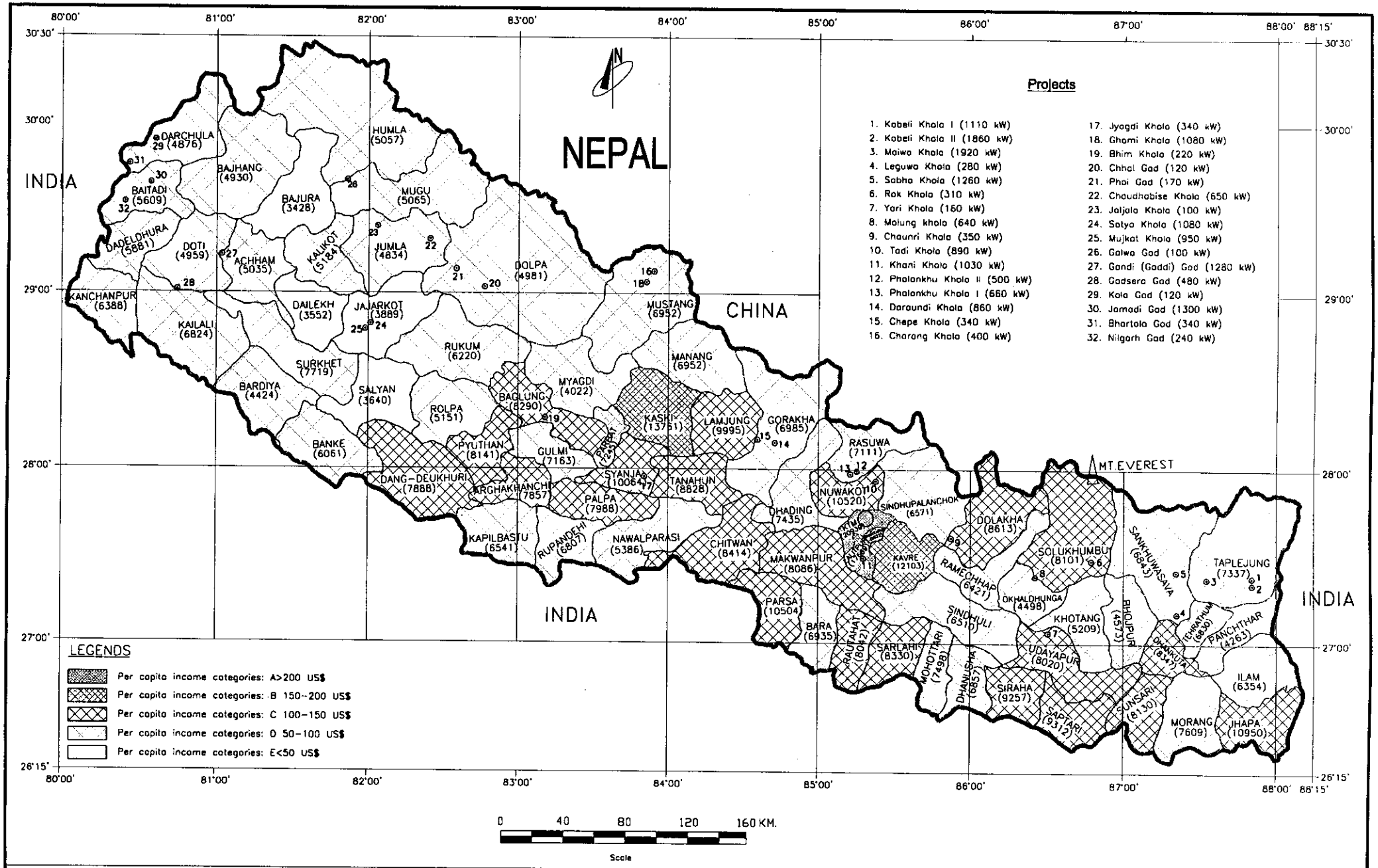

Japan International Co-operation Agency (JICA) and Nepal Electricity Authority (NEA)	Basic Study for the Rural Electrification Through Small Hydropower Development in Rural Hilly Areas in Nepal	DISTRICTWISE PER CAPITA INCOME	Scale As Shown	ITECO NEPAL (P) LTD. P. O.Box No. 2147, Min Bhawan, Kathmandu Email: iteco@mos.com.np, Tel: 493784, Fax 492298 Web site: www.acaf.com/iteconepal	Butwal Power Company Ltd. P. O.Box No. 11728, Kumaripati, Lalitpur Tel: 535585, Fax 527901 Email: bpc@hydroconsult.com.np	Prepared: / Checked: / Drawn: — Drawing No. / Sheet No.

