWER EVACUATION SURVEY

Power evacuation of the generation shall be made through a 22 kV line connecting to a nearby 22 kV feeder of the HPSEB.

CHAPTER – 5

HYDROLOGY

5.1 GENERAL

The hydrological studies of the Tarahn stream have been carried out in order to determine the optimum techno economic power potential of the site, to work out the design flood discharge and other related issues in respect of the Tranha Charroli HEP.

This chapter on hydrology deals with study of the hydro-Meteorological characteristics of the basin in the vicinity of the Tranha Charroli Small Hydro Power Project and the Methodo-logy adopted for establishing various hydro-meteorological parameters which will form the basic inputs for project Planning and design purpose.

Keeping in view of the above, the hydrological investigation and analysis have been carried out for this project to

assess the feasible power generation by establishing a long-term series of average monthly discharge for the project site, study the hydraulic behavior of the stream regime and to establish design flood for the safe design of intake works.

5.2 CATCHMENT AREA

Tarahn stream is the tributary of Sainj khad . The main source of Tarahn stream is the monsoon run-off as well as the run-off on account of snow melting. The elevation of catchment area of the Tarahn stream varies between 3600 meter to 1610 meter and it lies in the Shivalik ranges in Shimla Distt. of Himachal Pradesh. The entire catchment comprises mostly of mountaineous terrain with steep hill slopes but generally of forest cover, being primarily a very less populated area. The flow of the Tarahn stream are low during Nov. to Feb. but starts increasing from February onwards with high flows during July to October due to monsoon rain fall.

It has a medium size fan-shaped catchment area of 14.71 Sq. km. up to the proposed diversion

weir. The index location map and catchment area map is enclosed.

5.3 PRECIPITATION

The precipitation in the catchment of Tarahn stream had take place in the form of snow & rain. The higher reaches experience snow fall whereas the lower reaches experience heavy rain during monsoon i.e. from June to Sep., which occasionally extends up to early October due to south west monsoon. Rain fall is negligible during winter and spring season (Oct. to march) which is generally due to western disturbance that pass over the North-West part of the country. During winter, the precipitation is either in the form of snow or rain depending upon the altitude & other metrological conditions.

5.4 SEDIMENT LOAD

This stream carries significant sediment load during monsoon consisting of silt and suspended particles. In the winter, water is quite clear and free from all kind of impurities.

However, design of the scheme will ensure that rolling bed load as well as silt does not enter the turbine. Intake has been designed to keep in check all floating substances and desilting tank has been designed so as to exclude silt particles greater than and up to 0.25 mm size with about 96% efficiency.

5.5 STREAM FLOW DATA

Discharge observations have been recorded on Tarahn stream at Charroli village since January 2008 to March 2011. This data is available for two years. The discharge have been measured by float method and average ten daily observed data is appended in Annexure 5.1 for the above period.

5.6 EXTENSION OF FLOW DATA

The present scenario presents a grim picture when it comes to planning of small/ mini hydro projects on account of non-availability of stream flow data over a long period. Records which are available are of short durations and do not meet the reliability index in as far as planning of such small projects are concerned.

Project planning and design necessitates at least ten years of historical data. It is also not feasible to collect data over such long periods for planning the project and therefore arises the need for estimation and extension of stream flow data..

It is therefore certain that meteorological characteristics of this project catchment resembles within acceptable limits, with those of Sainj Khad catchment. This data of Sainj Khad has been further reduced on catchment area basis for the establishing of run-of series to carry out preliminary hydrological and power studies in case of Tranha Charroli hydro power project. The average ten days daily discharges computed on catchment area basis w.e.f 1977 to 1983 and 2002 to 2005 has been shown in Annexure 5.3.

5.7 DEPENDABLE YEAR

Diversion of Tranha Charroli small HEP has been designed to divert the flow by building diversion structures in the form of trench weir on the Tarahn stream. The net discharges from this stream are available for power generation

and as shown in Annexure 5.3 have been considered for carrying out power studies in respect of this project. As per CEA standing guidelines, for dependability analysis, the year-wise unrestricted energy generation from 1977 to 1983, 2002 to 2005 and 2008 to 2011, has been used by arranging the same in descending order. Based on data available as contained in Annexure- 5.3, analysis has been carried out to identify the 50%, 75% and 90% dependable years. The guidelines for establishing project capacities in respect of small hydro up to 25 MW requires to adopt the 75% dependable discharge, for this project, 75% dependable flows are considered. The results so obtained for identifying the dependable years are indicated in Annexure-5.4 to Annexure- 5.8

5.7.1 CONSISTANCY OF FLOWS

It is necessary to establish the consistency of observed discharge at Sainj Khad site which is in vicinity of the proposed weir sites. The consistency check studies for flows may be carried out in either of the following two methods;

i) Flow consistency with respect to rainfall.

ii) Flow consistency with respect to discharge of other catchment.

An analysis of Discharge data of Sainj Khad with flow of Tarahn stream has been carried out to ascertain the degree of its co-relation. The results so obtained indicates an acceptable degree of consistency . Accordingly, it has been found that 1981 discharges have a 90% dependability, while the year 2005 has a dependability of 75%. However, for this project 75% dependability is being used for fixing the station capacity.

5.7.2 CATCHMENT AREA

The catchment area of Tarahn stream at discharge site have been computed as below .

Tarahn Stream Charroli village (discharge site) = 14.71 sq. km..

Sainj Khad upto Sainj = 135 sq.km.

Modification Factor = $(14.71/135)^{3/4}$

= 0.1896

5.8 DESIGN FLOOD DISCHARGE

5.8.1 DESIGN CRITERIA

The proposed diversion structure is a trench weir type . In the event of failure of such a structure, it would not cause any loss of life or damages to the properties downstream of the weir. A flood discharge due to a 50 year return period storm rainfall is considered sufficient. Design flood has been worked out by following methods :-

i) Dicken's Empirical method.

ii) Unit Hydrograph Method.

5.8.2 DESIGN FLOOD (BY DICKEN'S EMPIRICAL METHOD)

The catchment area of this Stream is very small i.e. 14.71 sq.km. and therefore, use of empirical formula has been made to access the design flood. The design flood for Tarahn Stream with 1 in 50

years probability works out to 105.16 cumecs as computations below :

Max. Flood Discharge Q max. = C X $A^{3/4}$

Catchment Area Aw = 14.71 sq.km

Constant for hilly area 'C' = 14

Max.Flood Discharge Qmax = 14 x $(14.71)^{3/4}$

= 105.16 cumecs

5.8.3 DESIGN FLOOD (BY UNIT HYDROGRAPH METHOD)

Catchment area at Diversion site (A) = 14.71 sq.km

Qtp = $1.747*(A)^{0.75}$

Where

Qtp –Peak load discharge per cm of rainfall excess.

A ---- Catchment area in sq.km

Qtp = 1.747 x $(14.71)^{0.75}$

= 13.12 cumecs/cm

tc = 2.078 x $(A/Qtp)^{0.90}$

$= 2.078 \times (14.71/13.12)^{0.90}$

$= 2.30$ hr.

Design Flood = 50 years , 4 hours

Point rainfall = 80 mm

Area rainfall = 1.02 x 80

$= 81.60$ mm

Peak of 50 years

Flood Hydrograph = Qtp x Area rainfall

= 13.12 x 8.16

= 107.06 cumecs

5.8.4 DESIGN FLOOD NEAR POWER HOUSE SITE

The tail race channel from the power house discharges into Tarahn Stream. This outfall point is about 3.5 km. downstream of the Tarahn Stream diversion weir site (along the river) , where the catchment area is 34.15 sq.km. The flood discharge Qmax at the weir site where the catchment area is 14.71 sq.km is

Annexure 5.1

TRANHA CHARROLI HEP (2 MW)

HYDROLOGICAL DATA OF TRANAH KHAD

MONTH	PERIOD	2008	2009	2010	2011
	I	11	15	10	22
JANUARY	II	11	15	10	22
	III	13.2	16.5	11	24.2
	I	12	15	8.5	20
FEBURARY	II	12	15	9	20
	III	9.6	12	8.7	16
	I	11	15	10.5	20
MARCH	II	11	14	9.5	20
	III	12.1	14.3	9.9	
	I	11	12.1	8	
APRIL	II	10.5	11.5	8	
	III	10	11	8	
	I	10	10.4	9	
MAY	II	9	9.5	11	
	III	9.9	9.7	11	
	I	9	8	12	
JUNE	II	9	8	13.5	
	III	13.5	9	20	
	I	22	13	40	
JULY	II	32.5	25	40	
	III	44	27.5	44	
	I	40	25	40	
AUGUST	II	40	25	40	
	III	44	27.5	44	
	I	35	24.5	30	
SEPTEMBER	II	30	24	30	
	III	30	24	30	
	I	25	23	25	
OCTOBER	II	25	23	25	
	III	27.5	24.3	27.5	
	I	20	17.5	24	
NOVEMBER	II	20	15	24	
	III	20	15	24	
	I	20	12	23	
DECEMBER	II	20	12	23	
	III	18.5	12	25.3	

Annexure 5.2 (1 of 2)

TRANHA CHARROLI HEP (2 MW)

AVERAGE 10-DAILY DISCHARGE OF SAINJ KHAD

CATCHMENT AREA = 135 SQKM

MONTH	PERIOD	1977	1978	1979	1980	1981	1982	1983	2002
	I	1.42	1.38	2.94	2.72	3.3	1.97	2.53	3.75
JANUARY	II	1.4	2.04	3.01	2.51	2.55	2.06	2.22	3.87
	III	1.4	2.21	2.65	2.55	2.66	3.97	2.71	3.89
	I	1.42	2	2.76	2.64	2.67	9.95	5.51	4.04
FEBURARY	II	1.51	2.68	2.68	2.93	2.92	7.96	5.92	6.04
	III	1.54	1.94	2.61	2.66	3.37	6.78	6.13	5.12
	I	1.54	2.38	1.83	3.7	3.92	13.61	8.23	7.97
MARCH	II	1.59	3.73	2.47	3.07	2.65	12.14	6.28	6.76
	III	1.65	3.35	1.82	2.96	9.6	9.98	5.82	6
	I	1.66	2.39	2.55	2.47	4.2	9.17	9.17	4.73
APRIL	II	1.85	3.16	2.63	1.96	2.69	9.86	8.83	4.3
	III	2.39	3.45	2.7	1.51	3.69	10.93	7.06	3.79
	I	3.21	3.82	2.79	1.44	4.34	11.64	7.23	4.12
MAY	II	3.45	3.84	2.92	2.28	5.03	12.01	9.94	3.65
	III	3.48	3.4	2.67	2.22	3.54	12.81	12.14	3.48
	I	3.84	3.29	3.01	2.8	2.49	14.69	6.48	1.74
JUNE	II	3.79	3.09	3.22	2.73	2.16	16.62	3.99	16.85
	III	4.9	3.24	3.25	4.06	2.31	19.23	19.23	12.18
	I	8.1	4.23	3.75	6.99	2.74	20.03	20.03	11.56
JULY	II	7.31	6.52	4.58	19.07	3.92	17.06	17.06	14.37
	III	14.36	7.95	9.58	16.36	5.11	19.1	19.1	15.42
	I	15.5	11.67	6.38	28.95	4.85	14.59	14.59	14.77
AUGUST	II	8.4	12.58	5.79	25.02	6.52	15.25	15.25	12.34
	III	15.71	10.38	4.82	12.63	4.43	15.97	15.97	10.42
	I	24.33	14.78	3.75	7.32	4.3	11.32	11.32	8.78
SEPTEMBER	II	17.55	9.01	3.97	5.99	3.53	7.8	7.8	6.82
	III	10.21	7.64	4.48	4.39	3.31	7.33	7.33	6.45
	I	7.49	7.06	4.4	3.54	5.03	4.83	4.83	5.56
OCTOBER	II	6.46	5.61	4.37	3.29	4.21	4.12	4.12	5.24
	III	4.71	3.56	4.33	2.67	3.53	3.49	3.49	4.82
	I	3.69	3.75	2.74	2.99	5.32	3.1	3.56	4.57
NOVEMBER	II	6.46	5.61	4.37	3.29	4.21	4.12	4.12	5.78
	III	2.57	3.42	3.5	2.14	4.26	2.64	6.27	4.2
	I	2.29	3.39	2.63	2.46	3.88	1.91	4.76	3.67
DECEMBER	II	2.13	3.3	3.03	2.13	3.4	1.9	4.1	3.42
	III	2.6	3.49	1.84	2.65	1.78	1.77	3.96	2.98

Annexure 5.2 (2 of 2)

2003	2004	2005
2.71	4.13	3.02
2.45	3.95	3.26
2.46	3.93	3.89
2.47	3.79	4.77
3.33	3.53	6.38
7.06	3.52	4.69
12.68	2.89	4.86
13.85	2.67	5.41
7.48	2.55	5.17
6.55	2.41	3.11
6.23	2.36	2.12
5.25	2.36	2.3
5.72	2.4	3.04
5.46	2.52	1.94
5.02	4.11	1.76
2.34	2.43	1.83
26.12	2.52	1.71
13.94	3.22	2.73
16.96	7.86	6.92
19.29	11.47	10.47
15.96	16.21	13.36
7.7	17.1	12.57
12.04	18.52	10.36
15.65	8.96	7.8
11.03	6.56	5.49
8.31	6.16	9.87
19.67	9.12	10.59
13.75	6.07	7.07
32.25	5.68	5.29
18.74	5.16	3.7
10.09	4.8	2.76
7.78	4.44	2.5
6.79	4.27	2.18
5.24	4.14	4.28
4.72	3.96	3.73
4.44	4.21	3.35

Annexure 5.3 (1 of 2)

TRANHA CHARROLI HEP (2 MW)

CORELATING DISCHARGE BASED ON CATCHMENT AREA BASIS

CATCHMENT AREA (SAINJ KHAD) : 135.00 SQ. KM

CATCHMENT AREA TARANH : 14.71 SQ. KM

Multiplying factor 0.1897

MONTH	PERIOD	1977	1978	1979	1980	1981	1982	1983	2002
	I	0.269	0.262	0.558	0.516	0.626	0.374	0.480	0.711
JANUARY	II	0.266	0.387	0.571	0.476	0.484	0.391	0.421	0.734
	III	0.266	0.419	0.503	0.484	0.504	0.753	0.514	0.738
	I	0.269	0.379	0.523	0.501	0.506	1.887	1.045	0.766
FEBURARY	II	0.286	0.508	0.508	0.556	0.554	1.510	1.123	1.146
	III	0.292	0.368	0.495	0.504	0.639	1.286	1.163	0.971
	I	0.292	0.451	0.347	0.702	0.743	2.581	1.561	1.512
MARCH	II	0.302	0.707	0.468	0.582	0.503	2.302	1.191	1.282
	III	0.313	0.635	0.345	0.561	1.821	1.893	1.104	1.138
	I	0.315	0.453	0.484	0.468	0.797	1.739	1.739	0.897
APRIL	II	0.351	0.599	0.499	0.372	0.510	1.870	1.675	0.816
	III	0.453	0.654	0.512	0.286	0.700	2.073	1.339	0.719
	I	0.609	0.724	0.529	0.273	0.823	2.208	1.371	0.781
MAY	II	0.654	0.728	0.554	0.432	0.954	2.278	1.885	0.692
	III	0.660	0.645	0.506	0.421	0.671	2.429	2.302	0.660
	I	0.728	0.624	0.571	0.531	0.472	2.786	1.229	0.330
JUNE	II	0.719	0.586	0.611	0.518	0.410	3.152	0.757	3.196
	III	0.929	0.614	0.616	0.770	0.438	3.647	3.647	2.310
	I	1.536	0.802	0.711	1.326	0.520	3.799	3.799	2.192
JULY	II	1.386	1.237	0.869	3.617	0.743	3.235	3.235	2.725
	III	2.723	1.508	1.817	3.103	0.969	3.622	3.622	2.924
	I	2.940	2.213	1.210	5.490	0.920	2.767	2.767	2.801
AUGUST	II	1.593	2.386	1.098	4.745	1.237	2.892	2.892	2.340
	III	2.979	1.969	0.914	2.395	0.840	3.029	3.029	1.976
	I	4.614	2.803	0.711	1.388	0.816	2.147	2.147	1.665
SEPTEMBER	II	3.328	1.709	0.753	1.136	0.669	1.479	1.479	1.293
	III	1.936	1.449	0.850	0.833	0.628	1.390	1.390	1.223
	I	1.420	1.339	0.834	0.671	0.954	0.916	0.916	1.054
OCTOBER	II	1.225	1.064	0.829	0.624	0.798	0.781	0.781	0.994
	III	0.893	0.675	0.821	0.506	0.669	0.662	0.662	0.914
	I	0.700	0.711	0.520	0.567	1.009	0.588	0.675	0.867
NOVEMBER	II	1.225	1.064	0.829	0.624	0.798	0.781	0.781	1.096
	III	0.487	0.649	0.664	0.406	0.808	0.501	1.189	0.797
	I	0.434	0.643	0.499	0.467	0.736	0.362	0.903	0.696
DECEMBER	II	0.404	0.626	0.575	0.404	0.645	0.360	0.778	0.649
	III	0.493	0.662	0.349	0.503	0.338	0.336	0.751	0.565

2003	2004	2005
0.514	0.783	0.573
0.465	0.749	0.618
0.467	0.745	0.738
0.468	0.719	0.905
0.632	0.669	1.210
1.339	0.668	0.889
2.405	0.548	0.922
2.627	0.506	1.026
1.419	0.484	0.981
1.242	0.457	0.590
1.182	0.448	0.402
0.996	0.448	0.436
1.085	0.455	0.577
1.036	0.478	0.368
0.952	0.779	0.334
0.444	0.461	0.347
4.954	0.478	0.324
2.644	0.611	0.518
3.217	1.491	1.312
3.658	2.175	1.986
3.027	3.074	2.534
1.460	3.243	2.384
2.283	3.512	1.965
2.968	1.699	1.479
2.092	1.244	1.041
1.576	1.168	1.872
3.730	1.730	2.008
2.608	1.151	1.341
6.116	1.077	1.003
3.554	0.979	0.702
1.914	0.910	0.523
1.475	0.842	0.474
1.288	0.810	0.413
0.994	0.785	0.812
0.895	0.751	0.707
0.842	0.798	0.635

Annexure 5.4

TRANSHA CHARROLI HEP - POWER AND GENERATION (UNRESTRICTED)

HYDRAULIC YEAR

NET HEAD H 200 m

OVERALL EFFICIENCY n 0.87

MONTH	PERIOD		1977			1978			1979	
		DISCH.	POWER	ENERGY	DISCH.	POWER	ENERGY	DISCH.	POWER	ENERGY
		CUMECS	KW	MWH	CUMECS	KW	MWH	CUMECS	KW	MWH
	I	0.269	459.691	110.33	0.262	446.74	107.22	0.558	951.75	228.42
JANUARY	II	0.266	453.216	108.77	0.387	660.40	158.50	0.571	974.41	233.86
	III	0.266	453.216	119.65	0.419	715.43	171.70	0.503	857.87	205.89
	I	0.269	459.691	110.33	0.379	647.45	155.39	0.523	893.48	214.44
FEBURARY	II	0.286	488.826	117.32	0.506	867.59	208.22	0.508	867.59	208.22
	III	0.292	498.538	95.72	0.368	628.03	150.73	0.495	844.92	202.78
	I	0.292	498.538	119.65	0.451	770.47	184.91	0.347	592.42	142.18
MARCH	III	0.302	514.724	123.53	0.707	1207.50	289.80	0.468	799.60	191.90
	III	0.313	534.148	141.01	0.635	1084.48	260.28	0.345	589.18	141.40
	I	0.315	537.365	128.97	0.453	773.70	185.69	0.484	825.50	198.12
APRIL	II	0.351	598.893	143.73	0.599	1022.97	245.51	0.499	851.40	204.34
	III	0.453	773.705	185.69	0.654	1116.85	268.05	0.512	874.06	209.77
	I	0.609	1039.160	249.40	0.724	1236.63	296.79	0.529	903.20	216.77
MAY	II	0.654	1116.854	268.05	0.728	1243.11	298.35	0.554	945.28	226.87
	III	0.660	1126.566	297.41	0.645	1100.67	264.16	0.506	864.35	207.44
	I	0.728	1243.107	298.35	0.624	1065.06	255.61	0.571	974.41	233.86
JUNE	II	0.719	1226.921	294.46	0.586	1000.31	240.08	0.611	1042.40	250.18
	III	0.929	1586.257	380.70	0.614	1048.87	251.73	0.616	1052.11	252.51
	I	1.536	2622.180	629.32	0.802	1369.36	328.65	0.711	1213.97	291.35
JULY	II	1.386	2366.436	567.94	1.237	2110.69	506.57	0.869	1482.66	355.84
	III	2.723	4648.704	1227.26	1.508	2573.62	617.67	1.817	3101.29	744.31
	I	2.940	5017.751	1204.26	2.213	3777.88	906.69	1.210	2065.37	495.69
AUGUST	II	1.593	2719.297	652.63	2.386	4072.47	977.39	1.098	1874.37	449.85
	III	2.979	5085.734	1342.63	1.969	3360.27	806.47	0.914	1560.36	374.49
	I	4.614	7876.251	1890.30	2.803	4784.67	1148.32	0.711	1213.97	291.35
SEPTEMBER	II	3.328	5681.389	1363.53	1.709	2916.77	700.02	0.753	1285.19	308.45
	III	1.936	3305.241	793.26	1.449	2473.27	593.58	0.850	1450.29	348.07
	I	1.420	2424.707	581.93	1.339	2285.50	548.52	0.834	1424.39	341.85
OCTOBER	II	1.225	2091.269	501.90	1.064	1816.10	435.86	0.829	1414.68	339.52
	III	0.893	1524.749	402.53	0.675	1152.46	276.59	0.821	1401.73	336.42
	I	0.700	1194.549	286.69	0.711	1213.97	291.35	0.520	887.01	212.88
NOVEMBER	II	1.225	2091.269	501.90	1.064	1816.10	435.86	0.829	1414.68	339.52
	III	0.487	831.976	199.67	0.649	1107.14	265.71	0.664	1133.04	271.93
	I	0.434	741.332	177.92	0.643	1097.431	263.38	0.499	851.40	204.34
DECEMBER	II	0.404	689.536	165.49	0.626	1068.30	256.39	0.575	980.89	235.41
	III	0.493	841.687	222.21	0.662	1129.80	271.15	0.349	595.66	142.96
ENERGY GENERATED (MWH)				16004.46			13622.90			9853.18

Annexure 5.5

TRANHA CHARROLI HEP - POWER AND GENERATION (UNRESTRICTED)

MONTH	PERIOD		1980			1981			1982	
		DISCH.	POWER	ENERGY	DISCH.	POWER	ENERGY	DISCH.	POWER	ENERGY
		CUMECS	KW	MWH	CUMECS	KW	MWH	CUMECS	KW	MWH
	I	0.516	880.534	211.33	0.626	1068.30	256.39	0.374	637.74	153.06
JANUARY	II	0.476	812.552	195.01	0.484	825.50	198.12	0.391	666.88	160.05
	III	0.484	825.501	217.93	0.504	861.11	206.67	0.753	1285.19	308.45
	I	0.501	854.636	205.11	0.506	864.35	207.44	1.887	3221.07	773.06
FEBURARY	II	0.556	948.517	227.64	0.554	945.26	226.87	1.510	2576.86	618.45
	III	0.504	861.111	165.33	0.639	1090.96	261.83	1.286	2194.86	526.77
	I	0.702	1197.786	287.47	0.743	1269.01	304.56	2.581	4405.91	1057.42
MARCH	III	0.582	993.836	238.52	0.503	857.87	205.89	2.302	3930.03	943.21
	III	0.561	958.229	252.97	1.821	3107.77	745.86	1.893	3230.78	775.39
	I	0.468	799.603	191.90	0.797	1359.65	326.32	1.739	2968.57	712.46
APRIL	II	0.372	634.503	152.28	0.510	870.82	209.00	1.870	3191.94	766.06
	III	0.286	488.826	117.32	0.700	1194.55	286.69	2.073	3538.32	849.20
	I	0.273	466.165	111.88	0.823	1404.97	337.19	2.208	3768.17	904.36
MAY	II	0.432	738.095	177.14	0.954	1628.34	390.80	2.278	3887.95	933.11
	III	0.421	718.671	189.73	0.671	1145.99	275.04	2.429	4146.93	995.26
	I	0.531	906.432	217.54	0.472	806.08	193.46	2.786	4755.53	1141.33
JUNE	II	0.518	883.772	212.11	0.410	699.25	167.82	3.152	5380.32	1291.28
	III	0.770	1314.327	315.44	0.438	747.81	179.47	3.647	6225.25	1494.06
	I	1.326	2262.844	543.08	0.520	887.01	212.88	3.799	6484.23	1556.22
JULY	II	3.617	6173.453	1481.63	0.743	1269.01	304.56	3.235	5522.76	1325.46
	III	3.103	5296.156	1398.19	0.969	1654.24	397.02	3.622	6183.16	1483.96
	I	5.490	9371.865	2249.25	0.920	1570.07	376.82	2.767	4723.16	1133.56
AUGUST	II	4.745	8099.622	1943.91	1.237	2110.69	506.57	2.892	4936.82	1184.84
	III	2.395	4088.658	1079.41	0.840	1434.11	344.19	3.029	5169.90	1240.78
	I	1.388	2369.674	568.72	0.816	1392.02	334.09	2.147	3664.58	879.50
SEPTEMBER	II	1.136	1939.118	465.39	0.669	1142.75	274.26	1.479	2525.06	606.01
	III	0.833	1421.157	341.08	0.628	1071.53	257.17	1.390	2372.91	569.50
	I	0.671	1145.390	275.04	0.954	1628.34	390.80	0.916	1563.60	375.26
OCTOBER	II	0.624	1065.058	255.61	0.798	1362.89	327.09	0.781	1333.75	320.10
	III	0.506	864.348	228.19	0.669	1142.75	274.26	0.662	1129.80	271.15
	I	0.567	967.940	232.31	1.009	1722.22	413.33	0.588	1003.55	240.85
NOVEMBER	II	0.624	1065.058	255.61	0.798	1362.89	327.09	0.781	1333.75	320.10
	III	0.406	692.773	166.27	0.808	1379.07	330.98	0.501	854.64	205.11
	I	0.467	796.366	191.13	0.736	1256.056	301.45	0.362	618.32	148.40
DECEMBER	II	0.404	689.536	165.49	0.645	1100.67	264.16	0.360	615.08	147.62
	III	0.503	857.874	226.48	0.338	576.23	138.30	0.336	572.99	137.52
ENERGY GENERATED (MWH)				15753.43			10754.43			26548.89

Annexure 5.6

TRANHA CHARROLI HEP - POWER AND GENERATION (UNRESTRICTED)

MONTH	PERIOD		1983			2002			2003	
		DISCH.	POWER	ENERGY	DISCH.	POWER	ENERGY	DISCH.	POWER	ENERGY
		CUMECS	KW	MWH	CUMECS	KW	MWH	CUMECS	KW	MWH
	I	0.480	819.027	196.57	0.711	1213.97	291.35	0.514	877.30	210.55
JANUARY	II	0.421	718.671	172.48	0.734	1252.82	300.68	0.465	793.13	190.35
	III	0.514	877.297	231.61	0.738	1259.29	302.23	0.467	796.37	191.13
	I	1.045	1783.730	428.10	0.766	1307.85	313.88	0.468	799.60	191.90
FEBURARY	II	1.123	1916.457	459.95	1.146	1955.30	469.27	0.632	1078.01	258.72
	III	1.163	1984.440	381.01	0.971	1657.48	397.79	1.339	2285.50	548.52
	I	1.561	2664.264	639.42	1.512	2580.10	619.22	2.405	4104.84	985.16
MARCH	III	1.191	2032.999	487.92	1.282	2188.39	525.21	2.627	4483.60	1076.06
	III	1.104	1884.085	497.40	1.138	1942.36	466.17	1.419	2421.47	581.15
	I	1.739	2968.568	712.46	0.897	1531.22	367.49	1.242	2120.40	508.90
APRIL	II	1.675	2858.500	686.04	0.816	1392.02	334.09	1.182	2016.81	484.03
	III	1.339	2285.505	548.52	0.719	1226.92	294.46	0.996	1699.56	407.89
	I	1.371	2340.538	561.73	0.781	1333.75	320.10	1.085	1851.71	444.41
MAY	II	1.885	3217.835	772.28	0.692	1181.60	283.58	1.036	1767.54	424.21
	III	2.302	3930.032	1037.53	0.660	1126.57	270.38	0.952	1625.10	390.02
	I	1.229	2097.744	503.46	0.330	563.28	135.19	0.444	757.52	181.80
JUNE	II	0.757	1291.666	310.00	3.196	5454.78	1309.15	4.954	8455.72	2029.37
	III	3.647	6225.249	1494.06	2.310	3942.98	946.32	2.644	4512.74	1083.06
	I	3.799	6484.230	1556.22	2.192	3742.27	898.15	3.217	5490.39	1317.69
JULY	II	3.235	5522.764	1325.46	2.725	4651.94	1116.47	3.658	6244.67	1498.72
	III	3.622	6183.165	1632.36	2.924	4991.65	1198.04	3.027	5166.67	1240.00
	I	2.767	4723.161	1133.56	2.801	4781.43	1147.54	1.460	2492.69	598.25
AUGUST	II	2.892	4936.820	1184.84	2.340	3994.78	958.75	2.283	3897.66	935.44
	III	3.029	5169.902	1364.85	1.976	3373.22	809.57	2.968	5066.31	1215.91
	I	2.147	3664.577	879.50	1.665	2842.31	682.16	2.092	3570.70	856.97
SEPTEMBER	II	1.479	2525.062	606.01	1.293	2207.81	529.87	1.576	2690.16	645.64
	III	1.390	2372.911	569.50	1.223	2088.03	501.13	3.730	6367.69	1528.25
	I	0.916	1563.596	375.26	1.054	1799.92	431.98	2.608	4451.23	1068.30
OCTOBER	II	0.781	1333.751	320.10	0.994	1696.32	407.12	6.116	10440.16	2505.64
	III	0.662	1129.803	298.27	0.914	1560.36	374.49	3.554	6066.62	1455.99
	I	0.675	1152.464	276.59	0.867	1479.43	355.06	1.914	3266.39	783.93
NOVEMBER	II	0.781	1333.751	320.10	1.096	1871.14	449.07	1.475	2518.59	604.46
	III	1.189	2029.761	487.14	0.797	1359.65	326.32	1.288	2198.10	527.54
	I	0.903	1540.935	369.82	0.696	1188.074	285.14	0.994	1696.32	407.12
DECEMBER	II	0.778	1327.276	318.55	0.649	1107.14	265.71	0.895	1527.99	366.72
	III	0.751	1281.955	338.44	0.565	964.70	231.53	0.842	1437.34	344.96
ENERGY GENERATED (MWH)				23477.09			18914.66			28088.79

Annexure 5.7

TRANHA CHARROLI HEP - POWER AND GENERATION (UNRESTRICTED)

MONTH	PERIOD		2004			2005	
		DISCH	POWER	ENERGY	DISCH	POWER	ENERGY
		CUMECS	KW	MWH	CUMECS	KW	MWH
	I	0.783	1336.988	320.88	0.573	977.65	234.64
JANUARY	II	0.749	1278.717	306.89	0.618	1055.35	253.28
	III	0.745	1272.243	335.87	0.738	1259.29	302.23
	I	0.719	1226.921	294.46	0.905	1544.17	370.60
FEBURARY	II	0.669	1142.752	274.26	1.210	2065.37	495.69
	III	0.668	1139.515	218.79	0.889	1518.27	364.39
	I	0.548	935.568	224.54	0.922	1573.31	377.59
MARCH	III	0.506	864.348	207.44	1.026	1751.36	420.33
	III	0.484	825.501	217.93	0.981	1673.66	401.68
	I	0.457	780.179	187.24	0.590	1006.79	241.63
APRIL	II	0.448	763.993	183.36	0.402	686.30	164.71
	III	0.448	763.993	183.36	0.436	744.57	178.70
	I	0.455	776.942	186.47	0.577	984.13	236.19
MAY	II	0.478	815.789	195.79	0.368	628.03	150.73
	III	0.779	1330.513	351.26	0.334	569.76	136.74
	I	0.461	786.654	188.80	0.347	592.42	142.18
JUNE	II	0.478	815.789	195.79	0.324	553.57	132.86
	III	0.611	1042.397	250.18	0.518	883.77	212.11
	I	1.491	2544.485	610.68	1.312	2240.18	537.64
JULY	II	2.175	3713.136	891.15	1.986	3389.41	813.46
	III	3.074	5247.597	1385.37	2.534	4324.98	1037.99
	I	3.243	5535.713	1328.57	2.384	4069.23	976.62
AUGUST	II	3.512	5995.403	1438.90	1.965	3353.80	804.91
	III	1.699	2900.584	765.75	1.479	2525.06	606.01
	I	1.244	2123.642	509.67	1.041	1777.26	426.54
SEPTEMBER	II	1.168	1994.151	478.60	1.872	3195.17	766.84
	III	1.730	2952.380	708.57	2.008	3428.26	822.78
	I	1.151	1965.016	471.60	1.341	2288.74	549.30
OCTOBER	II	1.077	1838.763	441.30	1.003	1712.51	411.00
	III	0.979	1670.426	440.99	0.702	1197.79	287.47
	I	0.910	1553.884	372.93	0.523	893.48	214.44
NOVEMBER	II	0.842	1437.343	344.96	0.474	809.31	194.24
	III	0.810	1382.310	331.75	0.413	705.72	169.37
	I	0.785	1340.225	321.65	0.812	1385.547	332.53
DECEMBER	II	0.751	1281.955	307.67	0.707	1207.50	289.80
	III	0.798	1362.686	359.80	0.635	1084.48	260.28
ENERGY GENERATED (MWH)				15833.23			14317.49

Annexure 5.8

TRANIHA CHARROLI HEP - POWER AND GENERATION (UNRESTRICTED)

MONTH	PERIOD		2008			2009			2010	
		DISCH.	POWER	ENERGY	DISCH.	POWER	ENERGY	DISCH.	POWER	ENERGY
		CUMECS	KW	MWH	CUMECS	KW	MWH	CUMECS	KW	MWH
	I	1.100	1877.634	450.63	1.500	2560.41	614.50	1.000	1706.94	409.67
JANUARY	II	1.100	1877.634	450.63	1.500	2560.41	614.50	1.000	1706.94	409.67
	III	1.320	2253.161	594.83	1.650	2816.45	675.95	1.100	1877.63	450.63
	I	1.200	2048.328	491.60	1.500	2560.41	614.50	0.850	1450.90	348.22
FEBURARY	II	1.200	2048.328	491.60	1.500	2560.41	614.50	0.900	1536.25	368.70
	III	0.960	1638.662	314.62	1.200	2048.33	491.60	0.870	1485.04	356.41
	I	1.100	1877.634	450.63	1.500	2560.41	614.50	1.050	1792.29	430.15
MARCH	III	1.100	1877.634	450.63	1.400	2389.72	573.53	0.950	1621.59	389.18
	III	1.210	2065.397	545.26	1.430	2440.92	585.82	0.990	1689.87	405.57
	I	1.100	1877.634	450.63	1.210	2065.40	495.70	0.800	1365.55	327.73
APRIL	II	1.050	1792.287	430.15	1.150	1962.98	471.12	0.800	1365.55	327.73
	III	1.000	1706.940	409.67	1.100	1877.63	450.63	0.800	1365.55	327.73
	I	1.000	1706.940	409.67	1.040	1775.22	426.05	0.900	1536.25	368.70
MAY	II	0.900	1536.246	368.70	0.950	1621.59	389.18	1.100	1877.63	450.63
	III	0.990	1689.871	446.13	0.970	1655.73	397.38	1.100	1877.63	450.63
	I	0.900	1536.246	368.70	0.800	1365.55	327.73	1.200	2048.33	491.60
JUNE	II	0.900	1536.246	368.70	0.800	1365.55	327.73	1.350	2304.37	553.05
	III	1.350	2304.369	553.05	0.900	1536.25	368.70	2.000	3413.88	819.33
	I	2.200	3755.268	901.26	1.300	2219.02	532.57	4.000	6827.76	1638.66
JULY	II	3.250	5547.555	1331.41	2.500	4267.35	1024.16	4.000	6827.76	1638.66
	III	4.400	7510.536	1982.78	2.750	4694.09	1126.58	4.400	7510.54	1802.53
	I	4.000	6827.760	1638.66	2.500	4267.35	1024.16	4.000	6827.76	1638.66
AUGUST	II	4.000	6827.760	1638.66	2.500	4267.35	1024.16	4.000	6827.76	1638.66
	III	4.400	7510.536	1982.78	2.750	4694.09	1126.58	4.400	7510.54	1802.53
	I	3.500	5974.290	1433.83	2.450	4182.00	1003.68	3.000	5120.82	1229.00
SEPTEMBER	II	3.000	5120.820	1229.00	2.400	4096.66	983.20	3.000	5120.82	1229.00
	III	3.000	5120.820	1229.00	2.400	4096.66	983.20	3.000	5120.82	1229.00
	I	2.500	4267.350	1024.16	2.300	3925.96	942.23	2.500	4267.35	1024.16
OCTOBER	II	2.500	4267.350	1024.16	2.300	3925.96	942.23	2.500	4267.35	1024.16
	III	2.750	4694.085	1239.24	2.430	4147.86	995.49	2.750	4694.09	1126.58
	I	2.000	3413.880	819.33	1.750	2987.15	716.91	2.400	4096.66	983.20
NOVEMBER	II	2.000	3413.880	819.33	1.500	2560.41	614.50	2.400	4096.66	983.20
	III	2.000	3413.880	819.33	1.500	2560.41	614.50	2.400	4096.66	983.20
	I	2.000	3413.880	819.33	1.200	2048.328	491.60	2.300	3925.96	942.23
DECEMBER	II	2.000	3413.880	819.33	1.200	2048.33	491.60	2.300	3925.96	942.23
	III	1.850	3157.839	833.67	1.200	2048.33	491.60	2.530	4318.56	1036.45
ENERGY GENERATED (MWH)				29631.11			24182.56			30577.44

Annexure 5.9

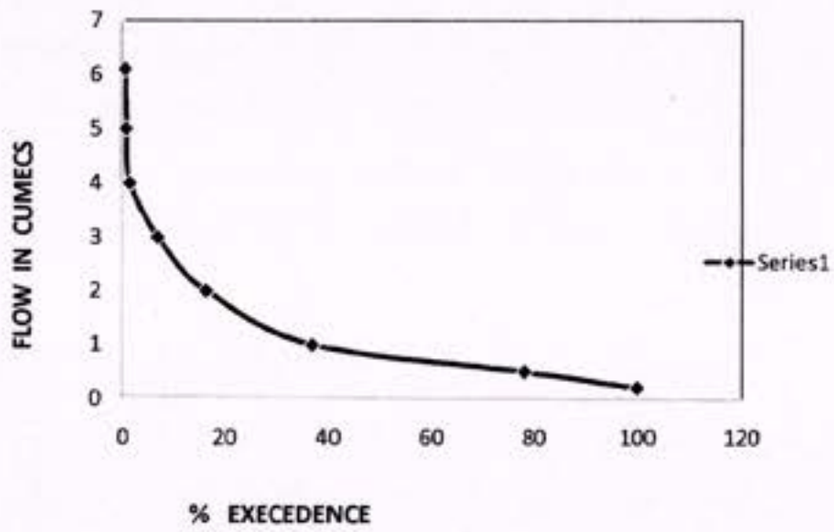
TRANHA CHARROLI HEP

IDENTIFYING 75% DEPENDABLE YEAR

YEAR	ENERGH M'WH				
1977	16004.46		30577.44	2010	
1978	13622.90		29631.11	2008	
1979	9853.18		28088.79	2003	
1980	15753.43		26548.89	1982	
1981	10754.43		24182.56	2009	
1982	26548.89		23477.09	1983	
1983	23477.09		18914.66	2002	50%
2002	18914.66		16004.46	1977	
2003	28088.79		15833.23	2004	
2004	15833.23		15753.43	1980	
2005	14317.49		14317.49	2005	75%
2008	29631.11		13622.90	1978	
2009	24182.56		10754.43	1981	90%
2010	30577.44		9853.18	1979	

Annexure 5.9

% Occ.	Dishrage
0.25	6.11
0.5	5
1.26	4
6.81	3
16.41	2
36.87	1
78.03	0.5
100	0.2



CHAPTER-6

GEOLOGY

6.1 Introduction

The northern state of India, Himachal Pradesh has a hilly topography. The topography of the state influences the weather which remains more or less pleasant throughout the year. The total area of Himachal Pradesh is more than 55,673 sq.km. It is surrounding by landforms from all sides. The topography of the land is hilly and average altitude of the region ranges from 450m and 6500m above the mean sea level. The elevation of the state increases from west to east.

The topography of the catchment is hilly because the project has been located in the middle Himalayas. From the toposheet of 53F/9 contour can be located thereby measuring the altitude of various sites of the project.

6.2 PHYSIOGRAPHY

The catchment area of the project is bounded by the Churdhar mountain belongs to Shivalik

range at an elevation of 3600m. On the basis of marked contour, it is observed that the upper catchment area is very steep. Steep to undulating and rugged terrain is the distinguishing feature of the area. Absence of valley and very little probability of finding terraces confirm the no habitation and cultivation zone within the catchment area above the trench weir site.

6.3 METEOROLOGY

a) CLIMATE

The climate of the catchment area is temperate Climatically, the year may be divided into four season namely winter, from Dec. to March, summer from April to June, monsoon from July to Sep.and autumn, during Oct. to Nov. In the winter season, the higher reaches of the watershed divider receives precipitation in the form of snow, while moderate rainfall occur in lower altitudes. The main source of winter precipitation is the weather disturbance, which approaches India from west through Iran, Afghanistan and Pakistan. The Temperature in the region varies from about thirty degree to minus twenty degree.

b) RAINFALL

Seventy percent of rain fall is experienced during month of July to Sep.

6.4 GEOLOGY

6.4.1 Regional Geology

The sub Himalaya zone between lesser Himalayan greater Himalaya which in turn is made up of the thrusted rocks of territiary. Mesozoic and Cambrian era and demarked/separated by plains of lesser Himalaya. The bed rock of the area undertaken for studies and surveys for geological consideration, consists of metamorphic rocks such as gneisses, quartzite, schist and to some extent phyllitic zone. The litho-unit of the lower Himalaya include meta-sedimentaries, central crystalline, quartzite syncline and anticline basic intrusive and intercalated hornblende schist, kyanite bearing schist and gneisses.

The intake area is marked by cobbles and boulders, wherein the intrusion of quartz-vein is prominent. The rounding of rock at surface corners and edges is a direct result of concentric weathering and abrasion.

6.4.2 Geological Setup

The rock type met within the area are having their physical order of superposition as under :

- Metamorphic/central crystalline Pre-Cambrian
- Middle Shivalik Tertiary
- Granite/Granitic gneiss Acidic rocks
- Meta-sedimentaries Phyllite,Quartzite
- Unconsolidated/semi-consolidated Recent Sediments
- Anticline/Syncline/Thrust/fracture --do—

These beds are characterized by deep seated metamorphism and basic intrusions being strongly thrusted, faulted anticlines, synclines, windows and nappy are prominent.

6.4.3 Project Component

i) **Trench weir/Water Conductor system :**

The intake area is surrounded by boulders and cobbles of varying sizes. Water Conductor System

in the form of part box channel and part open channel, shall travel a distance of 3000m upto forebay area. The proposed slope of the water conductor system will be 1 in 415m. No shear zone is likely to be encountered in the course of the water conductor system.

ii Penstock and Power House

Penstock will be installed in the hill slope with a gradient of nearly fifty to sixty degree. The penstock alignment is arranged along the ridge where slides in porphyroblastic gneiss/schist may be encountered. The power house to be installed is at elevation of 1608m. At this site, the insitu rocks are vary well exposed which is an encouraging condition for laying any type of foundation of the structure proposed to be constructed.

6.5 SEISMICITY OF THE PROJECT AREA

The project area falls within Himalayan Seismic belt and lies in Seismic zone iv of seismic map of India as per IS code 1893: 2000 which corresponding to the seismically active area in India.

6.6 SUMMARY OF GENERAL ASSESSMENT

The project layout has been conceived judiciously and no major geological surprises are expected to crop up. Further, no mineral of economic importance is likely to be submerged due to reservoir and development of this project is not going to create any seismological activity in the vicinity of area.

No deforestration is likely to occur, hence no resultant effect on environment and compensatory afforestation will be done in the low lying areas along the stream as per requirement and availability of suitable land.

CHAPTER – 7

POWER POTENTIAL & PLANT CAPACITY

7.1. GENERAL

Tranha Charroli Small HEP is a run–of–river scheme utilising inflows of Tarahn stream for power generation. The flow data for the stream as measured with effect from January 2008 to March 2011, by the Promoter by establishing a discharge observation station at a suitable site is available. This data covers two lean and two flood season flow in the stream.

7.2 WATER AVAILABILITY

Hydrology data series for 50%, 75% and 90% dependability discharges of average ten days of throughout the year have been worked out (for detail refer Chapter – 5, Hydrology).

Being a Small Hydro Project falling in the category of 'mini', the power optimization and

the energy calculations have been computed for 75% dependability discharge data.

7.3 DESIGN HEAD

The net operating head, expected to be available for power generation has been estimated by deducting the total head loss from the gross head on the basis of following design parameters:

Weir crest level (FRL at intake)		
		-EL 1822.0 m
Turbine centre line	-EL 1608.00 m	
Gross head	- 214.00 m	
Total hydraulic loss		
-From intake to forebay	- 8.47 m	
-From forebay to tail race	- 5.26 m	
Hence,		
Design (net) head	- 200.27m	

Adopted design head - 200 m

Hydraulic loss computations are enclosed at Annexure 8.10. Thus, for power potential studies

and power optimization study, a rated head of 200 m has been considered.

7.4 EFFICIENCIES OF TURBINE & GENERATOR

The efficiencies are guaranteed technical particulars of the manufacturer and would vary with variation of load. The pelton turbine efficiency at rated conditions has been taken as 91% and that of the synchronous generator as 96%. The overall efficiency adopted for the calculations is being considered as 87%.

7.5 POWER OPTIMISATION

The power optimization for 75% dependable discharge has been carried out for a range of installed capacities starting from 0.25 MW to 2.2 MW in steps of 0.25 MW upto 2MW, each installed capacity has been worked out separately and details are enclosed at Annexure 7.1.

Each of the computed energy for different installed capacities is then plotted against respective installed capacity. The curve so obtained depicts a definite trend (refer Annexure

7.2). It is observed from the curve that beyond a given capacity, the incremental energy generated decreases, indicating no further advantage to raise the plant capacity. Thus, point "A" which corresponds to an installation of 2.1MW indicates an optimum potential below which the available potential is underutilized and beyond which there is no economical advantage in raising the plant capacity. Therefore, the optimum capacity of the Project shall be 2.1 MW. The discharge corresponding to this capacity is 1.25 cumecs which is adopted as the design discharge of the Project.

7.5.1 POWER POTENTIAL

Corresponding to a design discharge of 1.25 cumecs and net head of 200 m, power potential study has been carried out for 50%, 75% and 90% dependable year for 2.1MW rated capacity and is appended at Annexure 7.3. It is found that 13.039 GWh, 11.142 GWh and 9.798 GWh of energy could be expected for 50%, 75% and 90% dependable discharge respectively.

7.6 CONCLUSIONS

The choice of installed capacity is governed not only by power optimization but also by the type of facility proposed (base load or peaking station), planned investments and other factors depending upon policies of the nodal agencies / Government. Optimization study is only one of the guidelines governing the choice of installed capacity. It only helps in identifying a range within which a project would yield attractive returns.

It has been argued above that an installed capacity of 2.1MW would be optimal. Hence, it is proposed to adopt an installed capacity of 2.1MW and design various components of the project accordingly. Further, it is proposed to install a two units each of 1.05MW so that the plant operates optimally as per the incoming discharge.

Annexure 7.1

TRANHA CHARROLI HEP (2.10 MW)
HYDRAULIC YEAR 2002
NET HEAD 200 m
EFFICIENCY 0.87

MONTH	PERIODS	50% dependable flow	Compensato n discharge	Available discharge	Unrestricted		Restricted	0.25	Restricted	0.5
			Cumecs	Cumecs	Power	Energy				
			(15% of min.)		MW	GWh	MW	GWh	MW	GWh
	I	0.711	0.122	0.589	1.005	0.241	0.25	0.060	0.5	0.120
January	II	0.734	0.122	0.612	1.044	0.251	0.25	0.060	0.5	0.120
	III	0.738	0.122	0.615	1.050	0.277	0.25	0.066	0.5	0.132
	I	0.766	0.122	0.644	1.099	0.264	0.25	0.060	0.5	0.120
February	II	1.146	0.122	1.023	1.747	0.419	0.25	0.060	0.5	0.120
	III	0.971	0.122	0.849	1.449	0.278	0.25	0.048	0.5	0.096
	I	1.512	0.122	1.389	2.371	0.569	0.25	0.060	0.5	0.120
March	II	1.282	0.122	1.160	1.980	0.475	0.25	0.060	0.5	0.120
	III	1.138	0.122	1.016	1.734	0.456	0.25	0.066	0.5	0.132
	I	0.897	0.122	0.775	1.322	0.317	0.25	0.060	0.5	0.120
April	II	0.816	0.122	0.693	1.183	0.284	0.25	0.060	0.5	0.120
	III	0.719	0.122	0.596	1.018	0.244	0.25	0.060	0.5	0.120
	I	0.781	0.122	0.659	1.125	0.270	0.25	0.060	0.5	0.120
May	II	0.692	0.122	0.570	0.973	0.233	0.25	0.060	0.5	0.120
	III	0.660	0.122	0.538	0.918	0.242	0.25	0.066	0.5	0.132
	I	0.330	0.122	0.208	0.354	0.085	0.25	0.060	0.354	0.085
June	II	3.196	0.122	3.073	5.246	1.259	0.25	0.060	0.5	0.120
	III	2.310	0.122	2.188	3.734	0.896	0.25	0.060	0.5	0.120
	I	2.192	0.122	2.070	3.533	0.848	0.25	0.060	0.5	0.120
July	II	2.725	0.122	2.603	4.443	1.066	0.25	0.060	0.5	0.120
	III	2.924	0.122	2.802	4.783	1.263	0.25	0.066	0.5	0.132
	I	2.801	0.122	2.679	4.573	1.097	0.25	0.060	0.5	0.120
August	II	2.340	0.122	2.218	3.786	0.909	0.25	0.060	0.5	0.120
	III	1.976	0.122	1.854	3.164	0.835	0.25	0.066	0.5	0.132
	I	1.665	0.122	1.543	2.634	0.632	0.25	0.060	0.5	0.120
September	II	1.293	0.122	1.171	1.999	0.480	0.25	0.060	0.5	0.120
	III	1.223	0.122	1.101	1.879	0.451	0.25	0.060	0.5	0.120
	I	1.054	0.122	0.932	1.591	0.382	0.25	0.060	0.5	0.120
October	II	0.994	0.122	0.871	1.488	0.357	0.25	0.060	0.5	0.120
	III	0.914	0.122	0.792	1.352	0.357	0.25	0.066	0.5	0.132
	I	0.867	0.122	0.744	1.271	0.305	0.25	0.060	0.5	0.120
November	II	1.096	0.122	0.974	1.662	0.399	0.25	0.060	0.5	0.120
	III	0.797	0.122	0.674	1.151	0.276	0.25	0.060	0.5	0.120
	I	0.696	0.122	0.574	0.979	0.235	0.25	0.060	0.5	0.120
December	II	0.649	0.122	0.526	0.898	0.216	0.25	0.060	0.5	0.120
	III	0.565	0.122	0.443	0.756	0.200	0.25	0.066	0.5	0.132
Total energy						17.371		2.190		4.345
Energy/MW								8.76		8.69015033
Load factor								1.000		0.992
Incremental energy,GWh								0		2.155

Annexure 7.2

TRANHA CHARROLI HEP (2.10 MW)

Restricted	0.75	Restricted	1	Restricted	1.25	Restricted	1.5	Restricted	1.75	Restricted
MW	GWh	MW	GWh	MW	GWh	MW	GWh	MW	GWh	MW
0.750	0.180	1.000	0.240	1.005	0.241	1.005	0.241	1.005	0.241	1.005
0.750	0.180	1.000	0.240	1.044	0.251	1.044	0.251	1.044	0.251	1.044
0.750	0.198	1.000	0.240	1.050	0.252	1.050	0.252	1.050	0.252	1.050
0.750	0.180	1.000	0.240	1.099	0.264	1.099	0.264	1.099	0.264	1.099
0.750	0.180	1.000	0.240	1.250	0.300	1.500	0.360	1.747	0.419	1.747
0.750	0.144	1.000	0.240	1.250	0.300	1.449	0.348	1.449	0.348	1.449
0.750	0.180	1.000	0.240	1.250	0.300	1.500	0.360	1.750	0.420	2.000
0.750	0.180	1.000	0.240	1.250	0.300	1.500	0.360	1.750	0.420	1.980
0.750	0.198	1.000	0.240	1.250	0.300	1.500	0.360	1.734	0.416	1.734
0.750	0.180	1.000	0.240	1.250	0.300	1.322	0.317	1.322	0.317	1.322
0.750	0.180	1.000	0.240	1.183	0.284	1.183	0.284	1.183	0.284	1.183
0.750	0.180	1.000	0.240	1.018	0.244	1.018	0.244	1.018	0.244	1.018
0.750	0.180	1.000	0.240	1.125	0.270	1.125	0.270	1.125	0.270	1.125
0.750	0.180	0.973	0.233	0.973	0.233	0.973	0.233	0.973	0.233	0.973
0.750	0.198	0.918	0.242	0.918	0.242	0.918	0.242	0.918	0.242	0.918
0.354	0.085	0.354	0.085	0.354	0.085	0.354	0.085	0.354	0.085	0.354
0.750	0.180	1.000	0.240	1.250	0.300	1.500	0.360	1.750	0.420	2.000
0.750	0.180	1.000	0.240	1.250	0.300	1.500	0.360	1.750	0.420	2.000
0.750	0.180	1.000	0.240	1.250	0.300	1.500	0.360	1.750	0.420	2.000
0.750	0.180	1.000	0.240	1.250	0.300	1.500	0.360	1.750	0.420	2.000
0.750	0.180	1.000	0.240	1.250	0.300	1.500	0.360	1.750	0.420	2.000
0.750	0.180	1.000	0.240	1.250	0.300	1.500	0.360	1.750	0.420	2.000
0.750	0.180	1.000	0.240	1.250	0.300	1.500	0.360	1.750	0.420	2.000
0.750	0.180	1.000	0.240	1.250	0.300	1.500	0.360	1.750	0.420	2.000
0.750	0.180	1.000	0.240	1.250	0.300	1.500	0.360	1.750	0.420	2.000
0.750	0.180	1.000	0.240	1.250	0.300	1.500	0.360	1.750	0.420	1.999
0.750	0.180	1.000	0.240	1.250	0.300	1.500	0.360	1.750	0.420	1.879
0.750	0.180	1.000	0.240	1.250	0.300	1.500	0.360	1.591	0.382	1.591
0.750	0.180	1.000	0.240	1.250	0.300	1.488	0.357	1.488	0.357	1.488
0.750	0.198	1.000	0.264	1.250	0.330	1.352	0.357	1.352	0.357	1.352
0.750	0.180	1.000	0.240	1.250	0.300	1.271	0.305	1.271	0.305	1.271
0.750	0.180	1.000	0.240	1.250	0.300	1.500	0.360	1.662	0.399	1.662
0.750	0.180	1.000	0.240	1.151	0.276	1.151	0.276	1.151	0.276	1.151
0.750	0.180	0.979	0.235	0.979	0.235	0.979	0.235	0.979	0.235	0.979
0.750	0.180	0.898	0.216	0.898	0.216	0.898	0.216	0.898	0.216	0.898
0.750	0.198	0.756	0.200	0.756	0.200	0.756	0.200	0.756	0.200	0.756
	6.439		8.435		9.923		11.097		12.053	
	8.585		8.435		7.939		7.398		6.887	
	0.980		0.963		0.906		0.845		0.786	
	2.094		1.996		1.488		1.174		0.956	

Annexure 7.3

TRANHA CHARROLI HEP (2.10MW)

2	Restricted	2.1	Restricted	2.2
GWh	MW	GWh	MW	GWh
0.241	1.005	0.241	1.005	0.241
0.251	1.044	0.251	1.044	0.251
0.252	1.050	0.252	1.050	0.252
0.264	1.099	0.264	1.099	0.264
0.419	1.747	0.419	1.747	0.419
0.348	1.449	0.348	1.449	0.348
0.480	2.100	0.504	2.200	0.528
0.475	1.980	0.475	1.980	0.475
0.416	1.734	0.416	1.734	0.416
0.317	1.322	0.317	1.322	0.317
0.284	1.183	0.284	1.183	0.284
0.244	1.018	0.244	1.018	0.244
0.270	1.125	0.270	1.125	0.270
0.233	0.973	0.233	0.973	0.233
0.242	0.918	0.242	0.918	0.242
0.085	0.354	0.085	0.354	0.085
0.480	2.100	0.504	2.200	0.528
0.480	2.100	0.504	2.200	0.528
0.480	2.100	0.504	2.200	0.528
0.480	2.100	0.504	2.200	0.528
0.480	2.100	0.504	2.200	0.528
0.480	2.100	0.504	2.200	0.528
0.480	2.100	0.504	2.200	0.528
0.480	2.100	0.504	2.200	0.528
0.480	1.999	0.480	1.999	0.480
0.451	1.879	0.451	1.879	0.451
0.382	1.591	0.382	1.591	0.382
0.357	1.488	0.357	1.488	0.357
0.357	1.352	0.357	1.352	0.357
0.305	1.271	0.305	1.271	0.305
0.399	1.662	0.399	1.662	0.399
0.276	1.151	0.276	1.151	0.276
0.235	0.979	0.235	0.979	0.235
0.216	0.898	0.216	0.898	0.216
0.200	0.756	0.200	0.756	0.200
12.799		13.039		13.279
6.399		6.209		6.036
0.731		0.709		0.689
0.746		0.240		0.240

Annexure -7.4

TRANHA CHARROLI HEP (2.10 MW)

NET HEAD 200 m

EFFICIENCY 0.87

HYDRAULIC YEAR 2005

MONTH	PERIODS	75% dependable flow	Compensation discharge	Available discharge	Unrestricted		Restricted	0.25	Restricted	0.5
			Cumecs	Cumecs	Power	Energy				
			(15% of min.)		MW	GWh	MW	GWh	MW	GWh
	I	0.573	0.086	0.487	0.831	0.199	0.25	0.060	0.500	0.120
January	II	0.618	0.086	0.532	0.909	0.218	0.25	0.060	0.5	0.120
	III	0.738	0.086	0.652	1.113	0.294	0.25	0.066	0.5	0.132
	I	0.905	0.086	0.819	1.398	0.335	0.25	0.060	0.5	0.120
February	II	1.210	0.086	1.124	1.919	0.460	0.25	0.060	0.5	0.120
	III	0.889	0.086	0.804	1.372	0.263	0.25	0.048	0.5	0.096
	I	0.922	0.086	0.836	1.427	0.342	0.25	0.060	0.5	0.120
March	II	1.026	0.086	0.940	1.605	0.385	0.25	0.060	0.5	0.120
	III	0.981	0.086	0.895	1.527	0.403	0.25	0.066	0.5	0.132
	I	0.590	0.086	0.504	0.860	0.206	0.25	0.060	0.5	0.120
April	II	0.402	0.086	0.316	0.540	0.130	0.25	0.060	0.5	0.120
	III	0.436	0.086	0.350	0.598	0.144	0.25	0.060	0.5	0.120
	I	0.577	0.086	0.491	0.837	0.201	0.25	0.060	0.5	0.120
May	II	0.368	0.086	0.282	0.481	0.116	0.25	0.060	0.481	0.116
	III	0.334	0.086	0.248	0.423	0.112	0.25	0.066	0.423	0.112
	I	0.347	0.086	0.261	0.446	0.107	0.25	0.060	0.446	0.107
June	II	0.324	0.086	0.238	0.407	0.098	0.25	0.060	0.407	0.098
	III	0.518	0.086	0.432	0.737	0.177	0.25	0.060	0.5	0.120
	I	1.312	0.086	1.226	2.094	0.502	0.25	0.060	0.5	0.120
July	II	1.986	0.086	1.900	3.243	0.778	0.25	0.060	0.5	0.120
	III	2.534	0.086	2.448	4.178	1.103	0.25	0.066	0.5	0.132
	I	2.384	0.086	2.298	3.923	0.941	0.25	0.060	0.5	0.120
August	II	1.965	0.086	1.879	3.207	0.770	0.25	0.060	0.5	0.120
	III	1.479	0.086	1.393	2.378	0.628	0.25	0.066	0.5	0.132
	I	1.041	0.086	0.955	1.631	0.391	0.25	0.060	0.5	0.120
September	II	1.872	0.086	1.786	3.049	0.732	0.25	0.060	0.5	0.120
	III	2.008	0.086	1.923	3.282	0.788	0.25	0.060	0.5	0.120
	I	1.341	0.086	1.255	2.142	0.514	0.25	0.060	0.5	0.120
October	II	1.003	0.086	0.917	1.566	0.376	0.25	0.060	0.5	0.120
	III	0.702	0.086	0.616	1.051	0.278	0.25	0.066	0.5	0.132
	I	0.523	0.086	0.438	0.747	0.179	0.25	0.060	0.5	0.120
November	II	0.474	0.086	0.388	0.663	0.159	0.25	0.060	0.5	0.120
	III	0.413	0.086	0.328	0.559	0.134	0.25	0.060	0.5	0.120
	I	0.812	0.086	0.726	1.239	0.297	0.25	0.060	0.5	0.120
December	II	0.707	0.086	0.621	1.061	0.255	0.25	0.060	0.5	0.120
	III	0.635	0.086	0.549	0.938	0.248	0.25	0.066	0.5	0.132
Total energy						13.263		2.190		4.320
Energy/MW								8.76		8.640
Load factor								1.000		0.986
Incremental energy,GWh								0		2.130

Annexure 7.5

TRANHA CHARROLI HEP (2.10 MW)

Restricted	0.75	Restricted	1	Restricted	1.25	Restricted	1.5	Restricted	1.75	Restricted
MW	GWh	MW	GWh	MW	GWh	MW	GWh	MW	GWh	MW
0.750	0.180	0.831	0.199	0.831	0.199	0.831	0.199	0.831	0.199	0.831
0.750	0.180	0.909	0.218	0.909	0.218	0.909	0.218	0.909	0.218	0.909
0.750	0.198	1.000	0.264	1.113	0.294	1.113	0.294	1.113	0.294	1.113
0.750	0.180	1.000	0.240	1.250	0.300	1.398	0.335	1.398	0.335	1.398
0.750	0.180	1.000	0.240	1.250	0.300	1.500	0.360	1.750	0.420	1.919
0.750	0.144	1.000	0.192	1.250	0.240	1.372	0.263	1.372	0.263	1.372
0.750	0.180	1.000	0.240	1.250	0.300	1.427	0.342	1.427	0.342	1.427
0.750	0.180	1.000	0.240	1.250	0.300	1.500	0.360	1.605	0.385	1.605
0.750	0.198	1.000	0.264	1.250	0.330	1.500	0.396	1.527	0.403	1.527
0.750	0.180	0.860	0.206	0.860	0.206	0.860	0.206	0.860	0.206	0.860
0.540	0.130	0.540	0.130	0.540	0.130	0.540	0.130	0.540	0.130	0.540
0.598	0.144	0.598	0.144	0.598	0.144	0.598	0.144	0.598	0.144	0.598
0.750	0.180	0.837	0.201	0.837	0.201	0.837	0.201	0.837	0.201	0.837
0.481	0.116	0.481	0.116	0.481	0.116	0.481	0.116	0.481	0.116	0.481
0.423	0.112	0.423	0.112	0.423	0.112	0.423	0.112	0.423	0.112	0.423
0.446	0.107	0.446	0.107	0.446	0.107	0.446	0.107	0.446	0.107	0.446
0.407	0.098	0.407	0.098	0.407	0.098	0.407	0.098	0.407	0.098	0.407
0.737	0.177	0.737	0.177	0.737	0.177	0.737	0.177	0.737	0.177	0.737
0.750	0.180	1.000	0.240	1.250	0.300	1.500	0.360	1.750	0.420	2.000
0.750	0.180	1.000	0.240	1.250	0.300	1.500	0.360	1.750	0.420	2.000
0.750	0.198	1.000	0.264	1.250	0.330	1.500	0.396	1.750	0.462	2.000
0.750	0.180	1.000	0.240	1.250	0.300	1.500	0.360	1.750	0.420	2.000
0.750	0.180	1.000	0.240	1.250	0.300	1.500	0.360	1.750	0.420	2.000
0.750	0.198	1.000	0.264	1.250	0.330	1.500	0.396	1.750	0.462	2.000
0.750	0.180	1.000	0.240	1.250	0.300	1.500	0.360	1.631	0.391	1.631
0.750	0.180	1.000	0.240	1.250	0.300	1.500	0.360	1.750	0.420	2.000
0.750	0.180	1.000	0.240	1.250	0.300	1.500	0.360	1.750	0.420	2.000
0.750	0.180	1.000	0.240	1.250	0.300	1.500	0.360	1.750	0.420	2.000
0.750	0.180	1.000	0.240	1.250	0.300	1.500	0.360	1.566	0.376	1.566
0.750	0.198	1.000	0.264	1.051	0.278	1.051	0.278	1.051	0.278	1.051
0.747	0.179	0.747	0.179	0.747	0.179	0.747	0.179	0.747	0.179	0.747
0.663	0.159	0.663	0.159	0.663	0.159	0.663	0.159	0.663	0.159	0.663
0.559	0.134	0.559	0.134	0.559	0.134	0.559	0.134	0.559	0.134	0.559
0.750	0.180	1.000	0.240	1.239	0.297	1.239	0.297	1.239	0.297	1.239
0.750	0.180	1.000	0.240	1.061	0.255	1.061	0.255	1.061	0.255	1.061
0.750	0.196	0.938	0.248	0.938	0.248	0.938	0.248	0.938	0.248	0.938
	6.106		7.539		8.680		9.639		10.331	
	8.142		7.539		6.944		6.426		5.903	
	0.929		0.861		0.793		0.734		0.674	
	1.786		1.433		1.141		0.959		0.691	