District wise per Capita Income

S. No.	District	Area (sq. km)	Population (2001)[1]	Per Capita Income (NRs.) per Annum (1996)[2]	Per Capita PPP Income (US$) per annum (1996)[2]	Per Capita Income Category[3]
1	Taplejung	3646	134698	7337	1134	D
2	Panchthar	1241	202056	4263	659	D
3	Ilam	1703	282806	6354	982	D
4	Jhapa	1606	688109	10950	1693	C
5	Morang	1855	843220	7609	1176	D
6	Sunsari	1257	625633	8130	1257	C
7	Dhankuta	891	166479	8247	1275	C
8	Bhojpur	1507	203018	4573	707	D
9	Terhathum	679	113111	6830	1056	D
10	Sankhuwasabha	3480	159203	6843	1058	D
11	Solukhumbu	3312	107686	8101	1252	C
12	Khotang	1591	231385	5209	805	D
13	Okhaldhunga	1074	156702	4498	695	D
14	Udaypur	2063	287689	8020	1240	C
15	Saptari	1363	570282	9312	1439	C
16	Siraha	1188	572399	9257	1431	C
17	Dhanusa	1180	671364	6857	1060	D
18	Mahottari	1002	553481	7498	1159	D
19	Sarlahi	1259	635701	8330	1288	C
20	Sindhuli	2491	279821	6510	1006	D
21	Ramechhap	1546	212408	6421	992	D
22	Dolakha	2191	204229	8613	1331	C
23	Sindhupalchok	2542	305857	6571	1016	D
24	Kavrepalanchok	1396	385672	12103	1871	B
25	Lalitpur	385	337785	17689	2734	A
26	Bhaktapur	119	225461	9922	1534	C
27	Kathmandu	395	1081845	20939	3236	A
28	Nuwakot	1121	288478	10520	1626	C
29	Rasuwa	1544	44731	7111	1099	D
30	Dhading	1926	338658	7435	1149	D
31	Rautahat	2426	545132	8042	1243	C
32	Makwanpur	1126	392604	8086	1250	C
33	Bara	1190	559135	6935	1072	D
34	Parsa	1353	497219	10504	1624	C
35	Chitawan	2218	472048	8414	1301	C
36	Gorkha	3610	288134	6985	1080	D

[1] Source: Population Census 2001, Central Bureau of Statistics, Nepal

[2] Source: District Development Profiles of Nepal, 2001 published by Informal Sector Research and Study Center, Kamaladi, Kathmandu, Nepal

[3] Per capita income categories: A > 200 US$, B 150-200 US$, C 100-150 US$, D 50-100 US$ and E < 50 US$