Annexure 7.6

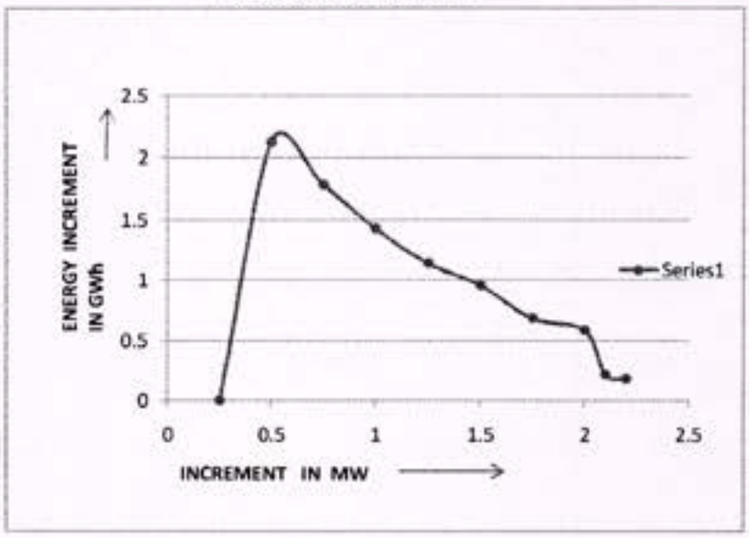
TRANHA CHARROLI HEP (2.10 MW)

2	Restricted	2.1	Restricted	2.2
GWh	MW	GWh	MW	GWh
0.199	0.831	0.199	0.831	0.199
0.218	0.909	0.218	0.909	0.218
0.294	1.113	0.294	1.113	0.294
0.335	1.398	0.335	1.398	0.335
0.460	1.919	0.460	1.919	0.460
0.263	1.372	0.263	1.372	0.263
0.342	1.427	0.342	1.427	0.342
0.385	1.605	0.385	1.605	0.385
0.403	1.527	0.403	1.527	0.403
0.206	0.860	0.206	0.860	0.206
0.130	0.540	0.130	0.540	0.130
0.144	0.598	0.144	0.598	0.144
0.201	0.837	0.201	0.837	0.201
0.116	0.481	0.116	0.481	0.116
0.112	0.423	0.112	0.423	0.112
0.107	0.446	0.107	0.446	0.107
0.098	0.407	0.098	0.407	0.098
0.177	0.737	0.177	0.737	0.177
0.480	2.094	0.502	2.094	0.502
0.480	2.100	0.504	2.200	0.528
0.528	2.100	0.554	2.200	0.581
0.480	2.100	0.504	2.200	0.528
0.480	2.100	0.504	2.200	0.528
0.528	2.100	0.554	2.200	0.581
0.391	1.631	0.391	1.631	0.391
0.480	2.100	0.504	2.200	0.528
0.480	2.100	0.504	2.200	0.528
0.480	2.100	0.504	2.142	0.514
0.376	1.566	0.376	1.566	0.376
0.278	1.051	0.278	1.051	0.278
0.179	0.747	0.179	0.747	0.179
0.159	0.663	0.159	0.663	0.159
0.134	0.559	0.134	0.559	0.134
0.297	1.239	0.297	1.239	0.297
0.255	1.061	0.255	1.061	0.255
0.248	0.938	0.248	0.938	0.248
10.923		11.142		11.325
5.462		5.306		5.148
0.623		0.606		0.588
0.592		0.219		0.183

Annexure 7.7

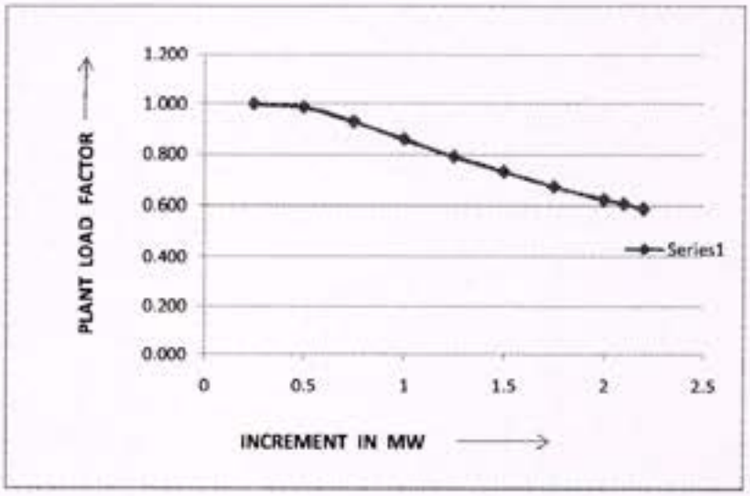
STATION CAPACITY FIXATION

IC IN MW	Incremental energy, GWh
0.25	0
0.5	2.130
0.75	1.7864
1	1.4325
1.25	1.1412
1.5	0.9592
1.75	0.6914
2	0.5925
2.1	0.2192
2.2	0.1829



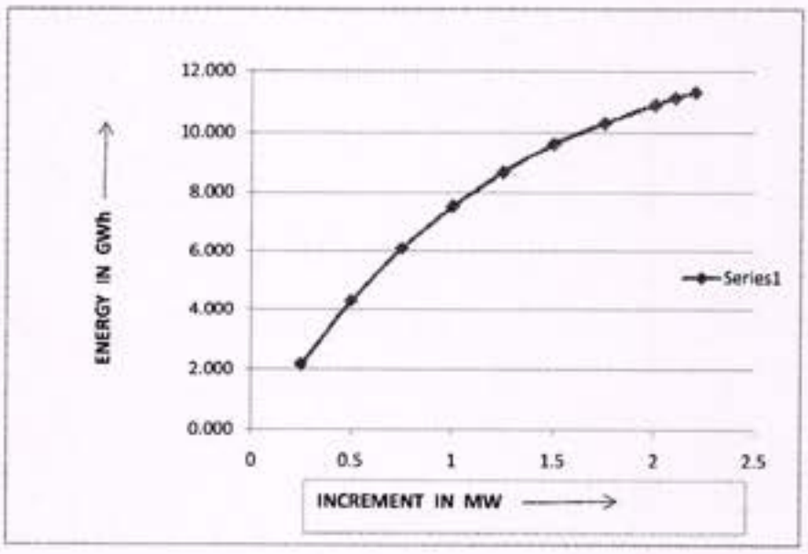
Annexure 7.8

IC IN MW	Plant load factor
0.25	1.000
0.5	0.986
0.75	0.9294
1	0.8606
1.25	0.7927
1.5	0.7336
1.75	0.6739
2	0.6235
2.1	0.6057
2.2	0.5877



Annexure 7.9

IC IN MW	ENERGY
0.25	2.190
0.5	4.320
0.75	6.1063
1	7.5388
1.25	8.6800
1.5	9.6391
1.75	10.3306
2	10.9231
2.1	11.1423
2.2	11.3252



Annexure 7.13

TRANHA CHARROLI HEP - POWER AND GENERATION (RESTRICTED)

HYDRAULIC YEAR - 90% , 75% , 50% DEPENDABLE YEAR

NET HEAD H 200 m

OVERALL EFFICIEN n 0.87

INSTALLED CAPACITY 2 .1 MW

MONTH	90% DEPENDABILITY		75% DEPENDABILITY		50% DEPENDABILITY	
	FLOW CUMECS	GENERATION GWH	FLOW CUMECS	GENERATIONGWH	FLOW, CUMECS	GENERATIOI
	0.626	0.236	0.573	0.199	0.711	0.241
January	0.484	0.177	0.618	0.218	0.734	0.251
	0.504	0.186	0.738	0.294	0.738	0.252
	0.506	0.187	0.905	0.335	0.766	0.264
Februray	0.554	0.206	1.210	0.460	1.146	0.419
	0.639	0.241	0.889	0.263	0.971	0.348
	0.743	0.284	0.922	0.342	1.512	0.504
March	0.503	0.185	1.026	0.385	1.282	0.475
	1.821	0.504	0.981	0.403	1.138	0.416
	0.797	0.306	0.590	0.206	0.897	0.317
April	0.510	0.188	0.402	0.130	0.816	0.284
	0.700	0.266	0.436	0.144	0.719	0.244
	0.823	0.316	0.577	0.201	0.781	0.270
May	0.954	0.370	0.368	0.116	0.692	0.233
	0.671	0.254	0.334	0.112	0.660	0.242
	0.472	0.173	0.347	0.107	0.330	0.085
June	0.410	0.147	0.324	0.098	3.196	0.504
	0.438	0.159	0.518	0.177	2.310	0.504
	0.520	0.192	1.312	0.502	2.192	0.504
July	0.743	0.284	1.986	0.504	2.725	0.504
	0.969	0.376	2.534	0.554	2.924	0.504
	0.920	0.356	2.384	0.504	2.801	0.504
August	1.237	0.486	1.965	0.504	2.340	0.504
	0.840	0.323	1.479	0.554	1.976	0.504
	0.816	0.313	1.041	0.391	1.665	0.504
September	0.669	0.254	1.872	0.504	1.293	0.480
	0.628	0.236	2.008	0.504	1.223	0.451
	0.954	0.370	1.341	0.504	1.054	0.382
October	0.798	0.306	1.003	0.376	0.994	0.357
	0.669	0.254	0.702	0.278	0.914	0.357
	1.009	0.393	0.523	0.179	0.867	0.305
November	0.798	0.306	0.474	0.159	1.096	0.399
	0.808	0.310	0.413	0.134	0.797	0.276
	0.736	0.281	0.812	0.297	0.696	0.235
December	0.645	0.243	0.707	0.255	0.649	0.216
	0.338	0.129	0.635	0.248	0.565	0.200
YEARS GENERATION GWH		9.798		11.142		13.039

CHAPTER 8

CIVIL WORKS

8.1 GENERAL

The main objective of the Tranha Charroli Small Hydro Electric Project is to generate power economically and expeditiously utilizing the local available construction material and labour to the extent possible, using the design parameters and studies for a simple and cost effective civil works. The civil structures have been planned to utilized a design discharge of 1.25 cumecs which is proposed to be diverted from Tarahn stream utilizing a net head of 200 m to generate 2.1MW of power in a surface power house. The scheme is envisaged to utilize additional discharge also whenever available in the stream during the monsoon period and the machines are expected to operate at 10% overload. The main civil structures of the project comprises a trench weir across Tarahn stream. Water conductor system located on the left bank of Tarahn stream. The water conductor

system comprises of a 3000 m of cut and cover R.C.C. box, circular M.S. Pipe and open channel section upto the forebay cum desilting tank. Wherever the Water Conductor System intercepts nallas, suitable cross drainage structures have been provided. A small forebay cum desilting tank is provided at the end of the water conductor.

The flushing operations at the desilting tank shall have to be carried out frequently during the monsoon season when water is turbid and availability is more than the design discharge. During the non-monsoon season, water will be normally clear and free from sediments and therefore, may not need frequent flushing operations. Flushing pipe with valve shall also be provided at forebay tank to flush out any silt or coarse material.

The forebay cum desilting tank provides for an opening from where a single penstock takes off and bifurcating into two penstock to feed the two generating unit of 1.05 MW each. An automatic surpassing spillway fitted with falling shutters has

been provided adjacent to the forebay cum desilting. A short tailrace leads the discharge from the Power House back to the stream.

The various component of the project is as under :

8.2 TRENCH WEIR

Diversion structure is required across the stream for diverting its discharge for power generation which should be least expensive and as simple as possible. This is a run -of- river type scheme and it is not possible to provide storage because of its inherent fast filling tendency. A trench type weir is considered suitable for the site. The trench type weir shall be capable of diverting all the lean season flow and the structure shall also be capable of passing flood.

Trench type weir is a simple trapezoidal trough made up of R.C.C. provided with sloping structural steel trash rack over the full width of weir on the top. The criteria for determining

the length of the trench weir is that it should be capable to pass the design flood discharge. In our case, length of the trench weir has been kept as 17.50m to pass the design flood discharge of 107.06 cumecs with HFL at EL.1825.00m.The bed of trench weir has been provided with a slope of 1 in 17.5 in the flow direction so that sufficient velocity is generated to carry away small stones and heavy silt upto 25mm size that may find entry into the weir through the trash rack openings. The d/s edge of the trench weir has been kept at EL.1820.15m.The width of trash rack is proposed as 1.20m, which is fabricated using 50x10 M.S. Flats along the direction of flow with 25mm clear spacing in between the flats. The intake structure is located on the left bank sufficiently away from the midstream so that the regime of the river is not affected during normal high flood level conditions. Two openings are provided in the intake structures , one of 1.20m x 1.00m for carrying the design discharge through the water conductor system and the other of 0.40m dia. for carrying

directly the shingle collected in the trench weir to a suitable location in the stream downstream . The intake opening is designed to carry discharge of 1.375 cumecs to allow for the additional requirements for flushing silt . Entry to these ducts are controlled by gates operated from the top of the intake structure . The intake structure permits the release of water to the desired extent. The top of the intake structure has been kept at EL 1825.50m which is above the maximum high flood level EL. 1825.00m The protection works in the river bed both upstream and downstream of the weir consist of wire crates 1500x1500x1500mm with a topping of 100 mm concrete M20. The concrete protects the wire mesh from tearing . These extend 6.00 m on upstream and 5.00m on the downstream . Concrete toe wall , one on the upstream and one on the downstream of the trench of 2.00m height serve as a safeguard against dislodging of the blocks and consequent erosion.

Plan and Section of the Diversion weir is shown in the Drg. No. TC – 2 and 3.

8.3 WATER CONDUCTOR SYSTEM

The water conductor system consists of a combination of cut and cover section and open channel section. Rectangular open channel section is provided in reaches where topography and geological strata is suitable. Where excavation are in geologically unstable strata, a reinforced concrete cut and cover section has been proposed. The water conductor system has been designed for a discharging capacity of 1.375 cumecs upto forebay cum desilting tank. A free board of 400mm has been proposed for both cut and cover and open channel section. The bed slope for water conductor system to provide for the friction losses and other losses is 1 in 415 and flow velocity is about 1.42m/sec to carry a discharge of 1.375 cumecs. This velocity is considered adequate to prevent deposition of silt in the system. The water conductor system shall be free flow type.

Section of the Water Conductor system is shown in the Drg. No. TC – 4.

8.4 FOREBAY CUM DESILTING TANK

The hilly streams generally carry appreciable quantities of coarse silt and sand during the monsoon season. It is, therefore necessary to provide desilting tank to exclude coarse particles so as to minimize the abrasion to the turbine runner or buckets especially in high and medium schemes where abrasion effect becomes more pronounced. A desilting tank is proposed to exclude the coarser particles of size exceeding 0.25mm.The desilting tank is of surface type open basin 9.50m long,5.0m wide and 3.0m deep, to keep the velocity within desired limit. The horizontal velocity of flow and the settling velocity of flow are 0.09 m/sec and 2.86 cm/sec respectively.

The main function of the forebay is to provide adequate depth of water at the penstock intake to prevent vortex formation and avoid the air entry into the penstock and also to meet the immediate water demand for generation. The FSL in the forebay is kept at El. 1813.53 m and providing a free board of 0.40 m, the top of the forebay is kept at El 1813.93 m.

Water seal of 0.42 m is provided between the Minimum Draw Down Level (MDDL) at El 1810.53 m and penstock top level at El 1810.11 m is considered adequate to prevent vortex formation and entry of air into penstock. The forebay is proposed to be lined with 300 mm thick RCC wall of M20 with reinforcement to prevent water seepage losses and water logging. At the penstock intake, a trash rack is provided to prevent entry of debris or floating material into the penstock. Provision of air vent pipe has been made in the penstock at first anchor block for release of entrapped air in the penstock. A butterfly valve is provided near the penstock intake for controlling the water discharges into the penstock from the forebay.

In order to achieve the objective of meeting the immediate water demand for starting the generating units and fluctuations in energy load, three minutes storage capacity of 216 cubic meter has been proposed in the forebay tank. One 100 mm dia flushing pipe with a manually operated valve is provided at the end of central silt gutter for flushing out the unwanted material which may collect at the floor of forebay in due

course of time and passing the same into the spill channel on downstream end.

Plan and section of the Forebay cum desilting tank are shown in the Drg. No. TC - 5 and 6.

8.5 PENSTOCK

Penstock alignment has been finalized after a careful study of the various proposals and adopting the one, which requires minimum excavation as well as minimum number of bends. Surface penstock has been provided as per the suitability of the topography of the area. One number penstock pipe of high tension steel confirming to IS-2062 grade B, 700 mm diameter has been provided from the intake with its center line at El. 1809.41 m. The length of penstock is 325 meter. It will be bifurcating near the power house to feed two units separately having appox. length of 30 m each, 350 mm dia. The penstock shells are proposed to be fabricated at site from structural steel plates and properly welded. Radiographic and ultrasonic testing of each welded joint shall be carried out besides the hydrostatic pressure testing which shall be

carried out at random on some of the ferrules. The welded penstock shall have less hydraulic losses besides ease of transportation and erection.

The plate thickness of penstock has been proposed as 6mm and 10mm. This has been calculated taking into account the water hammer pressure as 10% of net head and corrosion allowance of 1.5 mm. Flow velocity of 3.25 m/sec in the main penstock has been considered to reduce the losses. The tentative head loss of 5.26 m. have been estimated to be occurring in the penstock system.

The surface penstock will be anchored at both the horizontal and vertical bends to resist the unbalanced hydrostatic forces due to change in the direction of flow and to prevent movement of penstock on account of vibration or water hammer effect. All anchor blocks will be of RCC and their stability has been checked as per relevant IS codes.

The surface penstock is supported between the anchor blocks by the saddle supports. The spacing of saddle supports has been kept as 10

m. The saddles shall also be constructed in RCC as the head of water acting on the pipe is very high, flexible sleeve type expansion joint has been proposed down side of each anchor block in the surface penstock to permit expansion / contraction due to temperature variations. This shall also facilitate in erection of penstock on the slopes.

L-Section of Penstock has been shown in Drg. No. TC-7 whereas details of anchor blocks and saddle supports has been in drg. No. TC-8,9,10

8.6 POWER HOUSE AND TAIL RACE CHANNEL

The proposed power house building is 24.50m meter long and 18.00 meter wide for housing two number turbines, generating units, control panels, store cum workshop, battery room etc. The height of powerhouse from the floor up to the truss level has been kept as 9 meter. The sidewalls shall be made of stone masonry and RCC columns. Beams, foundations of generating units shall be laid in RCC M20 grade. The floor of battery room shall be laid in acid resistant finish, whereas the other floors shall be laid in terrazzo finish. The roof shall be constructed of

tubular trusses with CGI sheets. Provision has been made for 20/5 MT capacity EOT crane inside the powerhouse. The tail race channel is designed for carrying 1.25 cumecs discharge. The tail race water is carried through a 60 m long, free flow cut and cover channel at a slope of 1 in 100 up to Tarahn Stream.

Plan and section of the power house and the tail race system are shown in the Drg. No. TC - 11 and 12, respectively.

ANNEXURE 8.1

DESIGN CALCULATIONS

1. DIVERSION STRUCTURE (SHAMRI NALA SIDE)

1.1 Design Features

Design discharge	1.25 cumecs
Add 10% for silt flushing	0.125 cumecs
	1.375 cumecs
Add 15% for shingle flushing	0.206 cumec
Total Discharge drawn	1.58 cumecs
Pond level	1822.00m
High Flood Level	1825.00m
Average bed level at diversion site	1821.50m

1.2 Calculation of size of Trench Weir

$Bg = Q / E1 \times E2 \times L \times C1 \times \sqrt{2gE}$

Bg = width of trash rack for complete withdrawl of flow

$E = [Q / CX\ b]^{2/3}$

Where Q = Diverted discharge = 1.58 cumecs

C = Coefficient of discharge for board crested weir =1.53

L = Length of the trench weir = 17.50 m

E1 = Area of opening / total area of the trash rack surface = 0.50

E2 = Ratio of area of opening in the trash rack to be clogged = 0.50

C1 = Coefficient of discharge in Trash rack opening = 0.46

$E = [1.58/1.53*17.5]^{2/3} = 0.154$

$B_g = 1.58/0.50x\ 0.46x\ 0.50 \times 17.50 \times \sqrt{(2x9.81x0.154)}$

$= 0.451$ m

However, provide $B_g = 1.20$ m and length of trench weir as 17.50 m.

DEPTH OF TRENCH WEIR

0.85 m at right abutment end sloping down
to 1.85 m at intake end near left abutment

Length of water way = 17.50 m

Design discharge = 1.58 cumecs

Top width of Trench Section (Bg) = 1.20 m

Let water depth along any section
of the channel = d m

Area of the trench weir = B_g x d

= 1.20 x d

Velocity Head at the end
of the trench h_v = $\frac{n}{n+1} \times \frac{\Delta}{2T}$

Where

n = arbitrary constant depending upon bottom profile of channel — n = 0.50

Velocity head h_v = [0.50/1.50] x [d/2x1]

= d/6

The corresponding discharge is given by

$$Q = A \sqrt{2 g hv}$$
$$= 1.20 \times d \times \sqrt{2} \times 9.81 \times d/6$$
$$= 2.17 \times d^{3/2}$$
$$= 1.58$$
$$d = [\ 1.58 / 2.17]^{2/3}$$
$$= 0.810 \text{ m}$$
$$\text{Say} = 0.85 \text{ m}$$

However provide water way 0.85 m depth at start increasing to 1.85 m at the intake. This gives a bed Slope of 1 in 17.5

$$\text{Average Depth} = (0.85 + 1.85)/2$$
$$= 1.35 \text{ m}$$
$$Q = [\ 1/n\ ] \times A \times R^{2/3} \times S^{1/2}$$

$$= 1/0.018 \times 1.20 \times 1.35 \times [\ 1.20 \times 1.35 / 1.2 + 2 \times 1.35]^{2/3} \times [\ 1/17.5]^{1/2}$$

$$= (1/0.018) \times 1.20 \times 1.35 \times 0.56 \times 0.239$$

$$= 12.05 \text{ cumecs} > 1.580 \text{ cumecs}$$

The trench will have adequate capacity even if 50% of it was clogged with gravel for which the discharge, will be

$$Q = \frac{1}{0.018} \times 1.20 \times 0.68 \times [\ (1.20 \times 0.68)/(1.20 + 2 \times 0.68)\ ]^{2/3} \times [1/17.5\ ]^{1/2}$$

$$= (1/0.018) \times 1.2 \times 0.46 \times 0.352 \times 0.239$$

$$= 2.58 \text{ cumecs} > 1.58 \text{ cumecs}$$

1.4 INTAKE/CONTROL STRUCTURE

Size of opening provided for entry to water conductor .

Width	1.20 m
Depth of water	1.00 m
Area	1.20 sq.m
Discharge	1.58 cumecs
Velocity = 1.58/1.20	1.32 m/s

Size of Shingle Flushing pipe at Intake leading to the river -0.40 m diameter

Design discharge for Shingle Flushing pipe = 0.206 cumecs

(15% of design discharge)

Hence , invert level of intake opening works out to as follows.

Pond level	1822.00 m
R.L. at the junction of trench Weir and intake structure	1820.15 m
Diameter of Shingle flushing pipe	0. 40 m
Water cushion above Crown of intake opening	0.50 m
Sill level of intake structure	1819.65

2.0 Water coducter System (Box Type)

	Upto Desilting Tank
Discharge in W.C.S	1.375 cumecs
Width	1.20 m
FSD	1.00 m
Rugosity Coefficient	0.018
Area of section (A)	1.20 sq.m
Wetted Perimeter (P)	3.20 m
Let us provide Slope (S)	1:415
Velocity (V)	$(1/n)x S^{1/2} x (A/P)^{2/3}$
	$(1/0.018)x(1/415)^{0.5}x(1.20/3.20)^{2/3}$
	1.418 m/s
Let us provide Velocity (V)	1:42 m/s

Hence Provide a bed slope of 1 in 415 in box channel section from intake to desilting tank .

3.0 DESILTING TANK

Discharge	1.375 cumecs
Particle size to be excluded	0.25 mm
Settling velocity	3.10 cm/sec
Width proposed	5.00 m
Depth proposed	3.00 m
Flow through velocity	1.375/3.00 x 5.00 = 0.09 m/sec
Settling length	(Flow through velocity)/Settling velocity x depth

Moderation of settling velocity	(0.132) x v/√d (0.132 x 3.10)/√3 = 0.2365 cm/sec
Moderated settling velocity	3.10 – 0.2365 = 2.8635 cm/sec
Settling length	(0.09 x 3.0) /0.02863 = 9.50 m

4.0 FOREBAY TANK

4.10 Forebay Tank Capacity

FSL at Forebay	1813.53 m
Min. draw down level	1810.53
Depth of water bet. FSL and MDDL	3.00 m
Requirement for 2.75 min. capacity in Forebay during sudden demand condition	1.25 x2.75 x60 = 216.00 m^3
Area of the forebay tank	72.00 sq.m
Size of the forebay tank	5.0 x 14.50

4.2 Settling of Intake Opening

Opening height of Penstock	1.40 m
Min. draw down level	1810.53
Less water cushion above top of intake opening	0.30 x 1.40 = 0.42m
Less height of opening up to c/l of intake opening	1.40/2 = 0.70
C/L of intake opening	1809.41m (1810.53-0.42-0.70)

4.30 Surplus escape at Forebay

Design Discharge	1.25 cumecs
FSL at forebay	1813.53 m
Height of automatic falling shutters	0.40 m

Crest of surplus spillway escape	1813.53
Length of Spillway	$CLH^{3/2} = 1.25$ $1.70 \times L \times 0.40^{3/2} = 1.25$ $= 3.00$ m

5.0 Penstock

5.10 Design Features

Design Discharge	1.25 cumecs
Diameter of Penstock proposed	0.70 m
Velocity	3.25 m/sec.
Length of Penstock	325.00 m

5.20 Design of Steel Liner

Design Discharge	1.25 cumecs
FSL at forebay	1813.53 m
Lowest C/L elevation of penstock	1608.00 m
Head	205.53 m
Add 10% water hammer pressure	20.55 m
Max. design head	226.08 m
Thickness of steel liner	22.61 x 0.7/2X1050 = 7.53mm

Provide steel liner thickness varying from 6 mm at the top to 10 mm at the Power House end i/c allowance for corrosion.

5.30 Hydraulic Losses in Penstock

Friction Loss = $(f \times L \times V^2) / 2 \times g \times D$

= $(0.012 \times 325 \times 3.25^2) / 2 \times 9.81 \times 0.70$

= 3.00 m

Other losses (entrance loss, bend loss, losses in reducer pipe etc.) = 2.26 m

Total Losses in Penstock = 5.26 m

6.0 Power House

Calculation of Design Head for Turbine

Pond Level	1822.00
Entrance loss from intake to water Conductor system	$0.5 \times 1.14^2/2$ = 0.31 m
Friction losses in water conductor system	0.0024 x 3000 = 7.20 m
Other miscellaneous losses due to Transition etc.	0.96 m
Total Losses	8.47 m
FSL at Forebay	1813.53
C/L of unit	1608.00 m
Gross Head	205.53 m
Hydraulic losses in Penstock	5.26 m
Net Head	200.27m

CHAPTER 9

ELECTRO-MECHANICAL WORKS

9.1 General

The Tranha Charroli small hydro electric project is located on the Haripurdhar– Kupvi road . The net head available to the machine is 200 meter. An installation of 2.1 MW comprising of two units each of 1.05 MW is proposed to be provided in the surface type power station located on the left bank on Tarahn stream.

For the available discharge and head, impulse turbine is appropriate and being proposed. The main advantage of proposing a pelton turbine is its relative simplicity and capability to operate under low flow conditions. The turbine will be coupled to the synchronous generator and the configuration will be horizontal. The particulars of layout of the power station equipment and of the turbine, generator, switchgear, control and the other related equipment to be installed in the

power station and outdoor switchyard are described in this chapter.

9.2 Power house and equipment layout

The generating unit will have a horizontal shaft arrangement. The unit will have a longitudinal arrangement parallel to the lengthier axis of the power house. The duct from the unit will discharge water directly into Tarahn stream. The service bay is placed from where access is available from the contemplated path to the power house.

9.3 Hydraulic turbine

The turbine shall be horizontal shaft, impulse turbine, suitable for coupling to the horizontal shaft synchronous generator of 2.1 MW capacity. The turbine shall be capable of giving higher than the rated output to match 10% overload capacity of the generator. The specific speed of the generator shall be as per the best practices and with proven design and operation. The turbine will be provided with suitable electro

hydraulic governor to ensure speed control under all operating conditions. Speed response elements, restoring mechanism and load limiting devices will be integral parts of the governor system.

The turbine shall also be provided with safety devices, instrumentation, compressed air etc. A relatively moderate speed of the turbine shall be selected so as to help in controlling erosion damage. The turbine design shall permit for quick and easy replacement of worn out parts, including runner and the components shall be interchangeable. Materials and composition shall be resistant to wear.

The turbine runner shall be of 13% chromium and 4% nickel stainless steel having buckets integrally cast with the inner central disc. The distributor shall be fabricated from weld able steel plates and shall have suitable sections for ease of shipment within transport limitations. The discharge of the units shall be regulated by needles. The material of nozzles and needles shall be of the best quality stainless steel as per prudent practice

The turbine particulars shall be as follows:

Number of turbine	2
Type	Horizontal Pelton
Rated output	1260 kW
Rated head	200 meter
Nominal discharge	1.25 cumecs
Maximum pressure rise	25%
Maximum speed rise	30%

9.4 Generators

The generator shall be horizontal shaft, alternating current, synchronous/ induction generator type, directly coupled to the turbine on a common generator shaft.

The particulars of the generators shall be as follows:

Number of generators	2
Rated output	1050 kW
Cont. Overload capacity	10%
Rated voltage	3.3KV+/- 10%

Frequency	50 Hz.
Rated frequency variation	+/- 3%
Inertia constant	Not less than 1.0
Short circuit ratio	Not less than 1.0

As in the case of turbine, nearest standard rating of the manufacturers shall be considered, if financially advantageous. The generator shall be star connected and all the main leads, phases and neutral, shall be brought out for grounded operations. Necessary CTs and PTs, surge protection and the neutral grounding equipment shall form part of the generator supply. Brushless shaft driven excitor system shall be provided with the generators together with all equipment required for voltage control, output, power factor etc. along with the required instrumentations. The generator winding as well as rotor shall be provided class F insulation. However, the temperature rise for normal operation shall be limited to that of class B insulation to ensure long life of the machinery. The generator shall be natural air cooled, self ventilated type provided with cooling system based on closed circuit circulation principle. The

cooling system shall be complete with temperature and flow indicators, thermostats, relays, alarms, annunciation devices etc. Provisions of compressed air operated brakes shall be provided.

9.5 Fly wheel and field poles

Necessary fly wheel effect shall be incorporated with the rotating parts of the generator and shall be determined in consultation with the turbine manufacturer. The field poles shall be provided with adequate damper windings to improve stability under fault conditions.

9.6 Stator

The stator frame shall be of fabricated steel construction. The frame shall be designed to withstand bending stresses and deflections due to its self weight of the complete core to be supported by it. The stator core shall be built up of segmental punching of low loss. The design and construction of the rotor shall be in accordance with the best modern practices.

Adequate factor of safety at maximum runaway speed based on yield point of the material shall be ensured by the manufacturer and shall not be less than 1.5. The stator winding shall be of the type which will minimize losses and heating due to circulating currents. The strands shall be of annealed copper, free from splinters, flaws, rough spots or sharp edges. The end portion of the coils and the connections shall be rigidly supported and braced to prevent vibration and distortions under stress caused by the most severest short circuit conditions to which the generator may be subjected.

9.7 Generator shaft

The generator shaft shall be made of the best quality forged carbon steel properly heat treated. The shaft shall be of adequate size to operate at all speeds including maximum runaway speed and capable of withstanding short circuit stresses without excessive vibration or distortions. The generator shaft shall have provisions for mounting of the turbine. The generator bearings will be suitably designed to withstand safely all

the working forces without abnormal temperature rise.

9.8 Penstock

A single penstock from the forebay will carry water and it bifurcating into two parts at a distance of nearly 30m from the power house and will feed water to the pelton turbine controlled by an inlet valve.

9.9 Inlet valve

Butterfly type inlet valve of modern design shall be used as a closing device as this will be operationally more simple and economical. The inlet valve shall be activated by pressure from the hydraulic servomotor and counter weight. All accessories shall be provided including remote operation from control panel. A sluice valve shall also be provided before the inlet valve for ease of maintenance and smooth operations.

9.10 Electrical power scheme

Power will be generated at 3.3KV which is an economical voltage for generators in the capacity range being proposed for this station. Unit

system layout of the generating unit and its auxiliaries has been adopted for the station. The generating unit will be connected to a 3.3 Kv indoor bus. There will be a single step up transformer of 3.3kV/22 KV of a suitable capacity.

The 3.3 KV and 22 kV switchgear will be the main control centre at the power station, on which the required controls and monitoring equipment will be installed. The unit synchronization will be done on 3.3V indoor bus. The power shall be stepped up to 22 kV by a step up transformer, located in the outdoor switchyard, with power flowing into the HPSEB system through a 22 KV transmission line.

9.11 Control and protection

The control logic to be adopted in the station shall be semi-automatic, for unit starting, stopping and load management from a centralized control board. Manual synchronizing arrangement shall be provided for the generating unit and the 22 KV feeder. All necessary controls, indicating instruments/ signals and safety devices shall be

provided. The following control and relay panels complete with auxiliaries shall be provided at the station control desk.

Panel 1	Generator-turbine Unit I
Panel 2	3.3 kV indoor bus panel
Panel 3	Generator-turbine Unit II
Panel 4	Step up Transformer panel
Panel 5	22 kV feeder panel
Panel 6	22 KV incomer feeder panel

9.12 **Outdoor switchyard**

The outdoor switchyard is located adjacent to the power station on the erection bay side. The switchyard equipment shall comprise of one 3 MVA step up transformer, 22 KV circuit breakers, 22 KV bus and line isolators , Bus PTs, CTs bus bars, Las. There will be an incomer breaker on the 22 KV Chheonra feeder and a feeder breaker to connect to the HPSEB grid. In addition, there will be a station transformer,100 KVA, 22/0.415KV installed in the switch yard for taking station supply from the HPSEB system for station auxiliaries.

9.13 Transformer

The step-up generator transformer with a capacity of 3000 kVA, 22/3.3kV, shall confirm to IS standards. Its output voltage, BIL etc. shall allow for de-rating factors as applicable for altitude corrections.

9.14 415 V switchgear

The 415 V switchgear, for the station/unit auxiliaries, shall comprise of the required number of incomers and outgoing circuits for unit and station auxiliaries. Motor control of equipment shall be suitable for 415 V +/- 10%, 3 phase, 50 Hz grounded system having a fault level capable to withstand the fault currents. The motor control units shall be self standing metal cubicles of compartmentalized construction, complete with isolating switches of interlocking type. Bus bars shall be placed in separate compartments at the top of the circuit breakers, which shall be Air break, 3 pole indoor type, constructed as per latest practice. All accessories such as isolating switches, safety features,

instruments, controls, protective relays shall be provided.

9.15 Battery and DC Board

A 110 V DC battery, 50 AH capacity, maintenance free shall be provided at the power station for controls and protection, emergency lights, communications etc. A battery charger of suitable capacity and a DC distribution board for incoming and outgoing circuits shall be provided. All outgoing circuits shall be provided with necessary instruments and meters.

9.16 Power and control cables

The 3.3 kV connection from the generating units and thereafter to the step up transformer shall be made using single phase cables. Copper cables shall be used for connections of all controls, instruments, PTs, CTs. For the 415 V or the 230 V circuits, PVC insulated, PVC sheathed power cables shall be used. The cables used shall be capable of withstanding the short circuit ratings.

9.17 Earthing system

Power house shall be provided with ground mat. The ground mat shall be suitably designed to control the step and touch potentials and shall comprise of MS flats/ bars confirming to IS 3043. The size of the ground mat and its depth of laying , size of the flats and bars etc. shall be made according to the design based on the measured soil resistivity. Earthing buses of flats/ bars, shall be provided at all locations where equipments are to be installed.

9.18 Illumination

Indoor area of the machine hall shall be illuminated with high efficiency luminaries to provide the desired illumination level as per standards. Rooms and other locations shall be provided with fluorescent light. Outdoor areas shall be illuminated with sodium vapour lamps or other suitable luminaries.

9.19 HOT crane

The machine hall of the station shall have provision for an HOT crane of 10 Tonne capacity for meeting the handling needs of the plant and equipment during installation and subsequent maintenance.

9.20 Fire fighting equipment

Portable CO_2 fire extinguishers will be put up for fighting electrical fires, supplemented by portable foam type for oil fires and sand buckets to be provided at suitable locations. Dry powder, non-toxic type fire extinguishers will also be provided for electrical equipment. In addition, suitable fire protection will be provided at strategic locations with flexible hose pipes for water spray.

9.21 Power evacuation

The power generated at Tranha Charroli power station will be transmitted by a three kM long 22

KV transmission line to the adjoining 22 kV HV feeder of HPSEB.

CHAPTER - 10

CONSTRUCTION PROGRAMME

10.1 GENERAL

Tranha Charroli Small Hydro Electric Project is a run-of-the-river scheme in Shimla district of Himachal Pradesh. The project has been contemplated comprising following main civil structures,

- Diversion weir
- Intake structure
- Water Conductor System
- Forebay cum Desilting tank
- Penstock
- Power house

10.2 CONSTRUCTION TIME AND WORKING SEASON

Construction programme, selection of methodology and equipment has been planned with the aim of commissioning the project within Eighteen months with the expectation that working season shall be available round the year.

10.3 APPROACH ROADS AND LOCATION OF THE PROJECT

The project is located at about 170 km from Shimla town on Shimla– Solan– Haripurdhar– Kupvi motorable HPPWD road and is linked to the nearest rail head at Solan by a 70 km long road.

A small patch of approach road will have to be constructed to link the exact location of forebay and power house, as per requirements.

To link the intake area (Tarahn stream) about 900m long road has to be constructed bifurcating from existing HPPWD road at Bridge crossing, along the stream itself on left bank.

10.4 DUMP AREA

Excavated material from intake works, water conductor system, forbay cum desilting tank, penstock and power house area, shall be dumped in the identified dump areas, located within a distance of about 500 meter from the respective sites. Dump area shall be located much above the highest flood level of the stream and shall be protected with retaining walls and wire crates etc.

10.5 PRE-CONSTRUCTION FACILITIES

Pre-construction facilities such as Setting up of reference marks/ bench marks, arranging and marking of the detailed layout of different structures in the field; land acquisition for labour huts, plant areas, stores, residential and non-residential buildings, approach roads, paths, construction of bridges in the project area, construction power; slope protection works in the diversion weir and water conductor system, forebay cum desilting tank, shall be made available in the first year, to facilitate construction of the project. Most of these activities as well as other activities relating to project infra-structure shall be completed prior to commencement of major project components.

10.6 SEQUENCE OF WORKS

Following works are proposed to be executed in the project completion schedule of 24 months, since the area's location shall permit round the year working.

Excavation in diversion weir, water conductor system, forebay cum desilting tank, penstock

trench, power house complex and tail race system.

- All stone masonry/ RCC (1st stage) works, penstock, anchor blocks and power house complex.
- Construction of power house building, bench for switch yard.
- Placing of order for generating equipments and other auxiliaries including transmission and switch yard equipments.
- Fabrication of M.S. pipe for Water Conductor system and penstock
- Excavation and concreting in diversion weir (2nd half)
- All stone masonry and R.C.C. works (2nd stage) in diversion weir, intake structure, water conductor system, forebay cum desilting tank, penstock, anchor blocks,. saddle supports and power house complex.
- Complete erection of penstock.
- Complete erection/construction of water conductor system, penstocks, other hydro-mechanical works including gates, trash rack and valves etc.

- Supply and erection of generating equipments and other accessories.
- Completion of all Electrical and Hydro-mechanical works including erection of machines etc.
- Testing and commissioning of units.

The detailed schedule of the above works has been shown in the Construction Programme Bar Chart (Annexure-10.1)

10.7 MATERIAL PLANNING

The material requirement such as sand and stone aggregate etc. shall have to be sourced from Renukaji. Other items such as cement, steel, special steel plates for penstock etc shall be procured from Kala Amb.

10.8 MAN POWER PLANNING

As the work is proposed to be executed through local petty contractors, the labour required for the same shall be arranged by them from the villages in the vicinity of the project area where sufficient semi-skilled and unskilled labour force

prevails. However, skilled labour and for supervision and proper execution of works, manpower shall be brought from other areas through local employment exchange and other designated human resources agencies.

The operation and maintenance staff shall be accommodated in the colony near the power house area and intake area, at a reasonable distance .

10.9 MODE OF EXECUTION

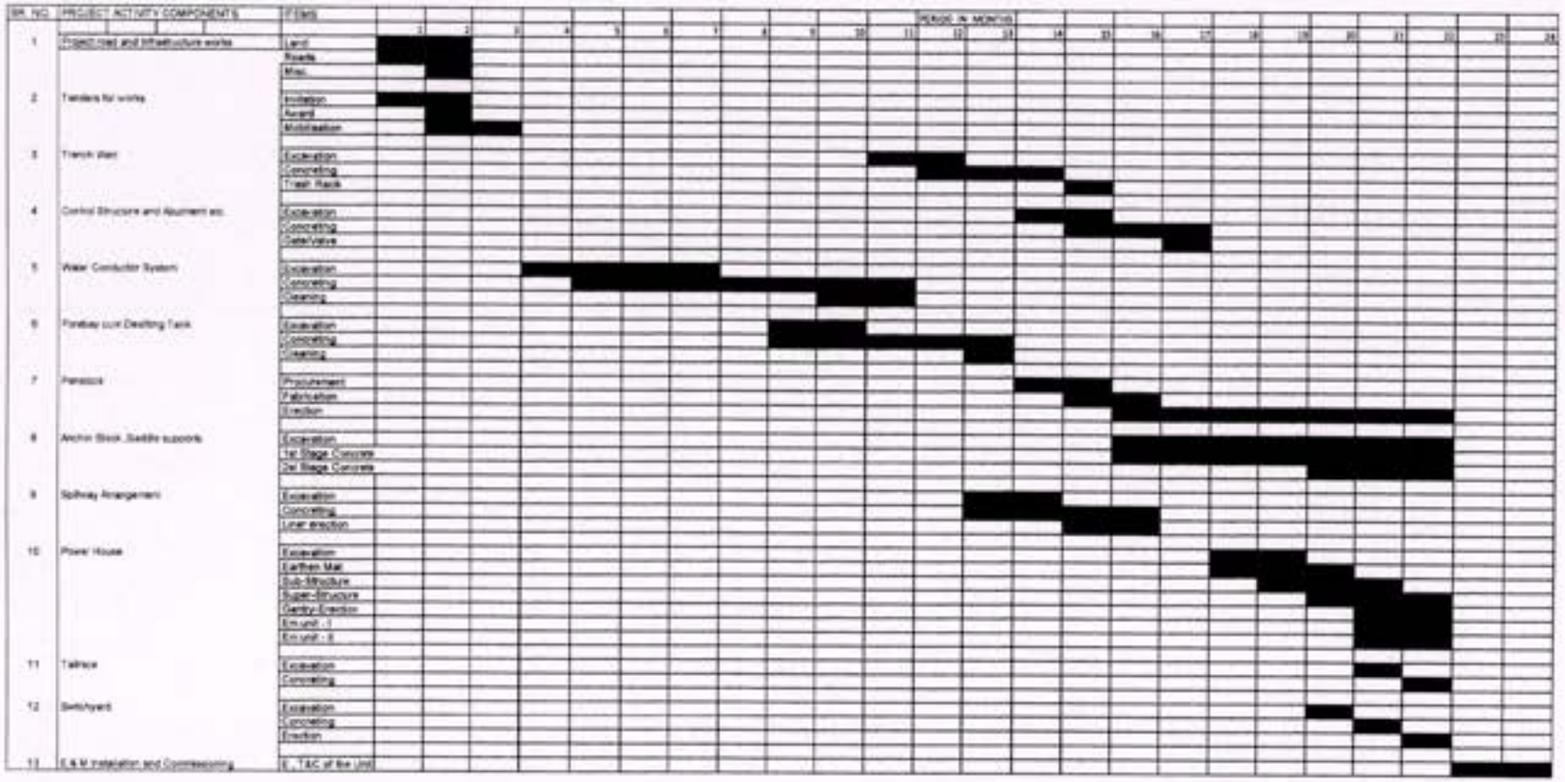
All the civil works are proposed to be executed through petty contractors, works relating to hydro-mechanical will be fabrication and installation and again will through site fabrication, while works relating to E&M package will on EPC contract . The works shall be awarded in following packages :-

- Civil works
- Hydro-mechanical works
- Electro-mechanical works.

ANNEXURE 10.1

CONSTRUCTION PROGRAMME

SR. NO.	PROJECT ACTIVITY COMPONENTS	ITEMS
1	Project road and Infrastructure works	Land
		Roads
		Misc.
2	Tenders for works	Invitation
		Award
		Mobilisation
3	Trench Weir	Excavation
		Concreting
		Trash Rack
4	Control Structure and Abutment etc.	Excavation
		Concreting
		Gate/Valve
5	Water Conductor System	Excavation
		Concreting
		Gauging
6	Forebay cum Desilting Tank	Excavation
		Concreting
		Gauging
7	Penstock	Procurement
		Fabrication
		Erection
8	Anchor Block ,Saddle supports	Excavation
		1st Stage Concrete
		2st Stage Concrete
9	Spillway Arrangement	Excavation
		Concreting
		Liner erection
10	Power House	Excavation
		Earthen Mat
		Sub-Structure
		Super-Structure
		Gantry Erection
		Ern.unit - I
		Ern.unit - II
11	Tailrace	Excavation
		Concreting
12	Switchyard	Excavation
		Concreting
		Erection
13	E & M Installation and Commissioning	E , T&C of the Unit



CHAPTER - 11

ENVIRONMENT AND ECOLOGY

11.1 GENERAL

Tranha Charroli small hydro electric project is proposed to be set up on the left bank of Tarahn stream in a location adjoining Kupvi Tehsil Chopal and Dist. Shimla. Project components do not fall into any habitated areas and the villages in the surrounding vicinity on the mountain slopes are sparsely populated.

11.2 SITE SELECTION AND CONSTRUCTION

Site selection of the scheme has been done keeping in view the ecological setting of the area. Being a run-of-river project, no land submergence is involved and unlike dam based projects, it is free from associated problems of water logging, salinity and rehabilitation of population.

Project components are planned to be constructed with foundations firmly embedded in the rocks or in ground. Hence, there is no danger of any erosion or disturbance to hill slopes. Project construction would neither affect nor bring any significant changes to the physical aspects of the project area. Soil stabilization measures will be a part of the design criteria. Excavated material from the various work sites will be suitably carried to the designated dumping areas and adequately settled / secured. The infrastructural facilities to be created for the construction activities will be mostly temporary in nature. Land acquired for temporary site office and labour colony shall be returned in its original shape after ,completion of project by taking adequate preventive / corrective measures.

11.3 NATURAL RESOURCE BASE

Project activities will not affect the natural resource base in the project area in short term or in the long term. Project does not envisage any consumptive use of water. Thus, the resource

for irrigation is not affected. Water flows from other small streams and nalas joining the Khads downstream of the diversion weir, coupled with the sacrificial discharge is considered to be adequate to meet all downstream requirements of water for irrigation, as and when required.

Also, there will be no adverse impact on aquatic wildlife or fish wealth. It is generally only due to large dams that the fish migration patterns change. In case of small hydro schemes such as the one being proposed, there is no significant change in the velocities of water current and hence no changes in the ambient conditions for the aquatic faunas. The fish migrate to higher elevation during summer months and at that time, there will be plenty of water in the khad/ nala.

11.4 PUBLIC HEALTH ASPECT

Being a small hydel scheme, public health aspect will not be affected. The EPC / Turnkey/ piece meal contractors would ensure to adopt and take suitable measures. Safe drinking water

arrangements shall be made and septic tanks shall be constructed to take care of public health requirements.

11.5 ESTIMATION OF MEASURES

Following measures with adequate budgetary provisions have been considered:

- Provision of safe drinking water and sanitation
- Provision of kerosene oil to labourers
- Restoration of temporary land acquired for site office and labour colony to its original shape.
- Plantation of trees in project area as well as powerhouse area.
- Anti-poaching measures shall be enforced by educating the work force

11.6 SEISMICITY

The project area lies in the region susceptible to damage due to earthquake. The area as per classification falls under Zone IV. Therefore, adequate seismic co-efficient shall be derived for adoption in the structure design of the project.

11.7 CLEAN DEVELOPMENT MECHANISM

Under Kyoto protocol, it has been decided to introduce Clean Developmental mechanism to bring down the green house gas emissions. The estimated support from such a mechanism, besides making the project financially viable, shall help in the preservation of environment. Ac separate chapter– 15 has been devoted on this important subject.

CHAPTER - 12

RATES FOR DIFFERENT ITEMS OF WORK

TRANHA CHARROLI HEP

Rates for various items of work are analysed on the basis of labour rates and material basic rates already derived on the basis of current market rates applicable at site of project. The rates so worked out are as under :-

Sr. No.	DESCRIPTION OF ITEM	UNIT	RATES
1	Cement	MT	7019
2	Sand	cum	1929.00
3	Coarse Aggregate 20/40 mm	cum	2139.00
4	Cement Concrete M-10	cum	4854.00
5	Cement Concrete M-15	cum	5390.00
6	Cement Concrete M-20	cum	6226.00
7	Supply of steel reinforcement	MT	45067.00
8	Supply of structural steel	MT	44016.00
9	Supply of Penstock steel	MT	55573.00
10	P/L CC M-15 in superstructure	cum	7304.00
11	P/L CC M-20 in superstructure	cum	8140.00
12	P/L CC M-10 in superstructure	cum	6768.00
13	Fab. and errection of steel reinforcement	MT	57834.00
14	Fab. and errection of Structural Steel	MT	76247.00
15	Fab. and errection of Penstock steel liner	MT	99057.00
16	Dewatering	kWh	43.20
17	Fab. and errection of Stop log /Gates	MT	122825.00
18	Stone masonary in CM 1:3	cum	3402.00
19	Wire Crates	cum	1630.00
20	Excavation in loose rock / overburden	cum	279.00
21	Rock Excavation	cum	522.00
22	Rock Bolting	m	551.00
23	Boulder Filling (Hand Packed)	cum	825.00
24	Plastering 6mm thick in CM 1:3	sq. m	83.50

ANALYSIS OF RATES - MATERIAL AND ITEMS OF WORK

CEMENT

Description		Unit	Qty	Rate	Amount
Cost of cement at Charroli		MT	1	6400	6400.00
Carriage of cement from store/depot to the project store in km	3				
Rate of truck per km	35.00				
Load carrying capacity of the truck in MT	8				
Carriage charges upto project site	13.125				13.13
Unloading & Stacking at store				LS	100.00
				Sub total (a+b+c)	6513.13
Storage charges @ 3%					195.39
Carriage by mannual labour to the work site taking average lead of 1 km rate as per HPSR-2009		MT	1	172.68	172.68
				Total	6881.20
Supervision charges @ 2%					137.62
				G-Total	7018.82
		COST PER MT			7018.82
		COST PER BAG			350.94
				Say	**351.00**

SAND

Description		Unit	Qty	Rate	Amount
Cost of sand at quarry site i/c royalty		cum	1	800	800.00
Carriage of sand from quarry site to the project store in km	65				
Rate of truck per km	35.00				
Load carrying capacity of the truck in cum	3.77				
Carriage charges upto project site	603.45				603.45
Unloading & Stacking at site					100.00
				S-Total (a+b+c)	1503.45
Storage charges @ 3%					45.10
Carriage by mannual labour to the work site taking average lead of 1 km rate as per HPSR-1999		cum	1	342.35	342.35

		Total		1890.90
Supervision charges @	2%			37.82
		G-Total per Cum		1928.72
			Say	**1929.00**

COARSE AGGREGATE 20/40 mm

Description		Unit	Qty	Rate	Amount
Cost of aggregate at crusher/quarry site i/c royalty		cum	1	1000	1000.00
Carriage of aggregate from crusher/quarry site to the project store in km	65				
Rate of truck per km	35.00				
Load carrying capacity of the truck in cum	3.77				
Carriage charges upto project site	603.4483				603.45
Unloading & Stacking at site					100.00
		S-Total (a+b+c)			1703.45
Storage charges @	3%				51.10
Carriage by mannual labour to the work site taking average lead of 1 km. rate as per HPSR-2009		cum	1	342.35	342.35
		Total			2096.90
Supervision charges @	2%				41.94
		G-Total per Cum			2138.84
				Say	**2139.00**

CEMENT CONCRETE M-10

Description	Unit	Qty	Rate	Amount
Material				
Cement	Bags	4.83	351	1695.33
Sand	cum	0.45	1929	868.05
Coarse aggregate 40 mm nominal size	cum	0.9	2139	1925.10
Water		LS		10.00
Admixture		LS		100.00
		Total		4598.48
Batching and mixing charges 280 ltr. Capacity concrete mixer				186.00

Labour charges per cum		LS		70.00
		Rate per cum.		4854.48
			say	**4854.00**

CEMENT CONCRETE M-15

Description	Unit	Qty	Rate	Amount
Material				
Cement	Bags	6.3	351	2211.30
Sand	cum	0.45	1929	868.05
Coarse aggregate 40 mm nominal size	cum	0.9	2139	1925.10
Water		LS		10.00
Admixture		LS		120.00
		Total		5134.45
Batching and mixing charges 280 ltr. Capacity concrete mixerwith use rate per cum.				186.00
Labour charges per cum		LS		70.00
		Rate per cum.		5390.45
			say	**5390.00**

CEMENT CONCRETE M-20

Description	Unit	Qty	Rate	Amount
Material				
Cement	Bags	8.51	351	2987.01
Sand	cum	0.45	1929	868.05
Coarse aggregate 20 mm nominal size	cum	0.9	2139	1925.10
Water		LS		10.00
Admixture		LS		180.00
		Total		5970.16
Batching and mixing charges 280 ltr. Capacity concrete mixerwith use rate per cum.				186.00
Labour charges per cum		LS		70.00
		Rate per cum.		6226.16
			say	**6226.00**

SUPPLY OF STEEL REINFORCEMENT

Description		Unit	Qty	Rate	Amount
Cost of Steel at market i/c taxes		MT	1	42000	42000.00
Carriage of steel from market to the project store in km	97				
Rate of truck per km	35.00				
Load carrying capacity of the truck in cum	8				
Carriage charges upto project site	424.375				424.38
Unloading & Stacking at site					100.00
		S-Total (a+b+c)			42524.38
Storage charges @ 3%					1275.73
Carriage by mannual labour to the work site taking average lead of 1 km. rate as per HPSR-2009		MT	1	383.1	383.10
		Total			44183.21
Supervision charges @ 2%					883.66
		G-Total per MT			45066.87
				Say	**45067.00**

SUPPLY OF STRUCTURAL STEEL

Description		Unit	Qty	Rate	Amount
Cost of Steel at Kala Amb i/c taxes		MT	1	41000	41000.00
Carriage of steel from Kala Amb to the project store in km	97				
Rate of truck per km	35.00				
Load carrying capacity of the truck in cum	8				
Carriage charges upto project site	424.375				424.38
Unloading & Stacking at site					100.00
		S-Total (a+b+c)			41524.38
Storage charges @ 3%					1245.73
Carriage by mannual labour to the work site taking average lead of 1 km. rate as per HPSR-2009		MT	1	383.1	383.10
		Total			43153.21
Supervision charges @ 2%					863.06
		G-Total per MT			44016.27
				Say	**44016.00**

SUPPLY OF PENSTOCK STEEL

Description			Unit	Qty	Rate	Amount
Cost of Steel at Kala Amb i/c taxes			MT	1	52000	52000.00
Carriage of steel from Kala Amb to the project store in km			97			
Rate of truck per km			35.00			
Load carrying capacity of the truck in cum			8			
Carriage charges upto project site			424.375			424.38
Unloading & Stacking at site						100.00
				S-Total (a+b+c)		52524.38
Storage charges @	3%					1575.73
Carriage by mannual labour to the work site taking average lead of 1 km. rate as per HPSR-2009			MT	1	383.1	383.10
				Total		54483.21
Supervision charges @	2%					1089.66
				G-Total per MT		55572.87
					Say	**55573.00**

PLACEMENT OF CONCRETE M-15 (SUPERSTRUCTURE)

Description			Unit	Qty	Rate	Amount
MATERIAL						
Cost of concrete at Concrete Mixer			Cum	1	5390	5390.00
CARRIAGE AND PLACEMENT CHARGES						
i) Labour to be deployed for placement of concrete and providing chutes etc.						
Mason	0.25	@	300.00			
Beldars	2	@	150.00			
Bhishti	0.25	@	150.00			
			600.00			600.00
Add 50% above for hidden cost of labour			50%			300.00
					Total	900.00
ii) Compaction charges					LS	15.00
iii) Catwalks and other aids					LS	25.00
iv) Cleaning slurry and curing etc.					LS	40.00
v) Other unforeseen items					LS	15.00
					Sub-Total	995.00
Shuttering compleyte in all respects					LS	600.00
					Prime Cost (A+B+C)	6985.00
Add 20% for overheads and contracto profit etc. on prime cost except cost of cement			20%			319.00
			1595.00		Gross Total per cum	7304.00
					Say	**7304.00**

PLACEMENT OF CONCRETE M-20 (SUPERSTRUCTURE)

Description			Unit	Qty	Rate	Amount
MATERIAL						
Cost of concrete at Concrete Mixer			Cum	1	6226	6226.00
CARRIAGE AND PLACEMENT CHARGES						
i) Labour to be deployed for placement of concrete and providing chutes etc.						
Mason	0.25	@	300.00			
Beldars	2	@	150.00			
Bhishti	0.25	@	150.00			
			600.00			600.00
Add 50% above for hidden cost of labour			50%			300.00
					Total	900.00
ii) Compaction charges					LS	15.00
iii) Catwalks and other aids					LS	25.00
iv) Cleaning slurry and curing etc.					LS	40.00
v) Other unforeseen items					LS	15.00
					Sub-Total	995.00
Shuttering compleyte in all respects					LS	600.00
					Prime Cost (A+B+C)	7821.00
Add 20% for overheads and contracto profit etc.			20%			319.00
on prime cost except cost of cement			1595.00		Gross Total per cum	8140.00
					Say	**8140.00**

PLACEMENT OF CONCRETE M-10 (SUPERSTRUCTURE)

Description			Unit	Qty	Rate	Amount
MATERIAL						
Cost of concrete at Concrete Mixer			Cum	1	4854	4854.00
CARRIAGE AND PLACEMENT CHARGES						
i) Labour to be deployed for placement of concrete and providing chutes etc.						
Mason	0.25	@	300.00			
Beldars	2	@	150.00			
Bhishti	0.25	@	150.00			
			600.00			600.00
Add 50% above for hidden cost of labour			50%			300.00
					Total	900.00
ii) Compaction charges					LS	15.00
iii) Catwalks and other aids					LS	25.00
iv) Cleaning slurry and curing etc.					LS	40.00
v) Other unforeseen items					LS	15.00
					Sub-Total	995.00
Shuttering compleyte in all respects					LS	600.00
					Prime Cost (A+B+C)	6449.00
Add 20% for overheads and contracto profit etc.			20%			319.00
on prime cost except cost of cement			1595.00		Gross Total per cum	6768.00
					Say	**6768.00**

FABRICATION AND ERRECTION OF STEEL REINFORCEMENT

Description		Unit	Qty	Rate	Amount
MATERIAL					
Cost of Steel at project site		MT	1	45067	45067.00
Add 2.5% for wastage etc.	2.50%				1126.68
				S-Total	46193.68
Handling and Placing					
i) Bending and cutting @	6% of -A		2771.62		
ii) Handling @	5% of -A		2309.68		
iii) Placing and Welding @	5% of -A		2309.68		
iv) Binding wire and other misc. material charges	5% of -A		2309.68		
		Total	9700.67		9700.67
			Prime cost (A+B)		55894.35
Add 20% as overhead charges on B		20%			1940.13
			G-Total per MT		57834.48
				Say	**57834.00**

FABRICATION AND ERRECTION OF M.S. PIPE AS WATER CONDUCTOR SYSTEM

Description		Unit	Qty	Rate	Amount
MATERIAL					
Cost of structuralSteel at project site		MT	1	44016	44016.00
Add 2.5% for wastage etc.	2.50%				1100.40
				S-Total	45116.40
FABRICATION					
i) Marking of plates @	2.5% of -A		1127.91		
i) Cutting @	3% of -A		1353.49		
ii) Bending and rolling @	6% of -A		2706.98		
iii) Placing and Welding @					
a. Electrodes etc.	8% of -A		3609.31		
b. Labour/electric charges @	10% of -A		4511.64		
c. Handling charges @	5% of -A		2255.82		
d. Temporary Fixtures @	8% of -A		3609.31		
	Total Welding Cost		13986.08		
	Sub- Total Fabrication cost		19174.47		19174.47
ERRECTION					
Transportation of material out of workshop.erecting, handling placing in position, final matching, field welding, field priming preparation of steel supports and all other related works complete in all respects @	15% of -A		6767.46		6767.46
			Prime cost (A+B+C)		71058.33
Add 20% as overhead charges on (B+C)		20%			5188.39
			G-Total per MT		76246.72
				Say	**76247.00**

FABRICATION AND ERRECTION OF PENSTOCL STEEL LINER

Description		Unit	Qty	Rate	Amount
MATERIAL					
Cost of structuralSteel at project site		MT	1	55573	55573.00
Add 2.5% for wastage etc.	2.50%				1389.33
				S-Total	56962.33
FABRICATION					
i) Marking of plates @	2.5% of -A		1127.91		
i) Cutting @	3% of -A		1353.49		
ii) Bending and rolling @	6% of -A		2706.98		
iii) Placing and Welding @					
a. Electrodes etc.	8% of -A		3609.31		
b. Labour/electric charges @	10% of -A		4511.64		
c. Handling charges @	5% of -A		2255.82		
d. Temporary Fixtures @	8% of -A		3609.31		
	Total Welding Cost		13986.08		
iv) Radiographical & Ultrasonic testing	10% of -A		4511.64		
	Sub- Total Fabrication cost		23686.11		23686.11
ERRECTION					
Transportation of material out of workshop.erecting, handling placing in position, final matching, field welding, field testing preparation of steel supports and all other related works complete in all respects @	20% of -A		11392.47		11392.47
			Prime cost (A+B+C)		92040.90
Add 20% as overhead charges on (B+C)		20%			7015.72
			G-Total per MT		99056.62
				Say	**99057.00**

DEWATERING

Description	Unit	Qty	Rate	Amount
Pump Charges				
Use rate of 10 HP Pump per hour	hour	1	196	196.00
			sub- total	196.00
Pipe Accessories				
Depreciation Charges				
i) 150 m pipe 100 mm dia @ Rs 150 per m	m	150	150	22500.00
ii) 5 No. MS bends 100 mm dia	No	5	110	550.00
iii) Foot valve	No	1	900	900.00
iv) Sluice valve	No	1	1780	1780.00
v) Other spares @ 10% of (i)	LS		10%	2250.00
			sub- total	27980.00
Rated life = 20000 hours				
Depreciation charges per hour = 0.9*Material cost/Rated life				1.26
Repair And Maintenance Charges @ 50% of deoreciation charges				0.63
Labour Charges				
One No. helper @ 3500 per month			3500	
Direct charges			3500	
Hidden cost @ 50% of direct charges			1750	
Total labour charges			5250	
average No. of working hours per month =	150			
Labour charges per hour			35	35.00
Misc. Charges				
Misc. charges @ 50% of repair charges	50%		0.31	0.31
		Total (a to d)		37.20
Making Sump for Placing pipes				
Labour Charges				
One Helper/Beldar @ 3500 per month			3500	
total direct charges			3500	
Add for hidden cost @ 50% of direct charges			1750	
Total labour charges			5250	
average No. of working hours per month =	150			
Labour charges per hour			35	35.00
ABSTRACT OF CHARGES				
A Pump Charges		196.00		
B Pipe And Accessories		37.20		
C Making sump for placing of pipes		35.00		
Prime cost total		268.20		268.20
Add for overhead and departmental charges @ 20% of prime cost				53.64
Grand Total				321.84
			say	322.00
Rate of dewatering charges per hour for 10 HP pump = 257/10*0.746				43.16
			Say Rs **43.20**	per hour

FABRICATION AND ERRECTION OF STOP LOG /GATES

Description			Unit	Qty	Rate	Amount
MATERIAL						
i) Cost of structuralSteel at project site			MT	1	44016	44016.00
Add 2.5% for wastage etc.	2.50%					1100.40
					sub total	45116.40
ii) 1.50 cum acyteline @ Rs 1900/ cum		1900				
iii) 7.5 cum Oxygen @ 890 / cum		6675				
iv) 200 No. electrodes @ Rs 11/- each		2200				
v) 12 kg gun metal ingots @ 165 / kg		1980				
vi) Rubber seal 2.5 m @ 175/- per m		437.5				
vii) Misc. material such as nuts and bolts, screws, paint, pattern wood, hard coke etc. @ 5% of i)		2255.82				
Total		15448.32				
		Total A				60564.72
LABOUR CHARGES						
i) Fabrication including cutting, welding and marking @ 30% of steel cost		13534.92				
ii) Machining i/c turning,drilling, threading, boring, teeth cutting @ 20% of steel cost		9023.28				
iii) Casting @ 20 % of steel cost		9023.28				
iv) Smithy and Forging charges @ 15% of steel cost		6767.46				
v) Misc labour charges @ 5% of steel cost		2255.82				
Total labour Cost		40604.76				40604.76
TRANSPORTATION AND ERRECTION CHARGES						
i) Transportation of Stop log /Gates to the site of work @ 10% of steel cost					4511.64	
ii) Errection of embeded parts including placing in position, final matching, field welding, field priming preparation of steel supports @ 15% of steel cost					6767.46	
			sub total		11279.10	11279.10
				Prime cost (A+B+C)		112448.58
Add 20% as overhead charges on (B+C)			20%			10376.77
				G-Total per MT		122825.35
					Say	**122825.00**

STONE MASONRY IN CEMENT MORTAR 1:3

Description			Unit	Qty	Rate	Amount
MATERIAL						
i) 1.10 cum of stones i/c collection, royalty and carriage to the site of work			Cum	1.1	800	880.00
ii) Cement			bags	3.06	351	1074.06
iii) sand			cum	0.38	1929	733.02
			Total Material charges			2687.08
LABOUR CHARGES (For 100cft)						
i) Labour to be deployed for placement of concrete and providing chutes etc.						
Mason	1.5	@	300.00			
Beldars	2	@	116.67			
Bhishti	1	@	200.00			
	total		616.67			616.67
Add 50% above for hidden cost of labour			50%			308.33
			Total labour charges			925.00
Labour charges per cum = 650*35.31/100						326.62
			Prime Cost (Laboue and Material)			3013.70
Add 20% for overhead charges			20%			387.93
			Total Cost per cum			3401.63
					Say	**3402.00**

WIRE CRATES

Description			Unit	Qty	Rate	Amount
MATERIAL						
i) 1.15 cum of stones i/c collection, royalty and carriage to the site of work			Cum	1.15	800	920.00
ii)Wire net for crates 3.2 kg/ cum @ Rs 35 per kg			kg	3.2	35	112.00
			Total Material charges			1032.00
LABOUR CHARGES (For 100cft)						
i) Labour to be deployed for placement of concrete and providing chutes etc.						
Mason	1	@	300.00			
Beldars	2	@	116.67			
B/smith	1	@	200.00			
	total		616.67			616.67
Add 50% above for hidden cost of labour			50%			308.33
			Total labour charges			925.00
Labour charges per cum = 775*35.31/100						326.62
			Prime Cost (Laboue and Material)			1358.62
Add 20% for overhead charges			20%			271.72
			Total Cost per cum			1630.34
					Say	**1630.00**

EXCAVATION IN LOOSE ROCK / OVERBURDEN

Description	Unit	Qty	Rate	Amount
Average lead	0.5 km			
Diesel hydraulic excavator	0.91 cum			
Ideal production per hour	120 cum			
Ataking angle of swing & depth of cut	0.88			
Actual production per hour	105.6 cum			
Efficiency	0.8			
Job management factor	0.69			
Out put of excavator per hour	58.29 cum			
Tipper	4.5 cum			
Swell factor	0.75			
Body capacity	3.38 cum			
MACHINERY CHARGES				
i) Hydraulic Excavator (Shovel)				
Use rate per working hour in Rs.	1350			
Rate per cum in Rs.	23.16		23.16	
ii) Tipper 4.5 cum capacity				
Total cycle time i/c loading, spotting, turning etc.	20.49 min.			
No. of trips per working hour of 50 min.	2.44			
Out put of tipper per working hr.	8.24 cum			
Use rate of tipper per hour	1243			
Rate per cum in Rs.	150.93		150.93	
iii) Crawler Dozer (90HP)				
Assuming that one dozer will work with one shovel hence output of dozer	58.29 cum			
Use rate of dozer per hour	1965			
Rate per cum in Rs.	33.71		33.71	
	Total machinery Charges		207.80	
Electric energy charges 2% of machinery charges			4.16	
Maintenance charges of haul roads @ 5% of machinery charges			10.39	
Levelling and trimming of waste earth @ 5% of machinery charges			10.39	
	Prime cost		232.73	
Add overhead and departmental charges @ 20% of prime cost			46.55	
	Grand Total		279.28	
	Say Rs		279.00	
Hence rate per cum				**Rs 279.00**

ROCK EXCAVATION

Description		Unit	Qty	Rate	Amount
For 100 cum					
Drilling and Blasting Charges					
Hole size	38	mm			
Spacing of holes	1.52*1.52	m			
Area per hole in sq m	2.31				
Qty of rock per linear m of hole	2.31	cum			
Depth of drilling for 100 cum	43.28	m			
Add for pull effect etc @ 50%	21.64				
Total drilling for 100 cum	64.92				
Rate of drilling per hour	2.3	m			
Use rate of Jack Hammer / hour	452				
i) Cost of drilling with Jack Hammer = 64.92* use rate/2.3	12758.94	100 cum			
ii) Cost of drill steel @ Rs14/m	908.93				
iii) Cost of blasting					
Gelatine 28 kg	1596				
Detonators 25 No.	300				
Blasting batteries @ 50% of above	150				
Stemming @ 40%	120				
Sub-Total	2166				
Total charges fordrilling and blasting	15833.88				
Add secondary drilling etc@ 10% of above	1583.388				
Gross total	17417.26				17417.26
Carriage Charges					
Average for poor and blasted rock	96	cum/hour			
Depth of cut and angle of Swing factor	0.88				
Bucket fill factor	0.69				
Job management factor	0.8				
Output of excavation per hour	46.63				
say	47.00	cum/hour			
Machinery charges					
Shovel Ues rate per hour	1350				
Rate per cum	28.72				
Tipper Rate per cum (as in item No.25 above)	150.93				
Crawler dozer					
Rate per cum	41.81				
Total machinery charges per cum	221.46				
Carriage charges for 100 cum	22145.97				22145.97
Total rate for 100 cum					39563.24
Add for electric charges @ 2% of(A+B)					791.26
Add for maintenance of haul roads @ 5% of (A+B)					1978.16
Add for levelling and trimming charges @ 3% of (A+B)					1186.90
			Prime Cost		43519.56
Add for overhead charges @ 20% on prime cost					8703.91
			Grand total		52223.47
Rate of excavation per cum = 47381/100				Rs	522.23
				Say Rs.	522.00
Hence rate per cum				**Rs.**	**522.00**

Rock Bolting

Description		Unit	Qty	Rate	Amount
		m			
Supply and making the bit					
i) Rock bolts 28 mm dia @ 31.50 per kg for 3.95kg per m		124.43			
ii) Wastage and cutting @ 2.5% of above		3.11			
iii)Cuttuing and making tips LS		15			
iv) Treading of bolts LS		15			
v) Nuts & washers, resin caps. etc. LS		20			
	Sub-total	177.54			177.54
Drilling					
i) Use rate of Jack Hammer per hour		452			
average rate of drilling per hour		2.3 m			
Rate of drilling per m		196.52			
ii) Cost of drilling rod for one metre LS		15			
iii) Labour, lighting & scaff @ 60% of (ii)		9			
iv) Ventilation and shop charges @ 40%		6			
	Sub-total	226.52			226.52
Installation					
i) Placing the bolts in position	LS	20			
ii) Grouting of rock bolt	LS	20			
iii) Misc. works	LS	15			
	Sub-total	55.00			55.00
Prime Cost Total (A+B+C)					459.06
Add overhead charges @ 20% of prime cost					91.81
			Grand Total		550.87
				Say Rs.	551.00
Hence rate of rock boltig per running metre				**Rs.**	**551.00**

BOULDER FILLING (HAND PACKED)

Description	Unit	Qty	Rate	Amount
Collection and carriage charges	cum	1	400	400.00
Hand Packing				
Beldars	each	0.5	116.67	58.33
		Sub total		458.33
Add 50% above for hidden cost of labour	50%			229.17
		Prime Cost		687.50
Add 20% as overhead on prime cost				137.50
		Grand total		825.00
	Hence cost per cum			**Rs. 825.00**

PLASTERING 6mm THICK IN C.M. 1:3 (1 CEMENT : 3 SAND)

Description	Unit	Qty	Rate	Amount
For 10 sq m				
MATERIAL				
Cement	bag	0.73	351	256.23
Sand	cum	0.077	1929	148.53
		Sub total		404.76
Labour charges				
Mason 2nd class	each	0.4	300.00	120.00
Beldar	each	0.4	116.67	46.67
Bhishti	each	0.5	200.00	100.00
Sundries	LS			20.00
		Sub total		286.67
Total (A+B)				691.43
Add @ 50% for hidden charges on 'B'				143.33
Cost of 10 sq.m				834.76
Cost per sq. m.				83.48
			Say	**Rs. 83.50**

ANALYSIS OF RATES - MACHINERY

1 MATERIAL TRUCK 10 MT CAPACITY

Cost of the machine IN Rs.				1200000
Rated life in km				200000
Rated life in years				10
Depreciation charges per km				5.40
Cost of tyres at site				60000
Rated life of tyres in km				30000
Depreciation charges per km				2.00
a.) Total depreciation charges				7.40
b.) Repair and maintenance charges @ 175% of truck depreciation and 15% of tyres depreciation				9.45
				0.3
			S-Total R & M charges	9.75
c.) POL Charges	HS Diesel @ Rs.	42.5		
	for 5 km per liter	5		8.5
	Lubricants @ of HS Diesel	25%		2.13
	Sundaries @	15%		1.28
			S-Total POL charges	11.90
d.) Man power charges				
	Driver 1 No	MRx12x1 / 20000		7.2
	Cleaner 1 No.	MRx12x1 / 20000		3.00
	Mechanic 1/8 No.	MRx12x1x8 / 20000		0.75
	Helper 1/6 No.	MRx12x1x6 / 20000		0.35
			Direct labour charges	11.30
		Add for hidden cost @ 50% of above		5.65
			S-Total labour charges	16.95
e.) Token Tax and Goods tax etc.				
	Token Tax @ 2000 per year			0.1
	Goods Tax @ 4000 per year			0.2
	Routes permits etc. @ 3000 per year			0.15
			S-total	0.45
	Use rate per km			34.55
			say	**35**

2 CONCRETE MIXER 280 LTR. CAPACITY

Cost of the machine in Rs.				175000
Rated life in hrs				6000
Rated life in years				5
a.) Depreciation charges per km				26.25
b.) Repair and maintenance charges @ 80% of truck depreciation and				21.00
			S-Total R & M charges	21.00

c.) POL Charges	HS Diesel @ Rs.	42.5			
	for 1.88 ltr per hr	1.88			79.90
	Lubricants @ of HS Diesel	25%			19.96
	Sunderies @	10%			7.99
				S-Total POL charges	107.87
d.) Man power charges					
	Operator 1 No	MRx12x1 / 6000			16.0
	Helper 1/2 No	MRx12x1 / 6000x2			3.50
	Chowkidar 1/6 No	MRx12x1 / 6000x6			1.17
			Direct labour charges		20.67
			Add for hidden cost @ 50% of above		10.33
				S-Total labour charges	31.00
		Use rate per hr			186.12
				say	**186**

3 DEWATERING PUMP 20 HP CAPACITY

Cost of the machine					45000
Rated life in hrs					20000
Rated life in years					12
a.) Depreciation charges per Hour					2.03
b.) Repair and maintenance charges @ 70% of truck depreciation and					1.42
				S-Total R & M charges	1.42
c.) POL Charges	Energy charges	7			
	2 X 7.46 kwh @				104.44
	Lubricants @ of above	25%			26.11
	Sunderies @	10%			10.44
				S-Total POL charges	140.99
d.) Man power charges					
	Operator 1 No	MRx12x1x12 / 20000			57.6
	Mechanic 1/4 No.	MRx12x1x12 / 20000x4			18.00
	Electrician 1/8 No.	MRx12x1x12 / 20000x8			7.20
			Direct labour charges		82.80
			Add for hidden cost @ 50% of above		41.40
				S-Total labour charges	124.20
		Use rate per hr			268.64
				say	**269**

4 CENTRIFUGAL PUMP 10 HP CAPACITY

Cost of the machine					22000
Rated life in hrs					20000
Rated life in years					12
a.) Depreciation charges per Hour					0.99
b.) Repair and maintenance charges @ 70% of truck depreciation and					0.69
				S-Total R & M charges	0.69

c.) POL Charges	Energy charges 7.46 kwh @	7		52.22
	Lubricants @ of above	25%		13.06
	Sundries @	10%		5.22
			S-Total POL charges	70.50
d.) Man power charges				
	Operator 1 No	MRx12x1x12 / 20000		57.6
	Mechanic 1/4 No	MRx12x1x12 / 20000x4		18.00
	Electroian 1/8 No	MRx12x1x12 / 20000x8		7.20
			Direct labour charges	82.80
		Add for hidden cost @ 50% of above		41.40
			S-Total labour charges	124.20
		Use rate per hr		195.38
			say	**196**

5 TIPPER 4.5 Cum. CAPACITY

Cost of the machine				700000
Rated life in Hrs				10000
Rated life in years				8
Depreciation charges per hour				63.00
Cost of tyres at site				60000
Rated life of tyres in hour				2750
Depreciation charges per hour				21.82
a.) Total depreciation charges				84.82
b.) Repair and maintenance charges @ 175% of tipper depreciation and 15% of tyres depreciation				110.25
				3.27
			S-Total R & M charges	113.52
c.) POL Charges	HS Diesel @ Rs.	42.5		
	for 13.0 litre/hour	13		552.5
	Lubricants @ of HS Diesel	25%		138.13
	Sundaries @	15%		82.88
			S-Total POL charges	773.50
d.) Man power charges				
	Driver 1 No	MRx12x1x8 / 10000		115.2
	Cleaner 1 No.	MRx12x1x8 / 10000		48.00
	Mechanic 1/8 No.	MRx12x1x8x8 / 10000		12.00
	Helper 1/6 No.	MRx12x1x8x6 / 10000		5.60
			Direct labour charges	180.80
		Add for hidden cost @ 50% of above		90.40
			S-Total labour charges	271.20
		Use rate per hour		1243.04
			say	**1243**

6 DOZER D-90 (90 HP)

Cost of the machine	3600000
Rated life in Hrs	9000
Rated life in years	8
Depreciation charges per hour	360.00
a.) Total depreciation charges	360.00
b.) Repair and maintenance charges @ 200% of depreciation charges	720.00

				S-Total R & M charges	720.00
c.) POL Charges	HS Diesel @ Rs.	42.5			
	for 10.64 litre/hour	10.64			452.2
	Lubricants @	25%			113.05
	of HS Diesel				
	Sundaries @	15%			67.83
				S-Total POL charges	633.08
d.) Man power charges					
	Operator 1 No	MRx12x1x8 / 9000			85.3
	Helper 1 No	MRx12x1x8 / 9000			37.33
	Chowkidar 1/4 No	MRx12x1x8 / 9000x4			13.33
	Foreman 1/4 No.	MRx12x1x8 / 9000x4			32.00
	Mechanic 1/4 No.	MRx12x1x8 / 9000x4			26.67
			Direct labour charges		168.00
			Add for hidden cost @ 50% of above		84.00
				S-Total labour charges	252.00
			Use rate per hour		1965.08
				say	**1965**

7 AIR COMPRESSOR 500cfm (ELECTRIC)

Cost of the machine					1000000
Rated life in Hrs					20000
Rated life in years					20
Depreciation charges per hour					45.00
a.) Total depreciation charges					45.00
b.) Repair and maintenance charges @ 100% of depreciation charges					45.00
				S-Total R & M charges	45.00
c.) POL Charges	Electric energy @ Rs.	7			
	for 90 kwh	90			630
	Lubricants @	25%			157.50
	of above				
	Sundaries @	10%			63.00
				S-Total POL charges	850.50
d.) Man power charges					
	Operator 1 No	MRx12x1x20 / 20000			96.0
	Helper 1 No	MRx12x1x20 / 20000			42.00
	Chowkidar 1/4 No	MRx12x1x20 / 80000			15.00
	Foreman 1/8 No	MRx12x1x20 / 160000			18.00
	Mechanic 1/4 No.	MRx12x1x20 / 80000			30.00
			Direct labour charges		171.00
			Add for hidden cost @ 50% of above		85.50
				S-Total labour charges	256.50
			Cost of 500 cfm air		1197.00
			Cost per 100 cfm		239.40
				say	**239**

8 CONCRETE PUMP 5.0 cum / hour CAPACITY

Cost of the machine	1000000
Rated life in Hrs	8000
Rated life in years	5
Depreciation charges per hour	112.50
a.) Total depreciation charges	112.50
b.) Repair and maintenance charges @ 80% of depreciation charges	90.00

			S-Total R & M charges	90.00
c.) POL Charges	Electric energy @ Rs.	7		
	for 10 kwh	10		70
	Lubricants @	25%		17.50
	of above			
	Sunderies @	10%		7.00
			S-Total POL charges	94.50
d.) Man power charges				
	Operator 1 No	MRx12x1x5 / 8000		60.0
	Helper 1 No	MRx12x1x5 / 8000		26.25
	Chowkidar 1/4 No.	MRx12x1x5 / 32000		9.38
	Foreman 1/8 No.	MRx12x1x5 / 64000		11.25
	Mechanic 1/4 No.	MRx12x1x5 / 32000		7.50
			Direct labour charges	106.88
		Add for hidden cost @ 50% of above		53.44
			S-Total labour charges	160.31
		Use rate per hour		457.31
			say	**457**

9 AIR COMPRESSOR 365cfm (DIESEL)

	Cost of the machine			700000
	Rated life in Hrs			12000
	Rated life in years			10
	Depreciation charges per hour			52.50
a.)	Total depreciation charges			52.50
b.)	Repair and maintenance charges @ 100% of depreciation charges			52.50
			S-Total R & M charges	52.50
c.)	POL Charges	H S Diesel @ Rs.	42.5	
		for 14.75 ltr	14.75	626.88
		Lubricants @	25%	156.72
		of above		
		Sunderies @	10%	62.69
			S-Total POL charges	846.28
d.)	Man power charges			
		Operator 1 No	MRx12x1x10 / 12000	80.0
		Helper 1 No.	MRx12x1x10 / 12000	35.00
		Chowkidar 1/4 No.	MRx12x1x10 / 48000	12.50
		Foreman 1/8 No.	MRx12x1x10 / 96000	15.00
		Mechanic 1/4 No.	MRx12x1x10 / 48000	15.00
			Direct labour charges	142.50
		Add for hidden cost @ 50% of above		71.25
			S-Total labour charges	213.75
			Cost of 500 cfm air	1165.03
		Cost per 100 cfm		233.01
			say	**233**

10 COMPOSITE RATE OF COMPRESSED AIR PER 100 cfm

a.)	Cost of 100 cfm air from Electric compressor 500 cfm		239
b.)	Cost of 100 cfm air from Diesel compressor 365 cfm		233
	It is assumed that 80% of the air requirement will be met with from electric compressor and balance 20% will be met with from the diesel air compressor		
	Electric compressor	80%	191.2
	Diesel Compressor	20%	46.6
	Hence composite rate of air		**237.8**

11 JACK HAMMER 120cfm

Annual scheduled production hours= (10mx25dx2cx4hrs)					2000	
Cost of equipment				=	30,000	
Scheduled life in year				=	10	
Scheduled life in hrs.				=	10,000	
Repair provision in %				=	80	
I	Ownership Cost					
Salvage value in %				=	10	
a)	With ref to life in yrs.= 0.9xcost of eqp./life in yrs.			=	2700	
b)	With ref to life in hrs.= 0.9xcost of eqp.xAnnu. lifelife in hrs.				5400	
Average yearly depriciation.				=	270	
Average hourly depriciation.				=	2.7	**2.7**
II	Operational Cost					
a)	Hourly repair charges LS			Rs.	2.4	
b)	Operation &maintenance crew for one year.					
S.N.	Category Nos.		Rate	Total		
A.	Regular Labour					
1	Operator	1	10000	10000		
2	Mechanic	0.25	10000	2500		
	SUB-TOTAL			12500		
B.	Casual Labour					
1	Helper	1	3000	3000		
2	Chowkidar	0.1	3000	300		
3	Belder	1	3000	3000		
	SUB-TOTAL			6300		
Total direct crew/year				229600		
Add for indirect crew cost@80% for Regular				10000		
Add for indirect crew cost@55% for Casual				3465		
Total crew charges/month.				32265		
Total crew charges/year.				387180		
Hourly crew charges				193.59		
Total operational cost				Rs.	195.99	
III	P.O.L. &ENERGY CHARGES					
Air consumption =			cfm	120		
Factor C1 i.e.Type factor =			1			
Factor C2 i.e.Duty factor =			1			
B.H.P./Kwh of Engine =						
Rate of 100cfm comp. air =			237.8			
Cost of air for 120 cfm				=	285.36	
Other charges @ 25% of air charges				=	71.34	
			TOTAL	Rs.	356.7	356.7
IV	MISCELLANEOUS CHARGES					
Misc. charges @ 10% of repair charges				=	Rs.	0.24
Total hourly operational cost				=	Rs.	555.63
Hourly use rate of equipment				=	Rs.	555.63
	Use rate per hour			=	Rs.	**556.00**

12 AUTO FEED

Annual scheduled production hours= (10mx25dx2cx4hrs)					2000	
Cost of equipment				=	20,000	
Scheduled life in year				=	8	
Scheduled life in hrs.				=	8,000	
Repair provision in %				=	80	

I		Ownership Cost			
		Salvage value in %	=		10
	a)	With ref.to life in yrs.= 0.9xcost of eqp./life in yrs.	=		2250
	b)	With ref.to life in hrs.= 0.9xcost of eqp.xAnnu. life/life in hrs.			4500
		Average yearly depriciation.	=		281.25
		Average hourly depriciation.	=		2.25
II		Operational Cost			
	a)	Hourly repair charges.	Rs.		2.00
	b)	Operation &maintenance crew	NIL		
III		P.O.L. &ENERGY CHARGES			
		Air consumption =			50
		Factor C1 i.e.Type factor = 1			
		Factor C2 i.e.Duty factor = 1			
		B.H.P./Kwh of Engine =			
		Rate of 100cfm comp. air = 237.8			
		Cost of air	=		118.9
		Other charges @ 25% of air charges	=		29.73
		TOTAL	Rs.		148.63
IV		MISCELLANEOUS CHARGES			
		Misc. charges @ 10% of repair charges	=	Rs.	0.2
		Total hourly operational cost	=	Rs.	153.08
		Hourly use rate of equipment	=	Rs.	153.08
		Use rate per hour	=	Rs.	**153.00**

13 PAVEMENT BREAKER

		Annual scheduled production hours= (10ms25dx1cwlhrs)			1000
		Cost of equipment	=		30,000
		Scheduled life in year	=		10
		Scheduled life in hrs.	=		10,000
		Repair provision in %	=		80
I		Ownership Cost			
		Salvage value in %	=		10
	a)	With ref.to life in yrs.= 0.9xcost of eqp./life in yrs.	=		2700
	b)	With ref.to life in hrs.= 0.9xcost of eqp.xAnnu. life/life in hrs.			2700
		Average yearly depriciation.	=		270
		Average hourly depriciation.	Rs.		2.7
II		Operational Cost			
	a)	Hourly repair charges.	Rs.	2.4	
	b)	Operation &maintenance crew			

S.No.	Category	Nos.	Rate	Total
A.	Regular Labour			
1	Operator	1	10000	10000
2	Mechanic	0.25	10000	2500
	SUB-TOTAL			12500
B.	Casual Labour			
1	Helper	1	3000	3000
2	Chowkidar	0.25	3000	750
3	Beldar	1	3000	3000
	SUB-TOTAL			6750

Add for indirect crew cost@80% for Regular			10000
Add for indirect crew cost@55% for Casual			3712.5
Total crew charges/month.			32962.5
Total crew charges/year.			395550
Hourly crew charges			395.55
Total operational cost		Rs.	395.55

III P.O.L. &ENERGY CHARGES

Fuel consumption inLit/hr.=0.22 x B.H.P.xC1xC2					
Factor C1 i.e.Type factor =	1				
Factor C2 i.e.Duty factor =	1				
Compressed air requirement =	60 cfm				
Rate of compressed air 100 cfm =	237.8				
Cost of air		=	142.68		
Other charges @ 25% of air charges		=	35.67		
	TOTAL	Rs.	178.35		

IV MISCELLANEOUS CHARGES

Misc. charges @ 10% of repair charges	=	Rs.		0.24
Total hourly operational cost	=	Rs.		579.24
Hourly use rate of equipment	=	Rs.		579.24
Use rate per hour	=	Rs.		**579.00**

14 VENTILATION BLOWER 1000 cfm

Annual scheduled production hours= (12mx25dx2cx4hrs)			2400
Cost of equipment	=		100.000
Scheduled life in year	=		12
Scheduled life in hrs.	=		50.000
Repair provision in %	=		80

I Ownership Cost

i) Blower

Salvage value in %	=		10
a) With ref.to life in yrs.= 0.9xcost of eqp./life in yrs.	=		7500
b) With ref.to life in hrs.= 0.9xcost of eqp.xAnnu. life/life in hrs.			4320
Average yearly depriciation	=		625
Average hourly depriciation	Rs.		1.8

ii) Air Duct

Cost of 400/600mm duct including fitting at site	=		100000
Rated life in hour	=		30000
Average hourly depriciation	Rs.		3.33
Total depriciation charges	Rs.		5.13

II Operational Cost

Hourly repair charges

a)	Blower @	80 % of depriciation cost	Rs.	1.44
b)	Air Duct @	10 % of depriciation cost	Rs.	0.33
	Total repair charges		Rs.	1.77

b) Operation &maintenance crew.

S.N.	Category	Nos.	Rate	Total
A.	Regular Labour			
1	Operator	0.5	10000	5000
2	Mechanic	0.25	10000	2500
3	Foreman	0.1	12000	1200
4	Electrician	0.25	10000	2500
	SUB-TOTAL			11200
B.	Casual Labour			
1	Helper	1	3000	3000
2	Chowkidar	0.25	3000	750
3	Beldar	1	3000	3000
	SUB-TOTAL			6750

Add for indirect crew cost@80% for Regular	8960					
Add for indirect crew cost@55% for Casual	3712.5					
Total crew charges/month	30622.5					
Total crew charges/year	367470					
Hourly crew charges	153.11					
Total operational cost			Rs.	154.89		

III P.O.L &ENERGY CHARGES

Fuel consumption in Ltr/hr.=0.746 x B.H.P.xC1xC2				7.46
Factor C1 i.e Type factor =	1			
Factor C2 i.e Duty factor =	1			
B.H.P./Kwh of Engine =	10			
Rate of Elect./Kwh =	7			
Cost of power		=		52.22
Other charges @ 25% of air charges		=		13.06
TOTAL		Rs.		65.28

IV MISCELLANEOUS CHARGES

Misc. charges @ 10% of repair charges	=	Rs.		0.18
Total hourly operational cost	=	Rs.		225.47
Hourly use rate of equipment	=	Rs.		225.47
Use rate per hour	=	Rs.		**225.00**

15 GROUT PUMP

Annual scheduled production hours= (10hrs25dx2cx8hrs)				3000
Cost of equipment		=		800,000
Scheduled life in year		=		10
Scheduled life in hrs.		=		20,000
Repair provision in %		=		100

I Ownership Cost

Salvage value in %		=		10
a) With ref.to life in yrs.= 0.9xcost of eqp./life in yrs.		=		72000
b) With ref.to life in hrs.= 0.9xcost of eqp.xAnnu. life/life in hrs.				108000
Average yearly depriciation.		=		7200
Average hourly depriciation.		Rs.		5.4

II Operational Cost

a) Hourly repair charges.		Rs.	40.00	

b) Operation &maintenance crew.

S.N.	Catogory	Nos.	Rate	Total
A.	Regular Labour			
1	Operator	1	10000	10000
2	Mechanic	0.5	10000	5000
3	Foreman	0.1	12000	1200
4	Electrician	0.1	10000	1000
	SUB-TOTAL			17200
B.	Casual Labour			
1	Helper	1	3000	3000
2	Chowkidar	0.25	3000	750
3	Beldar	1	3000	3000
	SUB-TOTAL			6750

Add for indirect crew cost@80% for Regular	13760		
Add for indirect crew cost@55% for Casual	3712.5		
Total crew charges/month	41422.5		
Total crew charges/year	497070		
Hourly crew charges	165.69		
Total operational cost		Rs.	205.69

III P.O.L &ENERGY CHARGES

Factor C1 i.e.Type factor =	1				
Factor C2 i.e.Duty factor =	1				
B.H.P./Kwh of Engine =	200				
Rate of Air in 100 cfm =	237.8				
Cost of compressed air			=	473.6	
Other charges @ 25% of air charges			=	118.9	
		TOTAL	Rs.	594.5	

IV MISCELLANEOUS CHARGES

Misc. charges @ 10% of repair charges	=	Rs.		4
Total hourly operational cost	=	Rs.		809.59
Hourly use rate of equipment	=	Rs.		809.59
Use rate per hour	=	**Rs.**		**810.00**

16 SHOT CRETING MACHINE 10 Cum PER HOUR

Annual scheduled production hours= (10mx25dx2cx6hrs)				3000
Cost of equipment		=		1,500,000
Scheduled life in year		=		5
Scheduled life in hrs.		=		6,000
Repair provision in %		=		100

I Ownership Cost

Salvage value in %		=		10
a) With ref to life in yrs.= 0.9xcost of eqp./life in yrs.		=		270000
b) With ref to life in hrs.= 0.9xcost of eqp.xAnnu. life/life in hrs.				675000
Average yearly depriciation.		=		54000
Average hourly depriciation.		Rs		112.5

II Operational Cost

a) Hourly repair charges.	Rs.	250.00		
b) Operation &maintenance crew.				

S.N.	Category	Nos.	Rate	Total
A.	Regular Labour			
1	Operator	1	10000	10000
2	Mechanic	0.25	10000	2500
3	Foreman	0.1	12000	1200
	SUB-TOTAL			13700
B.	Casual Labour			
1	Helper	1	3000	3000
2	Chowkidar	0.25	3000	750
3	Beldar	1	3000	3000
	SUB-TOTAL			6750

Add for indirect crew cost@80% for Regular	10960		
Add for indirect crew cost@55% for Casual	3712.5		
Total crew charges/month.	35122.5		
Total crew charges/year.	421470		
Hourly crew charges	140.49		
Total operational cost		Rs.	390.49

III P.O.L &ENERGY CHARGES

Factor C1 i.e.Type factor =	1			
Factor C2 i.e.Duty factor =	1			
B.H.P./Kwh of Engine =	250 cfm			
Rate of Air in 100 cfm =	237.8			
Cost of compressed air			=	594.5
Other charges @ 25% of air charges			=	148.63
		TOTAL	Rs	743.13

IV MISCELLANEOUS CHARGES

Misc. charges @ 10% of repair charges	=	Rs.		25.00
Total hourly operational cost	=	Rs.		1271.12
Hourly use rate of equipment	=	Rs.		1271.12
Use rate per hour	=	**Rs.**		**1271.00**

CHAPTER – 13

DETAILED ESTIMATE OF COST

13 GENERAL

13.1 Basis of the Estimate

The estimate has been prepared to arrive at the capital cost of the TRANHA CHARROLI Small Hydro-electric Project (2.1MW) and is of feasibility level of accuracy. The price level of the estimate is July, 2012. It is presumed that major civil works shall be executed through contractors. The following factors have not been considered in this estimate:

I. Escalation after July, 2012

II. Interest During Construction (IDC)

Detailed estimate of cost of Unit-I civil works is based mainly upon various designs/drawings finalized for appurtenant structures and the rates for principal items of work as furnished in the project report. Some rates for minor items of works and lump sum provision has been made on the basis of experience gained at similar

other projects currently under execution. A provision of 5% has been made for contingencies for preparation of estimate. Guidelines for Preparation of Projects Estimates" Issued by CEA, during March 1997, have generally been followed for formulation of this estimate.

13.2 DESCRIPTION OF ITEMS

13.2.1 UNIT–I CIVIL WORKS

Under the heading civil works, provision has been made for the various components of the project as detailed as under.

A–Preliminary

Under this head provision has been made for surveys and investigations conducted or to be conducted, to arrive at the optimum designs of project components. Provision under this sub head amounting to Rs. 10.00 lacs has been in the estimate.

B–Land

This covers the provision for acquisition of land for construction of the project components, colonies, offices, store complexes, compensation

for trees and standing crops. The present revised cost works out to Rs. 42.86 lacs.

C- works

This covers the cost of the civil engineering structure viz. Trench Weir and Intake. The revised cost works out of Rs 26.46 lacs.

J-Power Plant

The provision under this sub-head covers the cost of civil works of Desilting tank, Water Conductor System, Forebay, Penstock, Power House and Tail Race. The actual provision to the tune of Rs 568.74lacs has been made. The provision for protection works of all the structures has been made under this sub head.

K -Buildings

Buildings, both residential and non -residential, have been grouped separately under permanent and temporary construction. In the permanent category, all the buildings which will be subsequently used for the running and maintenance of project utilities, have been

grouped. The cost has been worked on the basis of plinth area rates after allowing allowable premium on the yardstick approved by the state PWD department. Provision under this sub head has been kept as Rs. 13.00 lacs.

M–PLANTATION

This covers the cost of plantation and protection of plants to be planted along project roads, colonies and in the project area. Provision under this sub head has been kept as Rs.1.58 lacs.

P–MAINTENANCE

A provision under this head has been made for meeting cost of various items listed therein. Provision under this sub head has been kept as Rs.6.49 lacs.

O– Miscellaneous

A provision of Rs 15.80 lacs has been made for meeting cost of various items listed therein. The increase is due to inadequate provision for some items as detailed in the estimate.

Q – Special T & P.

Provision of Rs. 18.35 lacs for special tools and plants is based upon the detailed requirement of machinery. Provision for receipt and recoveries in conformity with CEA guidelines, has also been made under this sub head.

R– Communication

Provision under this sub head covers the cost of roads and bridges. There is a provision of Rs 17.00 lacs under this head to provide for approaches to the project components, colonies, job facilities, stores etc.

X–Environment

A provision of Rs 4.00 lacs under this head has been made for maintaining/ improving the environmental and ecological status of the project area.

II – Establishment

The provision of Rs. 54.79 lacs under this sub–head has been kept @ 8% of the cost of I–works less cost of B–land, as per CEA norms.

V– Receipts and Recoveries

This provision of Rs. 29.15 lacs under this sub head covers estimated recoveries by way of resale value of Special T & P and Temporary Buildings etc.

13.2.2 UNIT–II GENERATION

The cost of electro–mechanical plant and equipment is based on indigenous sources. The prices of auxiliary equipment are as prevailing in the market. The cost under this sub head has been worked out as Rs 590.00 lacs.

13.2.3 UNIT– III TRANSMISSION

The provision of Rs 46.42 lacs as estimated cost of transmission line, sub station and other allied works, has been covered under this sub head.

The detailed estimate has been worked out hereinafter.

GENERAL ABSTRACT OF COST

Sr. No.	Description	Amount Rs. In lacs
Unit - I	Civil Works	768.00
Unit - II	Electro- mechanical Works (P-Production)	590.00
Unit - III	T- Transmission	46.42
	Total cost of Generation (At power house bus bars)	**1358.00**
	Gross Total (Generation and Transmission)	**1404.42**

DETAILED ESTIMATE OF COST
UNIT - I CIVIL WORKS

Sr. NO.	Description	Amount
A)	**DIRECT CHARGES**	
I	**Works**	
1	A - Preliminary	10.00
2	B - Land	42.86
3	C - Works	
3.1	Trench Weir	28.46
4	J - Power Plant (Civil Works)	568.74
4.1	Desilting Tank	39.84
4.2	Water Conductor System	375.87
4.2	Forebay	20.90
4.3	Penstock	70.62
4.4	Power House	55.15
4.5	Tail race	6.35
	Sub- Total (C-Works & J-Power Plant)	**597.20**
5	K - Buildings (Restricted to 7% of I- Works)	13
6	M - Plantation	1.58
7	O - Miscellaneous(Restricted to 4 % of I-Works)	15.8
8	P - Maintenance	6.49
9	Q - Special T&P	18.35
10	R - Communications	17
11	X - Environment & Ecology	4
12	Losses on stock @ 1/4% I-works	1.52
	Less A - Preliminary, B-Land, Q-Special T&P	
	Total of I - Works	**727.79**
II.	Establishment (Restricted to 8% of I- Works)	54.79
III.	T & P @ 1% of I-Works	7.28
IV.	Receipts & recoveries on capital cost (-)	29.15
	Sub-Total (I+II-III)	32.92
	Total of Direct charges	**760.71**
B)	**INDIRECT CHARGES**	
1).	Capitalised value of abatement of land revenue @ 5% of the cost of culturable land	0.50
2).	Audit & accounts (1% of I-Works)	7.28
	Total of Indirect charges	**7.78**
	Total of Direct & Indirect charges	**768.49**
	Say Rs.	**768.00**

A - PRELIMINARY

Sr. No.	DESCRIPTION	UNIT	QTY	RATE	AMOUNT Rs. In Lacs
1	Consultancy charges and field surveys and other investigations	LS			1.00
2	Design and Detailed Project Report	LS			5.00
3	Fixing bench marks and Layout of the project	LS			0.50
4	Hydrological observations	LS			1.00
5	Consruction material Surveys	LS			0.50
6	Collection of relevant inputs/ data	LS			0.50
7	Pre- site allotment Expenses	LS			0.50
8	MOU Expenses	LS			0.50
9	Misc. Expenses	LS			0.50
	Total				10.00

B - LAND

Sr. No.	DESCRIPTION	UNIT	QTY	RATE Rs.	AMOUNT Rs. In Lacs
1	Land acquisition - Govt. and Private land for project comp., job facilities etc.				
	a) Cultivated Land @ 15%	Hect.	0.5	20	10
	b) Non cultivated land @ 85%	Hect.	2	12	24
2	Solatium Charges @ 30% of culti.land				3.00
3	Legal Charges	LS			0.5
4	Interest Charges @ 9.5% on item no. I				3.23
5	Establishment charges for land acquisition @ 6.25 on item No. I				2.13
	Total				42.86

ABSTRACT OF COST C- WORKS

Sr. No.	DESCRIPTION	AMOUNT Rs. In Lac
1	Trench Weir and intake works	28.46
	Total	28.46

TRENCH WEIR AND INTAKE WORKS

Sr. No.	DESCRIPTION	UNIT	QTY	RATE Rs.	AMOUNT Rs. In Lacs
1	Site Clearance	LS	Job		0.5
2	Excavation				
	a) Over burden/ loose rock	cum	10	279.00	0.03
	b) hard rock	cum	85	522.00	0.44
3	Cement Concrete				
	a) M-10	cum	10	6768.00	0.68
	b) M-15	cum	20	7304.00	1.46
	c) M-20	cum	115	8140.00	9.36
4	Cement Plaster	sq. m	150	83.5	0.13
5	Reinforcement steel	MT	6.90	57834.00	3.99
6	Fab. & errection of intake gates	MT	1.5	122825.00	1.84
7	Trash rack over trench weir intake	MT	0.4	76247.00	0.30
8	Installation of gate hoist	LS	job		1.5
9	Wire crates	cum	50	1630.00	0.82
10	Stone pitching along the slopes	sq.m	20	825.00	0.17
11	Dewatering during construction	kWh.	60	43.20	0.03
12	PVC Water stop	m	50	750	0.38
13	Graded Filter	cum	10	855.00	0.09
14	Plateform for winch for gates	LS	job	1	0.5
15	Non Return Valve for silt flushing pipe	No.	1	0.4	0.4
16	Rock Bolt/ Anchors	m	50	551.00	0.28
17	SW Pipe for flushing	m	60	5000	3
18	Earth fill	cum	100	57.25	0.06
19	Misc. charges @ 5% of above except		Sub total		25.93
	LS items 23.43				1.17
			Total		27.10
	Add5% for contingencies				1.36
			G-Total		28.46

ABSTRACT OF COST J- POWER PLANT (CIVIL WORKS)

Sr. No.	DESCRIPTION	AMOUNT Rs. In Lac
1	Desilting Tank	39.84
2	Water conductor system	375.87
3	Forebay	20.90
4	Penstock, Anchor Blocks and Saddle Supports	70.62
5	Power House	55.15
6	Tail Race	6.35
	Total	568.74

DESILTING TANK

Sr. No.	DESCRIPTION	UNIT	QTY	RATE Rs.	AMOUNT Rs. In Lacs
1	Excavation				
	a) Over burden / loose rock	cum	50	279.00	0.14
	b) Hard rock	cum	100	522.00	0.52
	c) Earth fill	cum	56	57.25	0.03
2	Cement Concrete				
	a) M-10	cum	162.5	6768.00	11.00
	b) M-20	cum	121	8140.00	9.85
3	Reinforcement steel	MT	7.26	57834.00	4.20
4	SW. Flushing Pipe	m	40	5000	2
5	Sluice valve	No.	1	50000	0.5
6	PVC Water Stop	m	100	750	0.75
7	Sub surface drainage works				
	a) Coarse material	cum	40	2139	0.86
	b) Fine Material	cum	80	1929	1.54
8	Fab. & errection of intake gates	MT	1.5	122825.00	1.84
9	Stone Masonary in CM 1:3	cum	75	3402.00	2.55
10	Cement Plaster	sq. m	100	83.5	0.08
11	Dewatering During Construction	kWh	50	43.20	0.02
12	Stone Pitching	sq. m	30	825.00	0.25
13	Misc. charges @ 5% except on LS items				36.13
	1.81		Total		37.94
			Add 5% for contingencies		1.90
			Gross Total		39.84

WATER CONDUCTOR SYSTEM

Sr. No.	DESCRIPTION	UNIT	QTY	RATE Rs.	AMOUNT Rs. In Lacs
1	Excavation				
	a) Over burden / loose rock	cum	2000	279.00	5.58
	b) Hard rock	cum	800	522.00	4.18
	c) Earth fill	cum	1000	57.25	0.57
2	Cement Concrete				
	a) M-10	cum	540	6768.00	36.55
	b) M-20	cum	2760	8140.00	224.66
3	Reinforcement steel	MT	110.5	57834.00	63.91
4	Stone Pitching	sq .m	150	825.00	1.24
5	Cement Plaster	sq. m	50	83.5	0.04
6	Rock Bolting	m	50	551.00	0.28
7	PVC Water Stop	m	70	750.00	0.53
8	Stone Masonary in CM 1:3	cum	100	3402.00	3.40
			S-Total		340.93
9	Misc. charges@ 5% except on LS items				17.05
			Total		357.97
	Add 5% for contingencies				17.90
			Gross Total		375.87

FOREBAY

Sr. No.	DESCRIPTION	UNIT	QTY	RATE Rs.	AMOUNT Rs. In Lacs
1	Excavation				
	a) Over burden / loose rock	cum	80	279.00	0.22
	b) Hard rock	cum	100	522.00	0.52
	c) Earth fill	cum	30	57.25	0.02
2	Cement Concrete				
	a) M-10	cum	9	6768.00	0.61
	b) M-20	cum	96.3	8140.00	7.84
3	Reinforcement steel	MT	6.74	57834.00	3.90
4	Rock Bolting	m	50	551.00	0.28
5	SW Flushing Pipe	m	25	5000	1.25
6	Stone Masonary in CM 1:3	cum	50	3402.00	1.70
7	Trash Rack	MT	1.5	76247.00	1.14
8	Railing	LS			1.00
9	PVC Water Stop	m	70	750	0.53
			Sub-Total		19.00
10	Misc. charges@ 5% except on LS items	LS			0.90
			Total		19.90
	Add 5% for contingencies				1.00
			Gross Total		20.90

PENSTOCK, ANCHOR BLOCKS AND SADDLE SUPPORTS

Sr. No.	DESCRIPTION	UNIT	QTY	RATE in Rs.	AMOUNT Rs. In Lacs
1	Excavation				
	a) Over burden / loose rock	cum	20	279.00	0.06
	b) Hard rock	cum	15	522.00	0.08
	c) Earth fill	cum	10	57.25	0.01
2	Cement Concrete				
	a) M-10	cum	8	6768.00	0.54
	b) M-20	cum	60	8140.00	4.88
3	Reinforcement steel	MT	2	57834.00	1.16
4	Rock Bolting	m	40	551.00	0.22
7	Chain Pulley Block System	No.	1	100000	1.00
8	Stone Masonary in CM 1:3	cum	200	3402.00	6.80
10	Cement Plastering	sq.m	150	83.5	0.13
11	Stone Pitching	sq.m	150	825.00	1.24
12	Fabrication and errection of Steel Liner 700/350 mm dia, 8 mm thick	MT	45	99057.00	44.58
13	N.G Rail Track	MT	3.5	76247.00	2.67
14	Butterfly Valve	No.	1	70000	0.70
			Sub- Total		64.05
15	Misc. charges@ 5% except on LS items				3.20
			Total		67.26
	Add 5% for contingencies				3.36
			Gross Total		70.62

POWER HOUSE COMPLEX

Sr. No.	DESCRIPTION	UNIT	QTY	RATE Rs.	AMOUNT Rs. In Lacs
1	Excavation				
	a) Over burden / loose rock	cum	15	279.00	0.04
	b) Hard rock	cum	30	522.00	0.16
	c) Earth fill	cum	10	57.25	0.01
2	Cement Concrete				
	a) M-10	cum	40	6768.00	2.71
	b) M-15	cum	80	5661.00	4.53
	c) M-20	cum	180	8140.00	14.65
3	Reinforcement steel	MT	12.6	57834.00	7.29
4	N.G.Rail track for transformers	MT	2.5	76247	1.91
5	Stone Pitching	LS			1.0
6	Shot creting	LS			0.5
7	Doors and Windows	LS			1.5
8	CGI sheet Roofing	LS			1.5
9	Sub station building	LS			6.5
10	Fencing of switchyard	LS			1.0
11	Stone Masonary in CM 1:3	cum	150	3402.00	5.10
12	Cement Plastering	sq.m	250	83.5	0.21
14	MS Chequred Plates	MT	3.5	76247.00	2.67
15	Misc. charges@ 5% except on LS items	LS			1.26
			Total		52.53
	Add 5% for contingencies				2.63
		Gross Total			55.15

TAIL RACE CHANNEL

Sr. No.	DESCRIPTION	UNIT	QTY	RATE Rs.	AMOUNT Rs. In Lacs
1	Excavation				
	a) Over burden / loose rock	cum	40.00	279.00	0.11
	b) Hard rock	cum	0.00	522.00	0.00
	c) Earth fill	cum	0.00	57.25	0.00
2	Cement Concrete				
	a) M-10	cum	7	6768.00	0.47
	b) M-20	cum	30	8140.00	2.44
3	Reinforcement steel	MT	2.10	57834.00	1.21
4	PVC Water Stop	m	25	750	0.19
5	Stone Masonary in CM 1:3	cum	10	3402.00	0.34
6	Cement Plastering	sq.m	50	83.5	0.04
8	Vertical Gates at Outfall	MT	1.5	1.00	0.00
9	Hoisting Arrangement for Outfall gates	LS			1.00
			S-Total		5.81
10	Misc. charges@ 5% except on LS items				0.24
			Total		6.05
	Add 5% for contingencies				0.30
			Gross Total		6.35

K-BUILDINGS

Sr. No.	DESCRIPTION		AMOUNT	
1	Permanent Buildings		10.5	
2	Temporary Buildings		2.5	
	Grand Total		13	
	Say	Rs	13	lacs

COST ESTIMATE OF RESIDENTIAL BUILDINGS

Sr. No.	DESCRIPTION	UNIT	QTY	RATE Rs.	AMOUNT Rs. In Lacs
A	**PERMANENT BUILDINGS**				
i	Building - Plinth Area	sq. m	150	0.055	8.25
ii	Water supply and Sanitation @ 10%	10%			0.825
iii	Electrical Installation @ 7%	7%			0.58
iv	Site Development @ 2%	2%			0.165
v	Approach Roads in Colony @ 2%	2%			0.165
vi	Land scaping in the colony @ 1%	1%			0.08
		Total			10.065
B	**TEMPORARY BUILDINGS**				
i	Building - Plinth Area	sq. m	75	0.024	1.8
ii	Water supply and Sanitation @ 8%	8%			0.144
iii	Electrical Installation @ 5%	5%			0.09
iv	Site Development @ 2%	2%			0.036
v	Approach Roads in Colony @ 2%	2%			0.036
vi	Land scaping in the colony @ 1%	1%			0.02
		Total			2.124

M - PLANTATION

Sr. No.	DESCRIPTION	UNIT	QTY	RATE Rs.	AMOUNT Rs. In Lacs
1	Plantation cost of 5000 plants	No.	1000	10	0.1
2	Making pits of size 0.30m x0.30 m	No.	1000	25	0.25
3	Cost of one Gardener for two years	month	24	4500	1.08
4	Cost of protection of plants	No.	1000	15	0.15
			Total		1.58

O - MISCELLANEOUS

Sr. No.		DESCRIPTION	UNIT	QTY	RATE Rs.	AMOUNT Rs. In Lacs
A		**CAPITAL COST**				
	i	Construction Power	LS			1.0
	ii	Water Supply, Purification and distribution	LS			0.5
	iii	Sewerage Disposal and Storm Water Disposal	LS			0.5
				Sub-Total		2.0
B		**MAINTENANCE AND SERVICES**				
	i	Electrification @ Rs.1.0 lac per year for two years	year	2	1.0	1.0
	ii	Water supply, purification and Distribution for two years	year	2	0.5	0.5
	iii	Sewerage Disposal storm water drainage works for two years	year	2	0.5	0.5
	iv	Recreation of the staff for two years	year	2	0.5	0.5
	v	Security Arrangements for two years	year	2	0.4	0.8
	vi	Medical assistance for two years	year	2	0.6	1.0
	vii	Fire Fighting Arrangement	year	2	0.4	0.8
	viii	R/M of inspection vehicles for two years		2	0.8	1.0
C		**OTHER ITEMS**		Sub-Total		6.1
	i	Visits of Dignitaries	LS			0.1
	ii	Technical records, photography records	LS			0.5
	iii	Inaugral ceremony	LS			0.5
	iv	Compensation to workmen	LS			0.5
	v	Fencing of project area	LS			0.5
	vi	Anti Malaria measures	LS			1.0
	vii	R/M of rest house for two years	year	2	0.8	1.6
	viii	Models and Exhibits	LS			0.5
	ix	Retrenchment Compensation	LS			0.5
	x	Kerosine/fuel wood/LPG to worker/staff	LS			0.5
	xi	Co-operative stores	LS			0.5
	xii	Library Facilities	LS			0.5
	xiii	Public participation	LS			0.5
				Sub-Total		7.7
		G-Total (A+B+C)				**15.8**

R - COMMUNICATION

Sr. No.	DESCRIPTION	UNIT	QTY	RATE Rs.	AMOUNT Rs. In Lacs
1	Construction of Approach road to Intake, Forebay and Power house	km	1.5	10.0	15.0
3	Construction of approach Paths	LS			2.0
			Total		17.0

X - ENVIRONMENT AND ECOLOGY

Sr. No.	DESCRIPTION	UNIT	QTY	RATE Rs.	AMOUNT Rs. In Lacs
1	Compensatory Afforestation	LS			1.0
2	Treatment of Catchment Area	LS			0.5
3	compensation forTrees	LS			1.0
4	Wire crates and retaining walls in Dumping areas	LS			0.5
5	Restoration and Reclaimation of land at quarry sites and dumping areas	LS			0.5
6	Cost of Environmental Monitoring cell	LS			0.5
			Total		4.0

Q - SPECIAL T& P

Sr. No.	DESCRIPTION	UNIT	QTY	RATE Rs.	AMOUNT Rs. In Lacs
A	DRILLING EQUIPEMENTS				
i	Jack Hammers 120 cfm	No	2	0.19	0.38
ii	Auto feed	No	1	0.08	0.08
iii	Air compressor Diesel 365 cfm	No	0.5	6.00	3.00
			Sub total		3.46
B	EARTHMOVING EQUIPEMENTS				
i	Excavator 0.91 cum capacity	No	0.5	15.00	7.50
ii	Dumpers 7 MT capacity	No	1	8.00	8.00
			Sub total		15.50
C	CONSTRUCTION EQUIPMENTS				
i	Grout Pump	No	1	2.00	2.00
ii	Concrete Mixer 14/10 capacity	No	2	5.00	10.00
iii	Needle Vibrator	No	3	0.20	0.60
iv	Air Winch 5 MT Capacity	No	1	2.00	2.00
			Sub total		14.60
D	TRANSPORT EQUIPEMENTS				
i	Material Truck 10 MT Capacity	No	1	7.00	7.00
ii	Jeep	No	1	3.50	3.50
			Sub total		10.50
E	DEWATERING EQUIPEMENTS				
i	Sump Pump	No	2	0.15	0.30
ii	Pumps 5-10 HP capacity	No	4	0.20	0.80
iii	D.G. Set 100kVA	No	1	3.50	3.50
			Sub total		4.60
F	WORKSHOP EQUIPEMENTS				
i	Welding set	No	3	0.50	1.50
ii	Drilling Machine	No	2	0.35	0.70
iii	Lathe Machine a/w ancillary equip.	No	1	1.50	1.50
			Sub total		3.70
			Gross Total		52.36

Capital cost of production oriented construction plats and machinery (other than transport equipements) P	41.86	lacs
Cost recoverable as hourly use rates (debited to works) = 0.75 P	31.395	lacs
Capital cost of transport equipements Q	10.50	lacs
Provision to be made under sub head Q- Special T&P (=0.25P+Q)	**18.35**	lacs
Recoveries to be shown as Reciept and Recoveries	28.78	lacs

P - MAINTENANCE

Sr. No.	DESCRIPTION	UNIT	QTY	RATE Rs.	AMOUNT Rs. In Lacs
	1% of I-Works				
	C-Works				28.46
	J-Power Plants				568.74
	K-Buildings				13
	O- Miscelleneous				15.8
	R- Communication				17.0
	M- Plantation				1.58
	X- Environment and Ecology				4.0
				Total	648.58
	1% of total - I- Works				**6.49**

Y- LOSSES ON STOCK

Provision made @ 0.25% of I-Works less A-Preliminary, B-Land and Q-Special T&P
i.e. 0.25% of 1.52 lacs

Say Rs 1.52 lacs

V - RECIEPTS AND RECOVERIES

1 Credit on account of resale value of temporary Buildings (15% of cost of temporary buildings) 0.375 lacs

2 Credit on account of resale value of Special T&P (75% of the deperciable value) 28.78 lacs

Total 29.15 lacs

say Rs. 29.15 lacs

		TRANHA CHARROLI HEP ---- P PRODUCTION ELECTRO-MECHANICAL WORKS				
	S.No.	Item	Unit	Quantity	Rate (Rs.)	Amount (Rs.)
	I - Works					(Lacs)
	1	1000kW units,2nos. comprising:				
	a.	Turbine horizontal Pelton type to deliver 1000 kW(with 10% overload capacity) at rated head of 200 m and complete with governing system and all auxiliaries, instruments, control inlet valve, cooling water, one set of special tools and slings and consumables and spares for turbine / generator for 5 years.	Nos	2	LS	160
	b.	Synchronous generator, 1200 kW,3.3 kV, 50 Cycles, 0.85 power factor with brushless excitor, Digital AVR, generator protection panel, neUtral grounding etc. complete with accessories, special tools/ slings and spares for 5 years.	No.	2	LS	180
	2	6.6 kV switchgear and control panels complete with protection relays etc.	Nos.	1	LS	18
	3	Transformer 3000 kVA, 6.6 kV/22 kV ONAN cooling	Nos.	1	27	27
	4	22 kV Vacuum circuit breaker	Nos.	1	4	4
	5	22 kV Control and relay panel	Nos.	1	4	4
	6	22 kV lightning arrestors	Nos.	3	1	3
	7	22 kV single phase, 3 VT's	Set	1	LS	2.75
	8	22 kV, 3 phase line isolators with earthing switch.	No.	1	1	1
	9	22 kV current transformers		3	1	3
	10	Battery 110 V, 200 AH, complete with electrolyte plates, stands etc; complete with battery charger, panel etc. and distribution board	Nos.	1	7	7
	11	LT switchgear complete with measuring, control and protection scheme having incoming and outgoing feeders for station auxiliaries.	Sets	1	LS	7
	12	Control cables (copper) 2.5 mm with 2 core, 4 core, 6 core and 10 cores	Set	1	LS	5

	COST ANALYSIS OF 1 KM OF 22 KV LINE WITH						
	S.No.	Item	Quantity	Rate (Rs.)	Amount (Rs.)		
	1	ST Pole	10	13500	135000		
	2	Cost of sectio	5	35000	175000		
	3	Extra Cost of	2	2000	4000		
	4	ASCR Condu	3.09	65000	200850		
	5	GS Earthwire	130	55	7150		
	6	Aluminium joi	3	25	75		
	7	Extra costs fo	LS	5000	5000		
	8	Tree cutting c	LS		2000		
		Total (1-8)			529075		
	9	Cartage of Ma	9.50%		50262.13		
	10	Erection charg	10%		52907.5		
		Total (8+9+10)			632244.63		
	11	Contingencies	3%		18967.34		
		Total (10+11)			651211.96		
	12	T and P @ 1.5	1.50%		9768.18		
	13	Audit and acc	2%		13024.24		
	14	Extra cost of protection works of line suppo			40000		
		Grand Total			714004.38		
				Say Rs. Lacs/	7.14		

TRANSMISSION LINE EVACUATION OF POWER ON 22 KV S/C TRANSMISSION LINE						
S.No.	Item	Quantity	Rate (Rs.)	Amount (Rs. Lacs)		
1	Construction of 22 kV line from Powerhouse to the HPSEB to the LILO point on 10 m long STP poles with ACSR conductor	3 KM	7.14	21.42		
2	Creation of LILO bay at the adjoiuning line including cost of land development, steel structrues, line isolator, lighting arrestor, CT and PT's circuit breaker, power control cables, control and protection and metering equipment, civil works etc.	1No	LS	25		
	Total			**46.42**		

CHAPTER - 14

FINANCIAL APPRAISAL

14.1 Basic Criterion

The financial analysis of Tranha Charroli small hydro electric project has been carried out based upon following parameters:

- Hydrology of the project as worked out under Chapter 5 has been adopted.
- Energy calculations have been carried out for the dependable flow as described under Chapter 7. It is proposed to install two machines each of 1.05MW which would produce about 11.142GWh of energy annually in a 75% dependable year.
- Cost of civil works has been computed based upon the quantities worked out from the drawings and multiplying the same with rates analysed by using market rates of materials and prevailing rates of skilled/ semi-skilled workers.
- Cost of electrical-mechanical works has been estimated from our experience and discussions with reputable equipment manufacturers.
- Total Capital cost of civil, E & M works including cost of Switchyard equipment and transmission

line to HPSEB 22 kV system comes to Rs. 1512.62 lacs.

- Construction period of 24 months has been considered.
- Component of Loan and Equity have been kept as 70: 30 respectively
- Tax holiday for the first ten years
- Interest Rate on Loans has been considered at 12.5%.
- Repayment has been considered at 10 years.

14.2 Working criterion for financial analysis

The economic appraisal of Tranha Charroli project is based on the proposed financing package for the development of this project and also the standing Govt. of India policy guidelines for tariff calculation in small hydro sector. Power to be generated at this power station is proposed to be sold to HPSEB on the tariff fixed by Himachal Pradesh Electricity Regulatory Commission.

The energy cost from hydro power generating station shall comprise the recovery of annual capacity charges and energy charges. Annual capacity charges comprise interest on loan

capital and depreciation. Energy charges comprises operation and maintenance expenses, tax on income reckoned as expenses, return on equity and interest on working capital. The details of capital cost, the financial package, cost of generation, fixation of tariff for sale etc., are discussed here in after.

14.2.1 Annual charges

- Interest @ 12.5% on loan capital computed on outstanding loans.
- Repayment period is taken as ten years
- Rate of depreciation per annum is taken as 3% of the total completed cost of the project. The depreciation has been limited to 90% of the total cost of the project.

14.2.2 Energy charges

- Operation and maintenance charges, inclusive of insurance expenses for the first full year after commissioning of the project has been taken as 1.5% of the total cost of the project with escalation of 4% annually.

Income tax has been calculated on the basis of present tax concessions available under the Income Tax Act.

- Return on equity @ 14% as been assumed.
- Interest @ 14.50% on working capital covering operation and maintenance charges.
- Receivables equivalent to two months of average billing for sale of electricity.

14.3 FINANCIAL STRUCTURE

The methodology for carrying out the financial analysis is to find out the energy cost taking into account the total project cost and an assured return on equity @ 14%. Debt: Equity ratio of 70:30 have been considered as 70% and 30 % of the total cost of the project respectively.

14.3.1 CAPITAL COST OF THE PROJECT

The cost of the project comprising civil, electrical, and transmission works has been estimated on the basis of the cost of the similar projects in the area. The capital cost of

the project at July, 2012 price level, is shown in **Annexure–14.1**.

14.3.2 LOCAL AREA DEVELOPMENT AUTHORITY (LADA) CHARGES

Local Area Development Authority (LADA) charges@ 1.0% on the capital cost has been considered to be added in the capital cost for financial analysis as per HP Govt. standing instructions.

14.3.3 PHASING OF EXPENDITURE

The project is scheduled to be completed within two year from the date of financial closure of the project and proposed phasing of the expenditure has been shown in **Annexure–14.2**.

14.3.4 ESCALATION

Escalation @ 4% on civil works and @ 2% on Electro-mechanical works has been considered for one year working period and is shown in **Annexure 14.3**.

14.3.5 CALCULATION OF IDC

The Govt. of India vide its latest guidelines has permitted the interest charges during the

construction period, as accrued, to be capitalized.

The calculations of IDC, based on suggested phasing of expenditure and financing plan have been carried out as shown in the **Annexure-14.4.**

The total capital cost of the project on completion including Interest During Construction (IDC), Escalation and Financial charges works out to be Rs 1512.62 Lacs .

14.3.6 SALE RATE OF ENERGY

The sale rate of energy has been considered as Rs 2.95 per unit fixed by the H.P. Electricity regulatory Commission, even though the tariff shall be revised based on the enhanced project cost parameters as well as the concurrent interest charges, when the project is actually taken up for execution.

is observed that average tariff for first 10 years is Rs. 3.10 per unit whereas the same for full life of 40 years comes out as Rs.2.16 per unit.

The levellised tariff of the scheme for the complete life of 40 years works out to Rs. 2.75 per unit.

14.5 COST OF GENERATION

The cost of generation in the first year, from this project works out as Rs. 2.19 per unit, considering the annual charges @ 16% of the capital cost and net energy generation in 75% dependable year as 10.26 GWh.

14.6 FINANCIAL EVALUATION

The present tariff of Rs. 2.95 shall be revised upward after taking into consideration the increased capital cost as also the cost of money. The project is also expected to receive a GOI subsidy which shall make the project financially justifiable. However, with the CDM/ carbon credit, the project will become bankable.

Annexure 14.1

TRANHA CHARROLI SMALL HYDRO ELECTRIC PROJECT -2 MW

COMPLETE COST OF THE PROJECT

Sr. No	Description		Amount Rs. In Lacs
A)			
1	Civil Works		768
2	E & M Works		590
3	Transmission Works		46.42
		Sub-Total (a)	**1404.42**
B)			
1	Escalation		21.76
2	IDC		60.94
3	Financial Charges		10.53
		Sub-Total (b)	**93.23**
		Total (a+b)	**1497.65**
C)	LADA @ 1.0%		14.98
		G-Total	**1512.62**
		Loan @ 70%	**1058.84**
		Equity @ 30%	**453.79**

Annexure-14.2

TRANHA CHARROLI SMALL HYDRO ELECTRIC PROJECT (2 MW)

YEAR- WISE PHASING OF FUNDS

		COST	LADA @1.0%	TOTAL COST			
Unit- I	Civil Works	768	7.68	775.68	Lacs	Units	10.7 GWH
Unit -II	Production	590.00	5.90	595.90	Lacs	Gen. Cost	1371.58 Lacs
Unit -III	Transmission	46.42	0.46	46.88	Lacs		
TOTAL		1404.42	14.04	1418.46	Lacs		

Year	Percentage of work	Unit-I Civil works	Percentage of work	UNIT- II P-Prod.	Percentage of work	T-Trans.	Gener. Cost	Gener. & Tran. cost
1	2	3	4	5	6	7	5	6
							Col.3+5	Col.3+5+7
1st	15.00%	116.35	10.00%	59.59	5.00%	2.34	175.94	178.29
	20.00%	155.14	15.00%	89.39	10.00%	4.69	244.52	249.21
2nd	30.00%	232.70	30.00%	178.77	35.00%	16.41	411.47	427.88
	35.00%	271.49	45.00%	268.16	50.00%	23.44	539.64	563.09
Total		**775.68**		**595.90**		**46.88**	**1371.58**	**1418.46**

Annexuure 14.3

TRANHA CHARROLI SMALL HYDRO ELECTRIC PROJECT (2 MW)

ESCALATED COST

Escalation on civil works 4.00%

Escalation on elect. works 2.00%

Amt. Rs. in Lac

Year/ Month	Civil works Hard cost	Escalated Hard Cost @4%	P-Prod.Hard cost	Escalated Hard Cost @2%	T-Trans Hard cost.	Escalat-ed Hard Cost @2%	Gener. Cost	Genar. & Tran. cost
1	2	3	4	5	6	7	8	9
							Col.3+6	Col.3+5+7
6	116.35	118.66	59.59	60.18	2.34	2.37	178.84	181.21
12	155.14	158.21	89.39	90.27	4.69	4.74	248.48	253.22
18	232.70	237.31	178.77	180.55	16.41	16.57	417.86	434.43
24	271.49	276.86	268.16	270.82	23.44	23.68	547.69	571.36
Total	775.68	791.04	595.90	601.83	46.88	47.35	1392.87	1440.22

Annexure 14.4

TRANHA CHARROLI SMALL HYDRO ELECTRIC PROJECT (2 MW)

Rate of interest :- 12.50%

EQUITY 30%

LOAN 70%

COST OF THE PROJECT INCLUDING ESCALATION AND IDC.

(At power house bus bars)

Half-Year	Escalated Hard Cost	Equity 30%	LOAN 70%	Interest @ 12.50%	Gross Total	Total Loan	Total Equity
1	2	3	4	5	6	7	8
6	178.84	53.65	125.19	7.82	186.66	133.01	53.65
12	248.48	74.54	173.94	10.87	259.35	184.81	74.54
18	417.86	125.36	292.50	18.28	436.14	310.78	125.36
24	547.69	164.31	383.38	23.96	571.65	407.34	164.31
Total	1392.87	417.86	975.01	60.94	1453.81	1035.95	417.86

TRANHA CHARROLI SMALL HYDROELECTRIC PROJECT (2.10 MW) Annexure - 14.5

CALCULATION OF TARRIF FOR 75% DEPENDABLE YEAR (AT POWER HOUSE BUS BARS)

	Loan					Rate of interes	12.50%	Sale rate of energy/Unit	= Rs. 2.95
Amount ir (i/c IDC)	Repayment	Annual		O&M Charges	1.50%			Av.Tariff for total 40 years	=Rs. 2.16
Loan 1058.84	10	energy generated in GWh	11.142 GWh			Interest. Rate on		Av. Tariff for Ist 10 years	=Rs. 3.10
EQUITY 453.79	yrs.	Auxillary cons.incld. Transformation losses(0		ROE	14%	Working Capit.	14.50%	Escalation.	4.00%
Complete 1512.62			1.00%	Net energy ge	11.031	requirement	2	months billing	50.437 Lac
Dep. Ceili 1361.3621	Royalty @ 6%for first 12 year+1%Lada		10.26 GWh						
	Royalty @ 15% after 12 year+1%Lada		9.27 GWh						
	Royalty @ 24%after 30 year+1%Lada		8.27 GWh						

Operatio n Year	Return on Equity @14%	Loan repayment	Interest on loan @12.5%	O&M Charges @1.5% I/c escalation @ 4%	Interest on working capital @ 14.5%	Depreciat-ion @ 3%	Total Annual Charges (Col. 2 to Col.7)Inc IncomeTax	Annual Receiv-able (energy x sale rate)	Cash Inflow(Col. 9-Col. 8))	Tax @7.5% MAT for 5 Years Tax Holiday and then	Units sold GWH	Tariff in Rs./ Unit sold.(Col.8/Col.12)
1	2	3	4	5	6	7	8	9	10	11	12	13
1	63.53	105.88	132.35	22.69	7.31	40.84	372.61	302.62	-69.99	0	10.26	3.63
2	63.53	105.88	119.12	23.60	7.31	40.84	360.28	302.62	-57.66	0	10.26	3.51
3	63.53	105.88	105.88	24.54	7.31	40.84	347.99	302.62	-45.37	0	10.26	3.39
4	63.53	105.88	92.65	25.52	7.31	40.84	335.74	302.62	-33.11	0	10.26	3.27
5	63.53	105.88	79.41	26.54	7.31	40.84	323.52	302.62	-20.90	0	10.26	3.15
6	63.53	105.88	66.18	27.61	7.31	40.84	311.35	302.62	-8.73	0	10.26	3.04
7	63.53	105.88	52.94	28.71	7.31	40.84	299.22	302.62	3.40	1	10.26	2.92
8	63.53	105.88	39.71	29.86	7.31	40.84	287.13	302.62	15.49	5	10.26	2.80
9	63.53	105.88	26.47	31.05	7.31	40.84	275.09	302.62	27.53	10	10.26	2.68
10	63.53	105.88	13.24	32.29	7.31	40.84	263.10	302.62	39.53	14	10.26	2.56
11	63.53	0.00	0.00	33.59	7.31	40.84	145.27	302.62	157.35	55.07	10.26	1.42
12	63.53	0.00	0.00	34.93	7.31	40.84	146.61	302.62	156.01	54.60	10.26	1.43
13	63.53	0.00	0.00	36.33	7.31	40.84	148.01	273.34	125.33	43.86	9.27	1.60
14	63.53	0.00	0.00	37.78	7.31	40.84	149.46	273.34	123.87	43.36	9.27	1.61
15	63.53	0.00	0.00	39.29	7.31	40.84	150.98	273.34	122.36	42.83	9.27	1.63
16	63.53	0.00	0.00	40.86	7.31	40.84	152.55	273.34	120.79	42.28	9.27	1.65
17	63.53	0.00	0.00	42.50	7.31	40.84	154.18	273.34	119.16	41.70	9.27	1.66
18	63.53	0.00	0.00	44.20	7.31	40.84	155.88	273.34	117.46	41.11	9.27	1.68
19	63.53	0.00	0.00	45.96	7.31	40.84	157.65	273.34	115.69	40.49	9.27	1.70

20	63.53	0.00	0.00	47.80	7.31	40.84	159.49	273.34	113.85	39.85	9.27	1.72
21	63.53	0.00	0.00	49.72	7.31	40.84	161.40	273.34	111.94	39.18	9.27	1.74
22	63.53	0.00	0.00	51.70	7.31	40.84	163.39	273.34	109.95	38.48	9.27	1.76
23	63.53	0.00	0.00	53.77	7.31	40.84	165.46	273.34	107.88	37.76	9.27	1.79
24	63.53	0.00	0.00	55.92	7.31	40.84	167.61	273.34	105.73	37.01	9.27	1.81
25	63.53	0.00	0.00	58.16	7.31	40.84	169.84	273.34	103.49	36.22	9.27	1.83
26	63.53	0.00	0.00	60.49	7.31	40.84	172.17	273.34	101.17	35.41	9.27	1.86
27	63.53	0.00	0.00	62.91	7.31	40.84	174.59	273.34	98.75	34.56	9.27	1.88
28	63.53	0.00	0.00	65.42	7.31	40.84	177.11	273.34	96.23	33.68	9.27	1.91
29	63.53	0.00	0.00	68.04	7.31	40.84	179.72	273.34	93.61	32.77	9.27	1.94
30	63.53	0.00	0.00	70.76	7.31	40.84	182.44	273.34	90.89	31.81	9.27	1.97
31	63.53	0.00	0.00	73.59	7.31	40.84	185.28	244.05	58.78	20.57	8.27	2.24
32	63.53	0.00	0.00	76.53	7.31	40.84	188.22	244.05	55.83	19.54	8.27	2.28
33	63.53	0.00	0.00	79.60	7.31	40.84	191.28	244.05	52.77	18.47	8.27	2.31
34	63.53	0.00	0.00	82.78	7.31	13.61	167.24	244.05	76.81	26.89	8.27	2.02
35	63.53	0.00	0.00	86.09	7.31	0.00	156.93	244.05	87.12	30.49	8.27	1.90
36	63.53	0.00	0.00	89.53	7.31	0.00	160.38	244.05	83.67	29.29	8.27	1.94
37	63.53	0.00	0.00	93.12	7.31	0.00	163.96	244.05	80.09	28.03	8.27	1.98
38	63.53	0.00	0.00	96.84	7.31	0.00	167.68	244.05	76.37	26.73	8.27	2.03
39	63.53	0.00	0.00	100.71	7.31	0.00	171.56	244.05	72.49	25.37	8.27	2.07
40	63.53	0.00	0.00	104.74	7.31	0.00	175.59	244.05	68.47	23.96	8.27	2.12
Total	954.71	397.8				1361.36	3047.83		783.44			

Cost of C: 12%

Present Value of Annual Payments Rs.2,263.57

Present Value of Units sold Rs.82.35

Levelised Tariff/ Unit = Rs.2.75

Note :- The capital structure of the project envisaged 30% equity and 70% loan .

The repayment of loan has been proposed in 10 equal annual installments.

CHAPTER-15

CLEAN DEVELOPMENT MECHANISM

15.1 GENERAL

Since the beginning of industrial revolution, excessive use of fossil fuels by the industrialized countries has substantially increased the atmospheric concentrations of green house gases viz. Carbon dioxide, Methane, Nitrous Oxide, Hydro Fluorocarbons, per fluorocarbons, Sulfur hexafluoride. The rising concentration of these gases is resulting in global warming. It is estimated that with present trend of earth's surface warming, the earth's temperature is estimated to rise by 1.4 Deg.C to 5.80 Deg.C by year 2100. The climate change of this order may eventually lead to adverse effects on human health and also on the natural ecosystems.

Considering the global nature of climate change, the United Nations Framework Convention on Climate Change (UNFCCC) was adopted for the

protection of global climate for present and future generations of human kind. On the initiation of UNFCCC, the developed countries where the emission level of green house gases is higher, agreed to take a lead in combating climate change and its adverse effects.

15.2 KYOTO PROTOCOL

The UNFCCC defined broad guidelines and started discussing and finalizing different modalities to achieve the targets of reducing global warming by reducing emission of green house gases. Eventually in a conference held in Kyoto, Japan, known Kyoto Protocol, decided for stabilization of green house gases concentrations in the atmosphere at a level that would not disturb the present Ecosystem. The Kyoto Protocol finally came into force on 16th February 2005 which has been ratified by amount 175 countries (except USA and Australia). According to this Protocol, the developed countries are required to reduce their combined green house gases emissions by approx. 5.2% below their 1990 levels during the commitment period of 2008–12. When the

Protocol is fully implemented by 2012, it would result in producing a reversal of upward trend in emissions.

Protocol's emission reduction targets cover the following six gases.

	Warming potential
i) Carbon dioxide	1
ii) Methane	21
iii) Nitrous Oxide	310
iv) Hydro fluorocarbons	140–11700
v) Per fluorocarbons	6500–9200
vi) Sulphur hexafluoride	23900

Developed countries can choose which of the above six gases emission they would like to reduce.

The Protocol requires the signatory developed countries to bring down their emissions mostly by their domestic actions. However, Protocol also introduced three flexibility mechanisms viz. (i) joint implementation among developed countries (ii) Emissions trading among developed countries

(iii) Clean Development Mechanism between a developed and a developing country.

15.3 CLEAN DEVELOPMENT MEHANISM

Out of three flexible mechanisms, Clean Development Mechanism (CDM) is the only one which involves developing countries and is of interest to India. India signed the Protocol in 2002 as it offers a large potential for CDM benefits because of an energy intensive industry and high growth rate in commercial energy usage to fuel the economic development and also an enabling environment in the country.

The CDM was meant to enable developed countries to finance emission reduction projects in developing countries to meet their targets in achieving their emission reduction commitments under the Protocol. For developing countries, it meant access to finance and better technologies helping them in achieving their substantial development.

The Protocol does not bind any country to follow any particular emission reduction policy but has given following indicatives for emission reduction which may help in reducing global warming.

a) Enhancing Energy Efficiency.
b) Protecting and enhancing of green house gas sinks.
c) Promoting sustainable agriculture.
d) Promoting renewable energy development.
e) Small Scale Projects which environment friendly.

Renewable energy projects with output capacity upto 15 MW have been categorized as small sale projects and are eligible for fast track CDM benefit procedures.

15.4 VERIFIED EMISSIONS REDUCTION - VER

Verified Emission Reductions are carbon credits generated from the environment friendly projects and are sold to any person or organization who wants to make their project carbon neutral. VER's generated by projects are assessed and verified

by their party organization and may not yet met the requirement for registration, verification, certification and issuance of CER's.

After a successful VER validation, the project developer can sell the emission reduction generated by their project to the interested buyers in developed countries. Buyers of VER assume all carbon specific policy and regulatory risks.

15.5 IDENTIFICATION OF PROJECT

A process of developing a project eligible for CDM benefits starts by identifying the type of project that will reduce green house gases emissions and also where these reductions will be additional and sustainable. Further, it has to be assessed whether the project is of small scale nature (up to 15 MW capacity) or medium/ large scale project as different conditions apply to small scale project activities. Once the project is conceived and finalized. The developer should begin searching four potential buyers. For this a

project concept note may be prepared and put up on website.

Under the project development stage, developer is required to prepare project design document which contains organizational and technical activities of the project. It is most important document of the CDM process and is a key input into the validation, registration and verification of the project.

15.6 CDM ELIGIBILITY CRITERIA

For a project to qualify for CDM benefits, it needs to satisfy the clauses of additional and sustainable development. The former is necessary to make the project eligible from the UNFCCC angle and later is required for the host country's approval.

Only projects where the emissions are measurable, would qualify for CDM benefits. Measurement of emission reduction throughout the project life is essential and important.

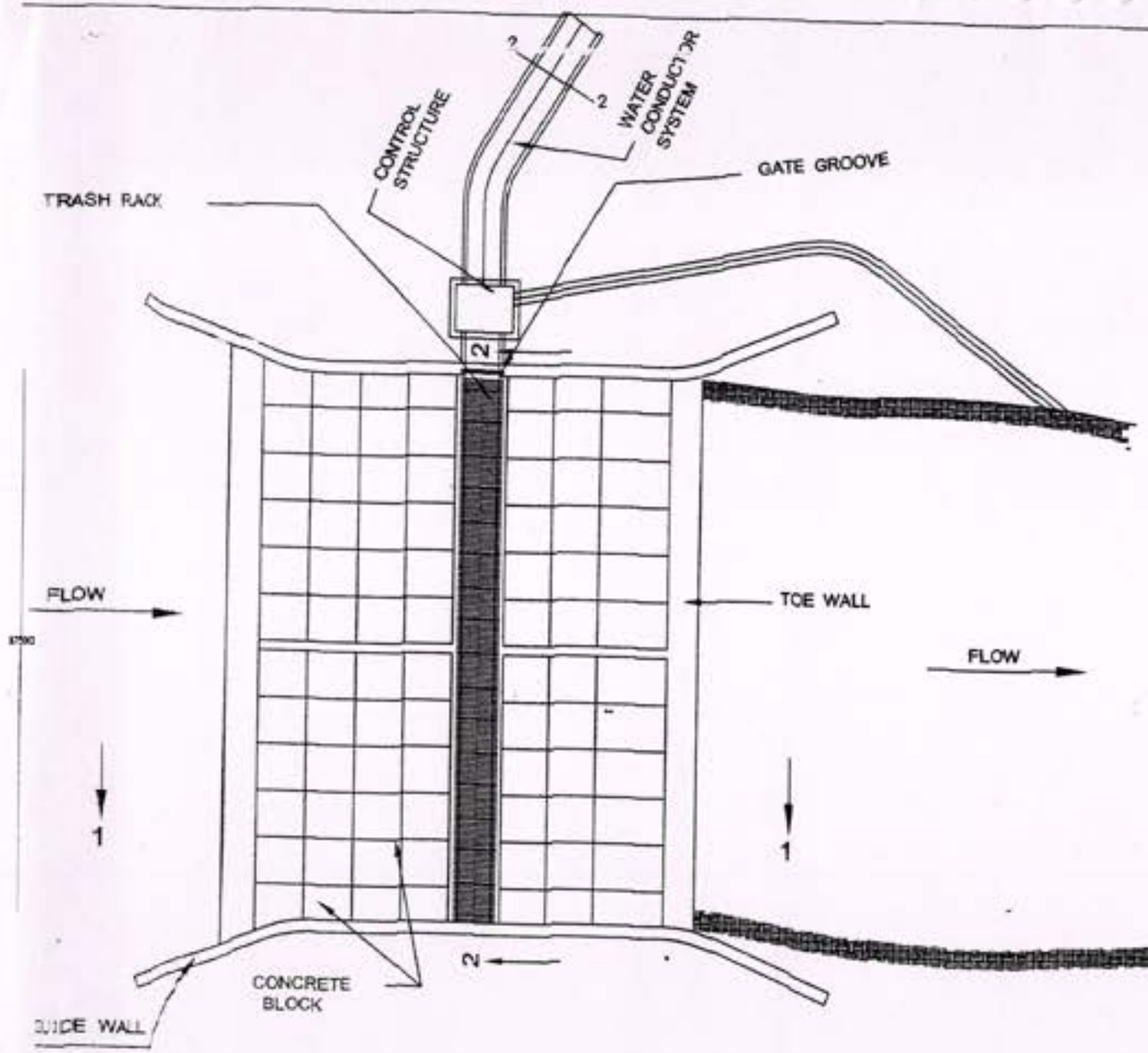
15.7 HYDRO POWER GENERATION

Hydro power is a renewable source of energy and hydro power generation projects results in continuous and long term reduction in emission of green house gases which in turn helps in reducing the global warming. These projects are very environment friendly. Further, hydro power generation projects also met the National priorities set by Govt. of India in its Five Year Plan for achieving sustainable economic growth.

Thus hydro power generation projects are eligible for getting clean development mechanism benefits.

LIST OF DRAWINGS

Sr.No	Description	Drawing No.
1.	Location & Vicinity Map	Photo Copy
2.	General Layout Plan	TC-1
3.	Trench Weir Plan	TC-2
4.	Trench Weir Section	TC-3
5.	Water Conductor System	TC-4
6.	Forebay Cum Desilting Tank Plan	TC-5
7.	Forebay Cum Desilting Tank Section	TC-6
8.	L-Section of Penstock	TC-7
9.	Section of Anchor Block	TC-8,9,10
10	Power House Plan	TC-11
11	Power House Section	TC-12
12	Single Line Diagram	TC-13
13	LT Scheme	TC-14



PLAN

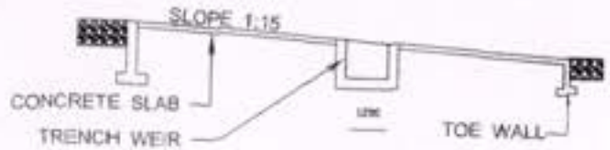
NOTES :-

1. All dimensions are in millimetres and Elevations & R.D's in metres unless specified otherwise.
2. No dimension shall be scaled out .Only written dimens ions are to be followed.
3. This drawing is for planning purpose only .

M/S LUCKY POWER PRIVATE LTD.	
TRANHA CHARROLI HEP	
COMPONENT - TRENCH WEIR	
DATE	DRG.NO.TC 2

NOTES :-

1. All dimensions are in millimetres and Elevations & R.D's in metres unless specified otherwise.
2. No dimension shall be scaled out .Only written dimens ions are to be followed.
3. This drawing is for planning purpose only .



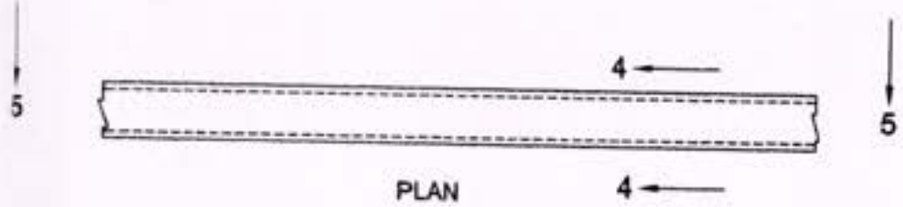
SECTION 1-1

SECTION ALONG 2-2

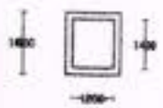
M/S LUCKY POWER PRIVATE LTD.	
TRANHA CHARROLI HEP	
COMPONENT - TRENCH WEIR	
DATE	DRG.NO.TC 3

NOTES :-

1. All dimensions are in millimetres and Elevations & R.D's in metres unless specified otherwise.
2. No dimension shall be scaled out .Only written dimens ions are to be followed.
3. This drawing is for planning purpose only .



PLAN



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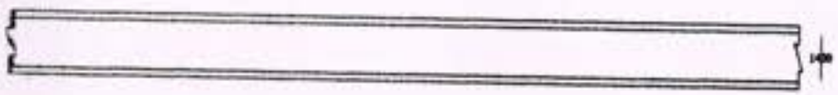


SECTION OF 5.5

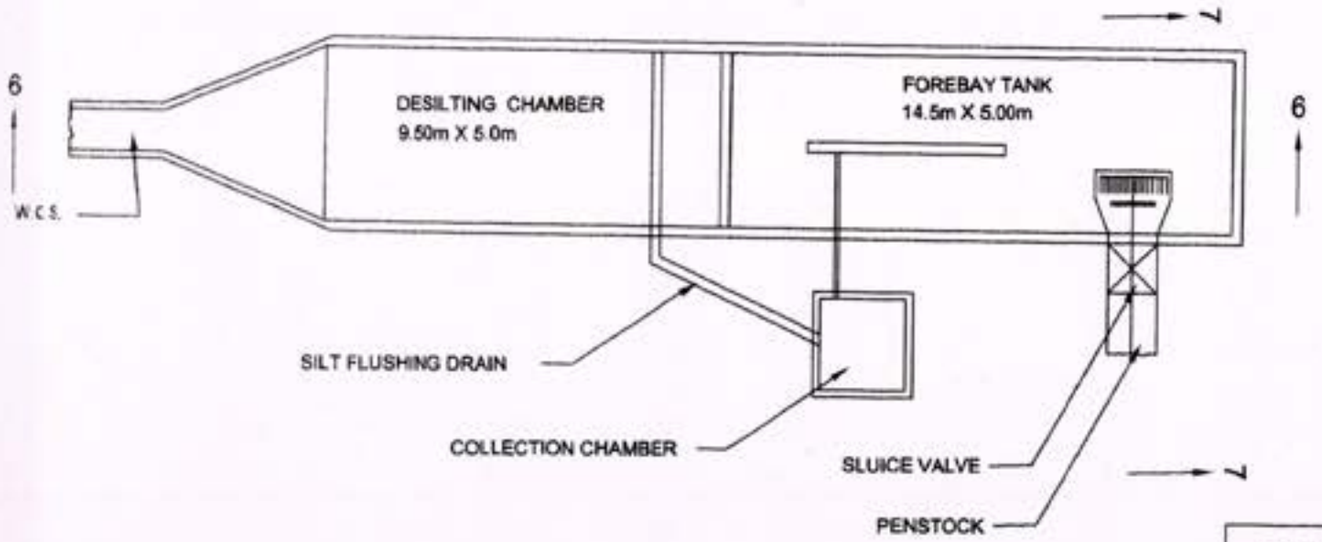
M/S LUCKY POWER PRIVATE LTD.	
TRANHA CHARROLI HEP	
COMPONENT - W.C.S.	
DATE	DRG.NO.TC 4

NOTES :-

1. All dimensions are in millimetres and Elevations & R.D's in metres unless specified otherwise.

2. No dimension shall be scaled out .Only written dimens ions are to be followed.

3. This drawing is for planning purpose only .

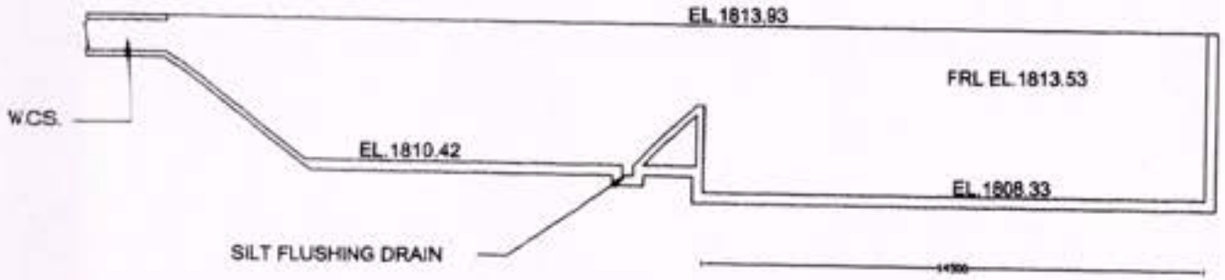


PLAN

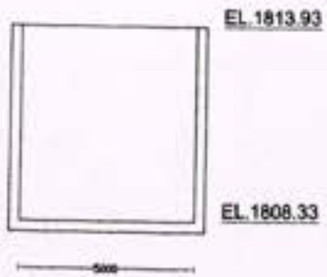
M/S LUCKY POWER PRIVATE LTD.	
TRANHA CHARROLI HEP	
COMPONENT - FOREBAY CUM DESILTING TANK	
DATE	DRG.NO.TC 5

NOTES :-

1. All dimensions are in millimetres and Elevations & R.D's in metres unless specified otherwise.
2. No dimension shall be scaled out .Only written dimens ions are to be followed.
3. This drawing is for planning purpose only .

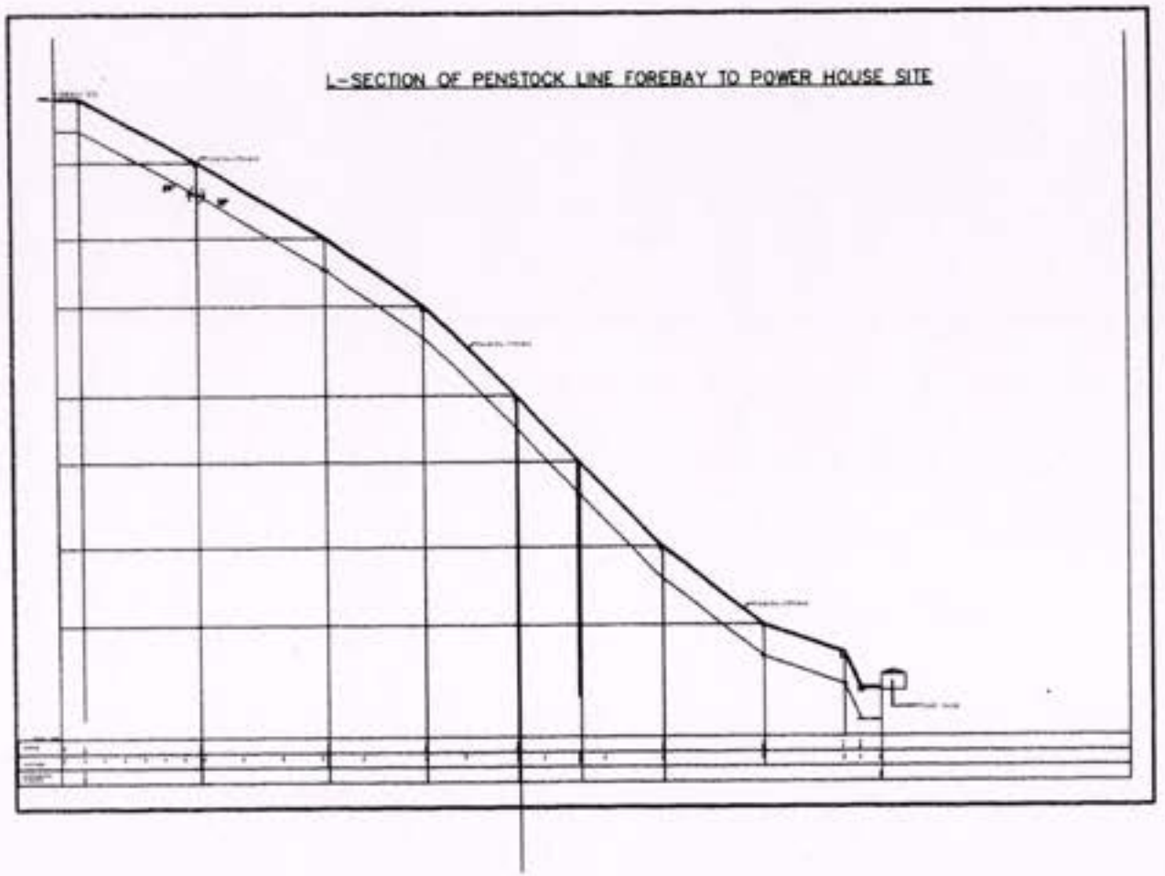


SECTION OF 6-6



SECTION OF 7-7

M/S LUCKY POWER PRIVATE LTD.	
TRANHA CHARROLI HEP	
COMPONENT - FOREBAY CUM DESILTING TANK	
DATE	DRG.NO.TC 6



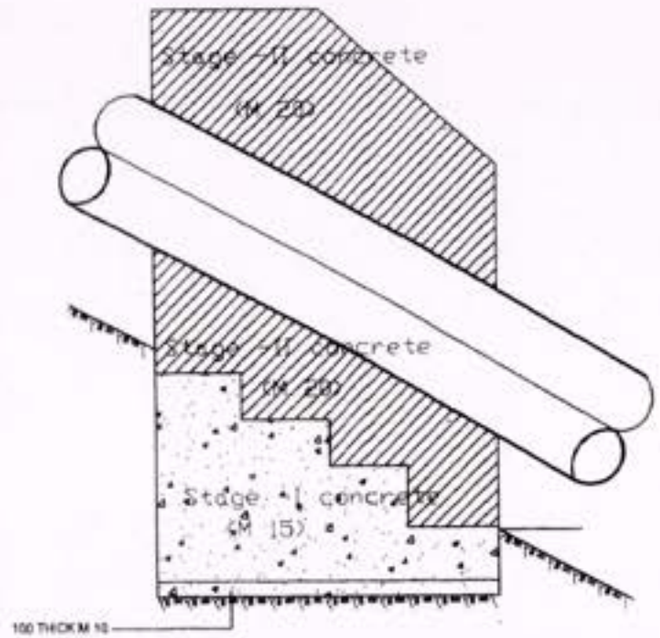
M/S LUCKY POWER PRIVATE LTD.	
TRANHA CHARROLI HEP	
COMPONENT - L SECTION OF PENSTOCK	
DATE	DRG.NO. TC 7

NOTES :-

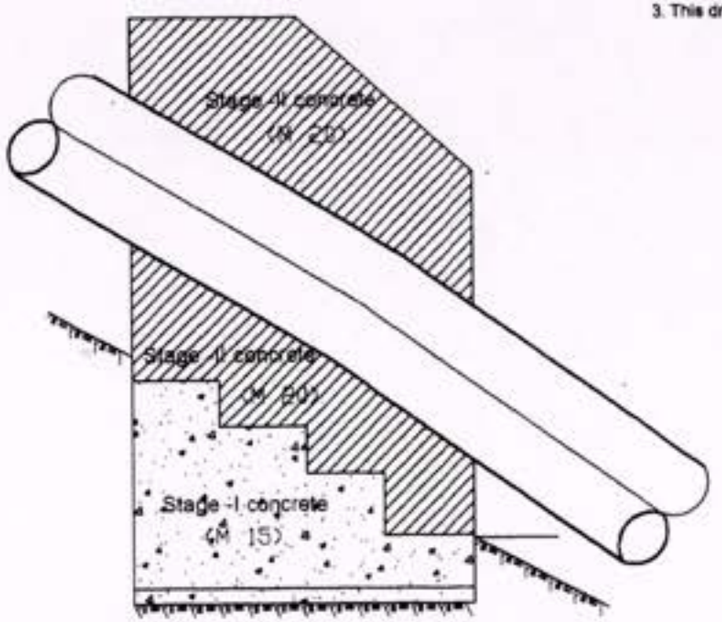
1. All dimensions are in millimetres and Elevations & F in metres unless specified otherwise.

2. No dimension shall be scaled out .Only written dime ions are to be followed.

3. This drawing is for planning purpose only .



SECTION
ANCHOR BLOCK 1

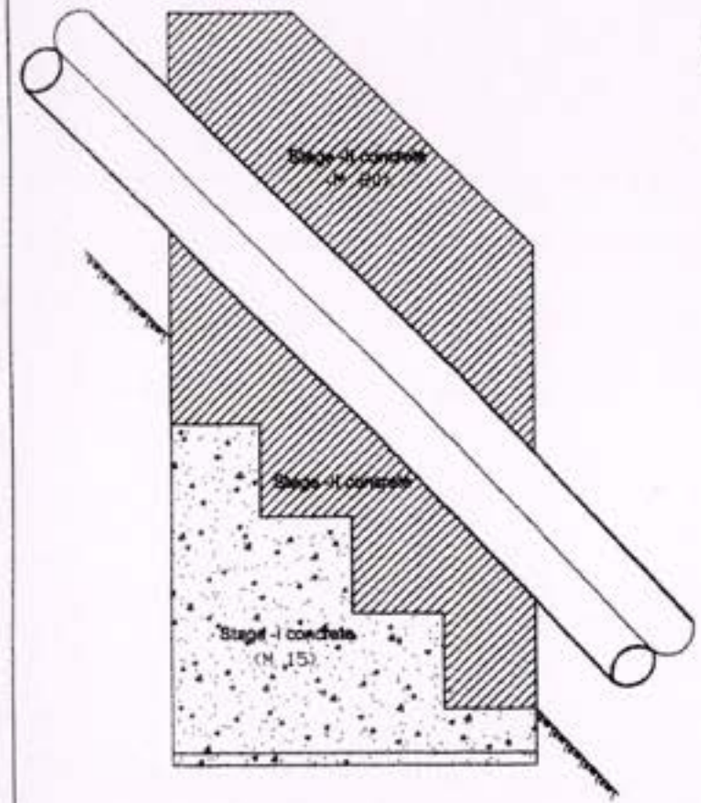


SECTION
ANCHOR BLOCK 2

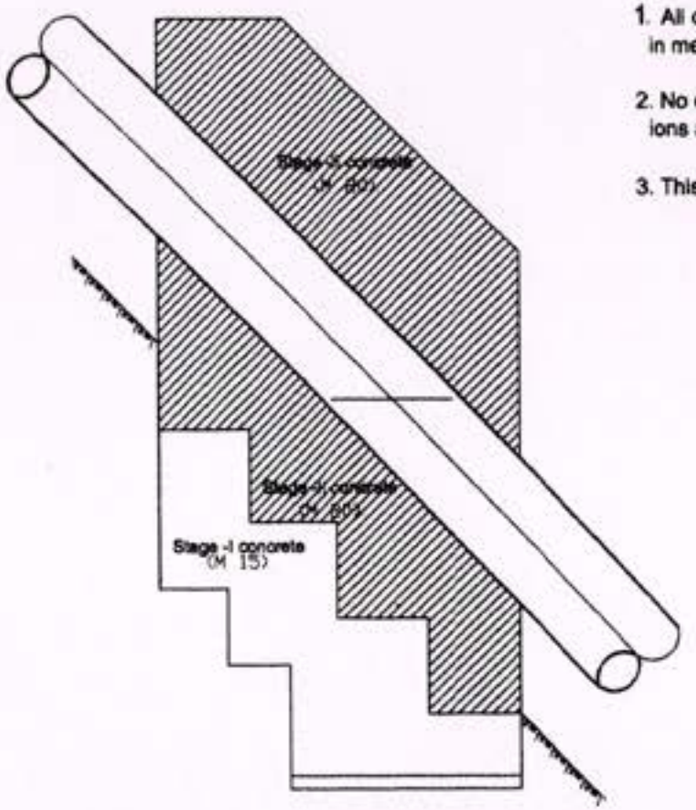
M/S LUCKY POWER PRIVATE LTD.	
TRANHA CHARROLI HEP	
COMPONENT - TRENCH WEIR	
DATE	DRG.NO.TC 8

NOTES :-

1. All dimensions are in millimetres and Elevations & R.D's in metres unless specified otherwise.
2. No dimension shall be scaled out .Only written dimens ions are to be followed.
3. This drawing is for planning purpose only .



SECTION
ANCHOR BLOCK 3

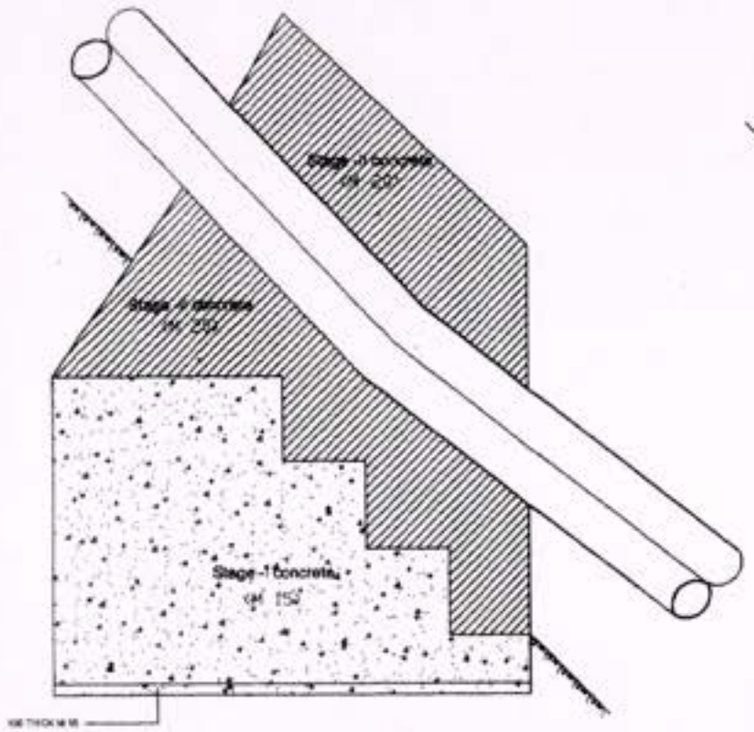


SECTION
ANCHOR BLOCK 4

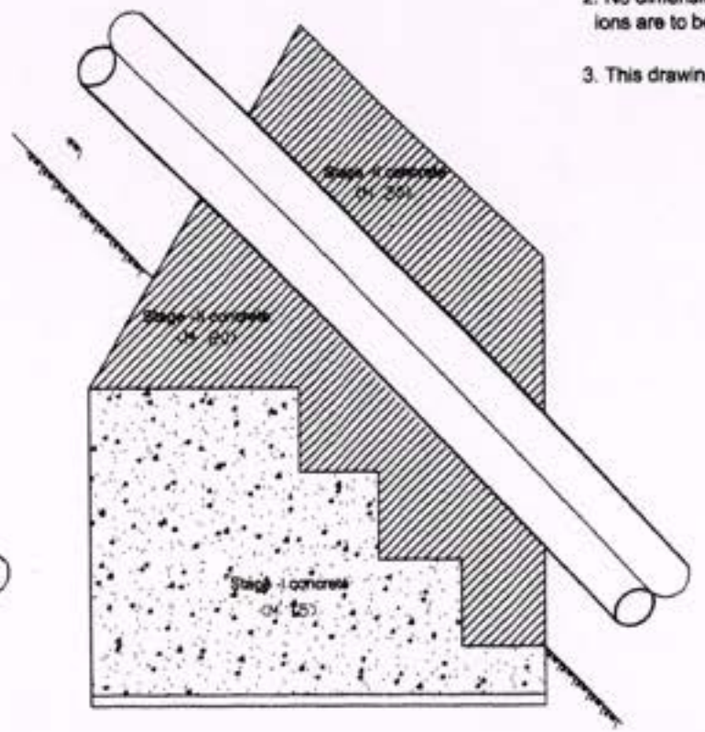
M/S LUCKY POWER PRIVATE LTD	
TRANHA CHARROLI HEP	
COMPONENT - ANCHOR BLOCK	
DATE	DRG.NO.TC 9

NOTES :-

1. All dimensions are in millimetres and Elevations & R.D's in metres unless specified otherwise.
2. No dimension shall be scaled out .Only written dimens ions are to be followed.
3. This drawing is for planning purpose only .

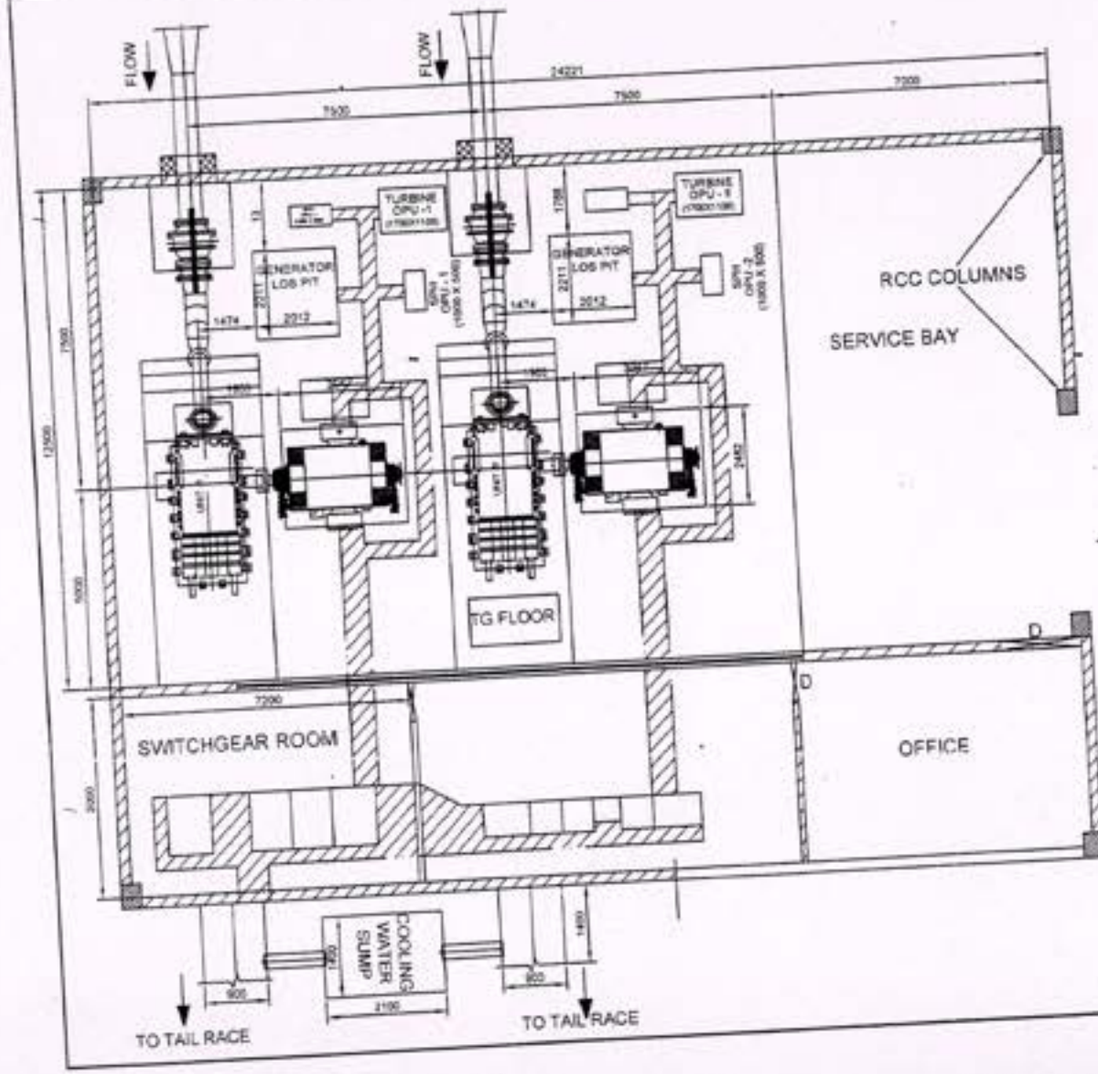


SECTION
ANCHOR BLOCK 5



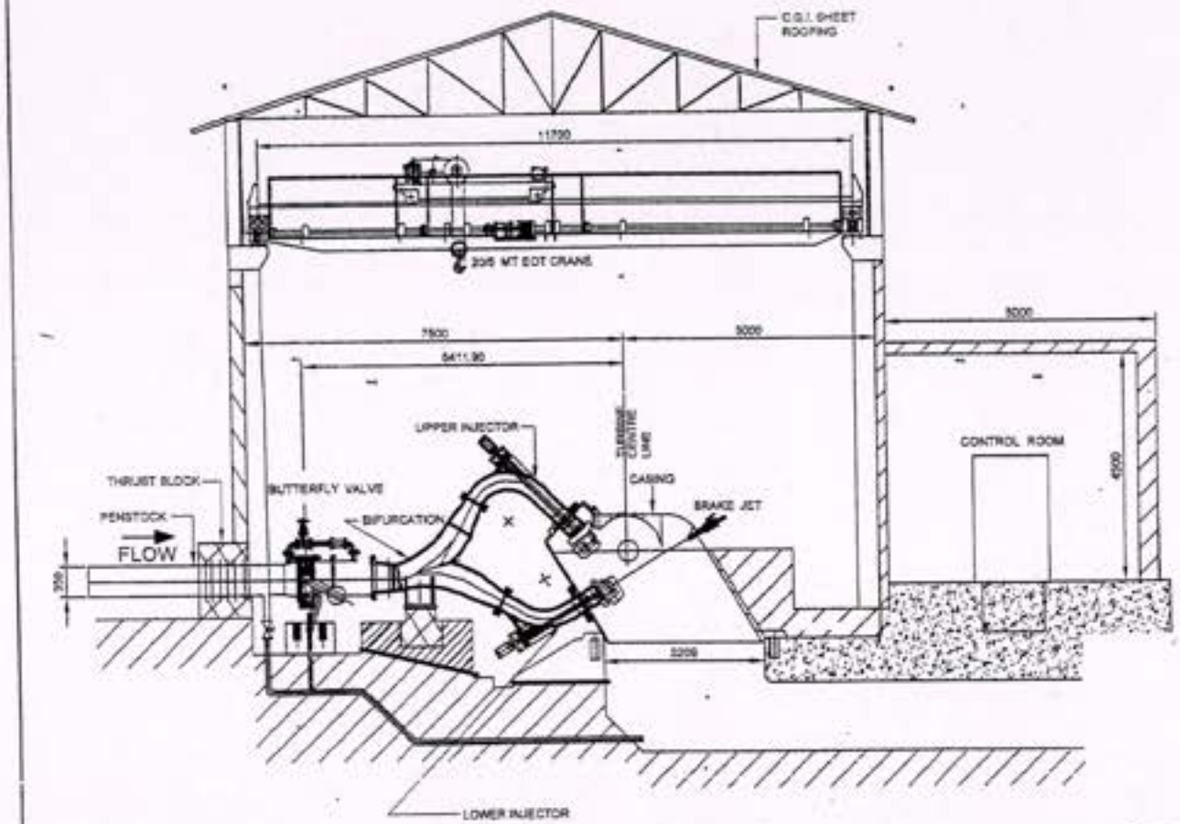
SECTION
ANCHOR BLOCK 6

M/S LUCKY POWER PRIVATE LTD	
TRANHA CHARROLI HEP	
COMPONENT - ANCHOR BLOCK	
DATE	DRG.NO TC 1 0



NOTES:
1. All dimensions are in mm.
2. This drawing is for planning purpose and not to be used for construction.

M/S LUCKY POWER PVT. LTD.	
TRANHA CHARRDLI HEP	
POWER HOUSE – PLAN	
DATE-	DRG.NO. TC 11



HYDRAULIC PARTICULARS

1.
2.DIA. OF SPHERICAL VALVE : 500mm

TURBINE DETAILS

1.TYPE : HORIZONTAL 2-JET PELTON.
2. RUNNER PCD : 880 mm.
3.NO. OF BUCKETS : 21
4.RUNNER SPEED : 750 RPM.
5.RUNAWAY SPEED : 1350 RPM.
6.RATED TURBINE OUTPUT : 1002 KW.
7.NO. OF UNITS : 2
8.DEFLECTOR CLOSING TIME : 1.5 SEC.
9.NEEDLE CLOSING TIME : 15 SEC..

GENERATOR DETAIL

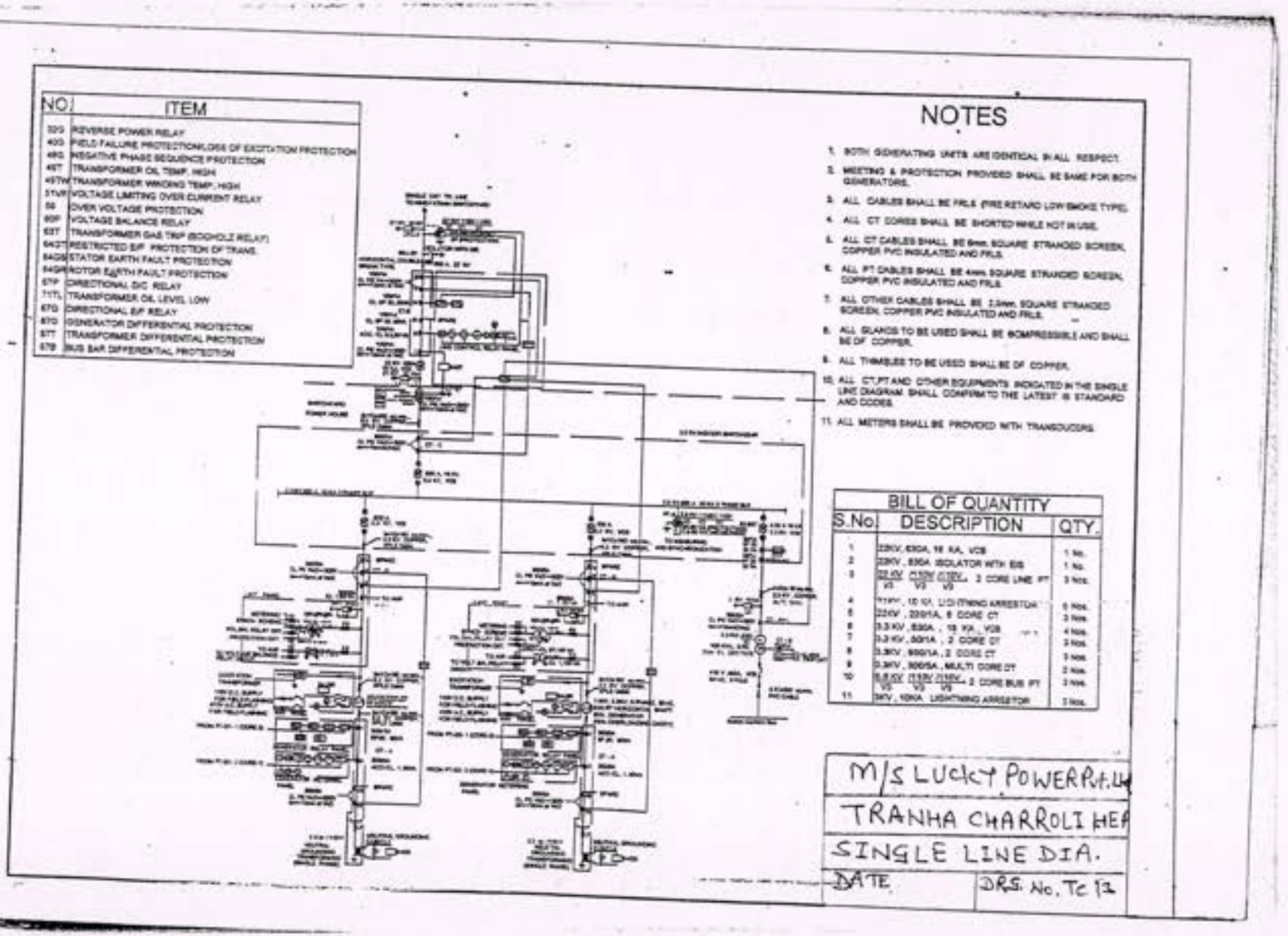
1.TYPE : HORIZONTAL SYNCHRONOUS
2.SPEED : 750 RPM.
3.RATED OUT PUT : 1000 KVA (15 % OVERLOAD).
4.VOLTAGE : 3.3 kV
5.FREQUENCY : 50 Hz

NOTES:

1.ALL DIMENSIONS ARE IN mm & ELEVATION IN m.

2.THIS DRAWING IS FOR PLANNING PURPOSE AND NOT TO BE USED FOR CONSTRUCTION.

M/S LUCKY POWER Pvt. Ltd.	
TRANHA CHARROLI HEP	
POWER HOUSE - SECTION	
DATE -	DRG. NO. 12



NO.	ITEM
32G	REVERSE POWER RELAY
40G	FIELD FAILURE PROTECTION/LOSS OF EXCITATION PROTECTION
46G	NEGATIVE PHASE SEQUENCE PROTECTION
49T	TRANSFORMER OIL TEMP. HIGH
49TW	TRANSFORMER WINDING TEMP., HIGH
51VR	VOLTAGE LIMITING OVER CURRENT RELAY
59	OVER VOLTAGE PROTECTION
60F	VOLTAGE BALANCE RELAY
63T	TRANSFORMER GAS TRIP (BUCHOLZ RELAY)
64GT	RESTRICTED E/F PROTECTION OF TRANS.
64GS	STATOR EARTH FAULT PROTECTION
64GR	ROTOR EARTH FAULT PROTECTION
67P	DIRECTIONAL O/C RELAY
71TL	TRANSFORMER OIL LEVEL LOW
67G	DIRECTIONAL E/F RELAY
87G	GENERATOR DIFFERENTIAL PROTECTION
87T	TRANSFORMER DIFFERENTIAL PROTECTION
87B	BUS BAR DIFFERENTIAL PROTECTION

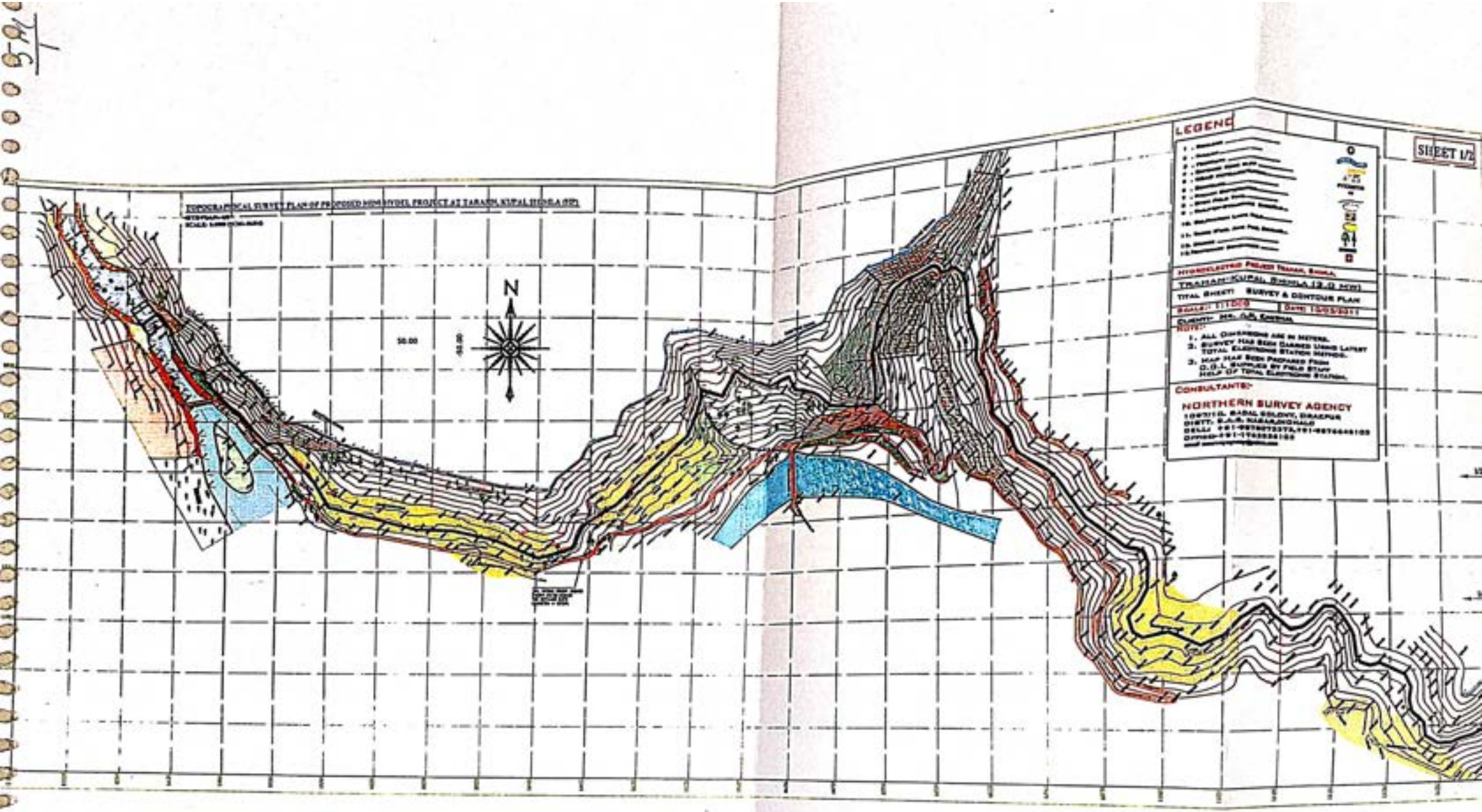
NOTES

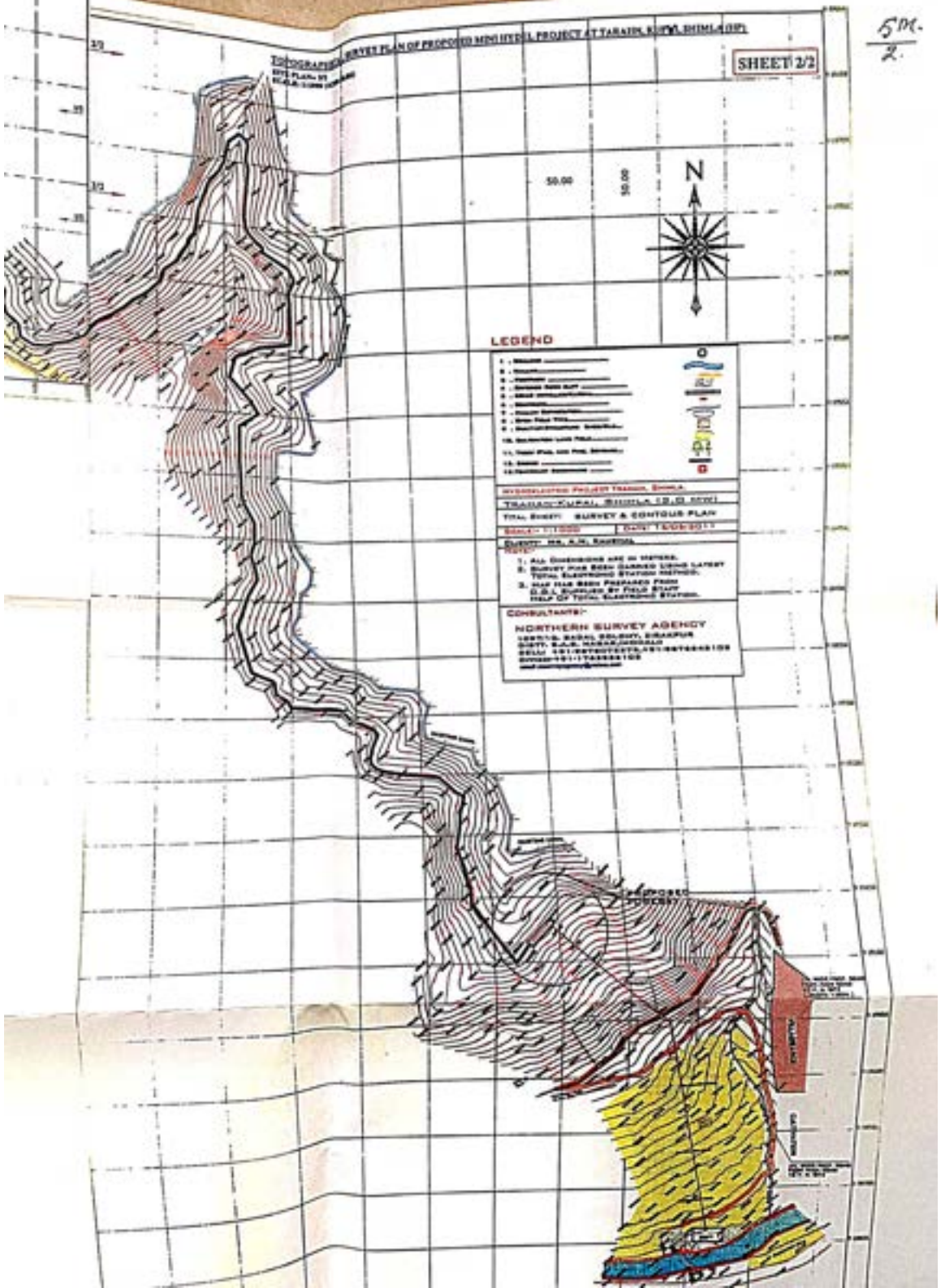
1. BOTH GENERATING UNITS ARE IDENTICAL IN ALL RESPECT.
2. METERING & PROTECTION PROVIDED SHALL BE SAME FOR BOTH GENERATORS.
3. ALL CABLES SHALL BE FRLS (FIRE RETARD LOW SMOKE TYPE).
4. ALL CT CORES SHALL BE SHORTED WHILE NOT IN USE.
5. ALL CT CABLES SHALL BE 6mm. SQUARE STRANDED SCREEN, COPPER PVC INSULATED AND FRLS.
6. ALL PT CABLES SHALL BE 4mm. SQUARE STRANDED SCREEN, COPPER PVC INSULATED AND FRLS.
7. ALL OTHER CABLES SHALL BE 2.5mm. SQUARE STRANDED SCREEN, COPPER PVC INSULATED AND FRLS.
8. ALL GLANDS TO BE USED SHALL BE ◉COMPRESSIBLE AND SHALL BE OF COPPER.
9. ALL THIMBLES TO BE USED SHALL BE OF COPPER.
10. ALL CT,PT AND OTHER EQUIPMENTS INDICATED IN THE SINGLE LINE DIAGRAM SHALL CONFIRM TO THE LATEST IS STANDARD AND CODES.
11. ALL METERS SHALL BE PROVIDED WITH TRANSDUCERS.

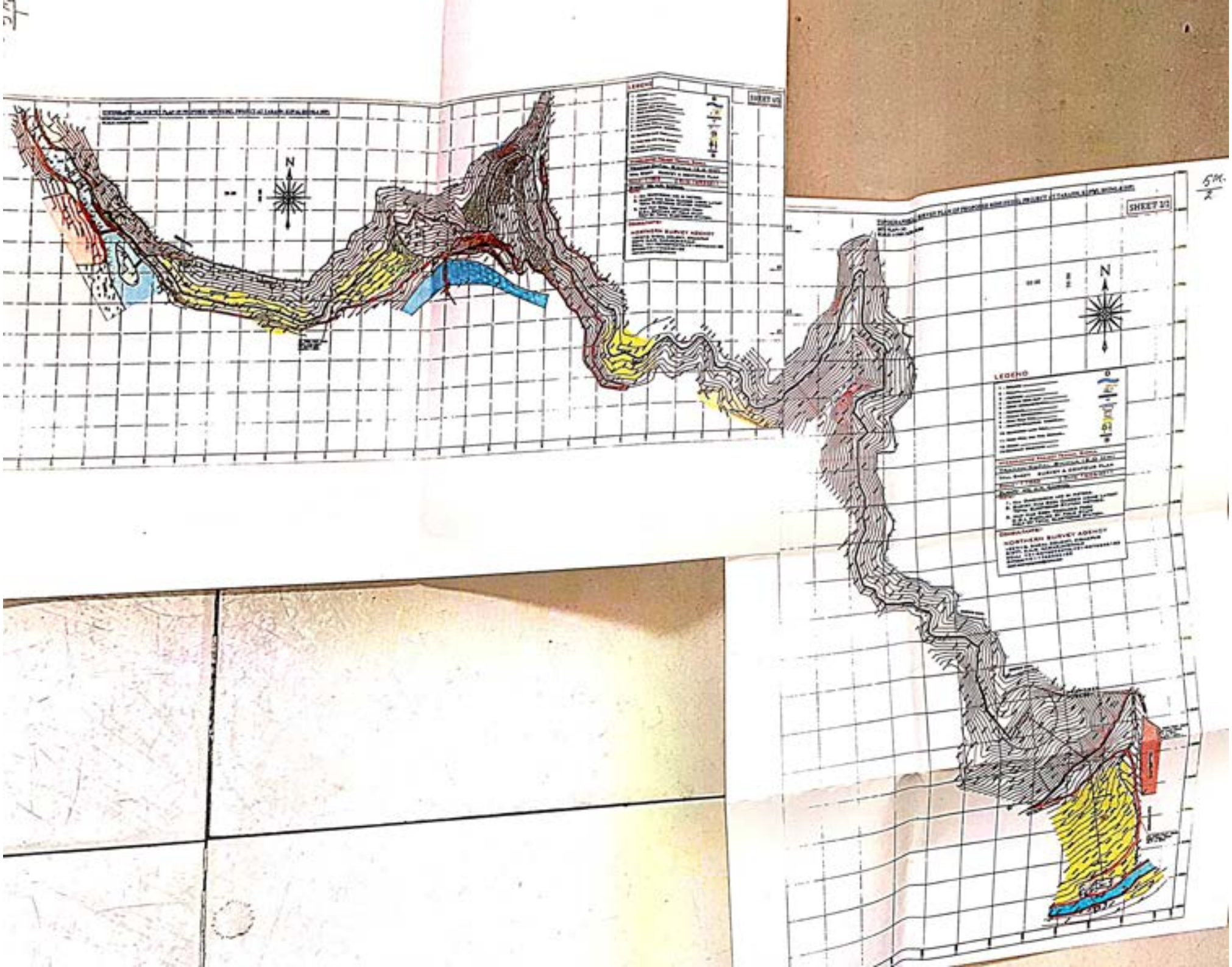
BILL OF QUANTITY

S.No.	DESCRIPTION	QTY.
1	33KV, 630A, 16 KA, VCB	1 No.
2	33KV, 630A ISOLATOR WITH ES	1 No.
3	33 KV 110V/√3 110V/√3 110V/3 3 CORE LINE PT	3 Nos.
4	11KV, 10 KA, LIGHTNING ARRESTOR	6 Nos.
5	33KV, 2201A, 5 CORE CT	3 Nos.
6	3.3 KV, 630A, 16 KA, VCB	4 Nos.
7	3.3 KV, 601A, 2 CORE CT	3 Nos.
8	3.3KV, 600/1A, 2 CORE CT	3 Nos.
9	3.3KV, 300/5A, MULTI CORE CT	2 Nos.
10	3.3 KV 110V/√3 110V/√3 110V/3 2 CORE BUS PT	3 Nos.
11	33KV, 10KA LIGHTNING ARRESTOR	3 Nos.

M/S LUCKY POWER Pvt. Ltd.
TRANHA CHARROLI HEA
SINGLE LINE DIA.
DATE
DRG. No. TC 12


SHEET 1/2
LEGEND
CONSULTANTS:-
NORTHERN SURVEY AGENCY
N


SHEET 2/2
N
LEGEND
CONSULTANTS:-
NORTHERN SURVEY AGENCY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