37	Lamjung	1692	177149	9995	1545	C
38	Tanahun	1546	315237	8828	1365	C
39	Syangja	1164	317320	10064	1556	C
40	Kaski	2017	380527	13761	2127	B
41	Manang	2246	9587	6952	1075	D
42	Mustang	3573	14981	6952	1075	D
43	Myagdi	2297	114447	4022	622	D
44	Parbat	494	157826	7245	1120	D
45	Baglung	1784	268937	8290	1281	C
46	Gulmi	1149	296654	7163	1107	D
47	Palpa	1373	268558	7988	1235	C
48	Nawalparasi	2162	562870	5386	833	D
49	Rupandehi	1360	708419	6807	1052	D
50	Kapilbastu	1738	481976	6541	1011	D
51	Arghakhanchi	1193	208391	7857	1214	C
52	Pyuthan	1309	212484	8141	1258	C
53	Rolpa	1879	210004	5151	796	D
54	Rukum	2877	188438	6220	961	D
55	Salyan	1462	213500	3640	563	E
56	Dang	2955	462380	7888	1219	C
57	Banke	2337	385840	6061	937	D
58	Bardiya	2025	382649	4424	684	D
59	Surkhet	2451	288527	7719	1193	D
60	Dailekh	1502	225201	3552	549	E
61	Jajarkot	2230	134868	3889	601	E
62	Dolpa	7889	29545	4981	770	D
63	Jumla	2531	89427	4834	747	D
64	Kalikot	1741	105580	5184	801	D
65	Mugu	3535	43937	5065	783	D
66	Humla	5655	40595	5057	782	D
67	Bajura	2188	108781	3428	530	E
68	Bajhang	3422	167026	4930	762	D
69	Achham	1680	231285	5035	778	D
70	Doti	2025	207066	4959	767	D
71	Kailali	3235	616697	6824	1055	D
72	Kanchanpur	1610	377899	6388	987	D
73	Dadeldhura	1538	126162	5881	909	D
74	Baitadi	1519	234418	5609	867	D
75	Darchula	2322	121996	4876	754	D

[3] Per capita income categories: A > 200 US$, B 150-200 US$, C 100-150 US$, D 50-100 US$ and E < 50 US$

APPENDIX - B

APPENDIX – B

HYDROLOGY COMPUTATION

- Ghami Khola Small Hydropower Project Result from HydrA
- Ghami Khola Small Hydropower Project Result from MIP
- Ghami Khola Small Hydropower Project Result from HYDEST
- Ghami Khola Small Hydropower Project Result from MHSP

DESIGN CALCULATION

- Design of Free flow Rectangular Headrace Canal
- Headrace Canal Design
- Hydraulic Design

COST ESTIMATE

- Total Project Cost
- Summary of Unit Rates
- Basic Rates of Labour and Materials of Mustang District
- Rate Analysis

SOCIO ECONOMIC TABLES

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Table 2: Household Income Distribution
Table 3: Average Household size
Table 4: Willingness to pay by Income Level
Table 5: Willingness to pay by Land Holding Size
Table 6: Willingness to pay by Floor Area
Table 7: Willingness to pay by Expenditure on Energy
Table 8: Literacy Status
Table 9A: Affordability by Income Status
Table 9B: Energy Consumption Pattern by Household (In Nature Unit)
Table 10: Energy Consumption Pattern by Household (In GJ Unit)
Table 11: Type of End use and Energy use by Household
Table 12: Energy Source by Income Level
Table 13: Energy by End use Activities

DRAWINGS

- List of Drawings
- Project Location Map
- General Layout Plan
- Section of Intake
- Plan, Section of Desilting Basin and Canal Section
- Longitudinal Profile of Canal
- Plan and Section of Fore bay
- Profile of Penstock Line
- Plan and Section of Powerhouse
- Plan of Powerhouse with Switchyard
- Electrical Diagram
- Transmission Line
- Geological Map of Project Area
- Geological Section of Intake
- Geological Profile from Intake to Forebay
- Geological Profile from Forebay to Powerhouse

HYDROLOGY COMPUTATION

- Ghami Khola Small Hydropower Project Result from HydrA
- Ghami Khola Small Hydropower Project Result from MIP
- Ghami Khola Small Hydropower Project Result from HYDEST
- Ghami Khola Small Hydropower Project Result from MHSP

Catchment Characteristics and Site Flow Details
Ghami Khola, Mustang, Nepal

Run Date / Time:	Monday, February 10, 2003 at 14:28
Catchment definition file:	c:\pb\hydra-~1\ghami.prn
Total area:	232.32 km^2
Rainfall (average annual):	(No Data)
Potential evaporation (average annual):	(No Data)
Runoff (average annual):	587 mm
Mean flow estimate:	4.30 m^3/s
Standard low flow , as % of mean flow:	26.0 %
Standard low flow (absolute):	1.1 m^3/s

Flow Regime Report
Ghami Khola, Mustang, Nepal

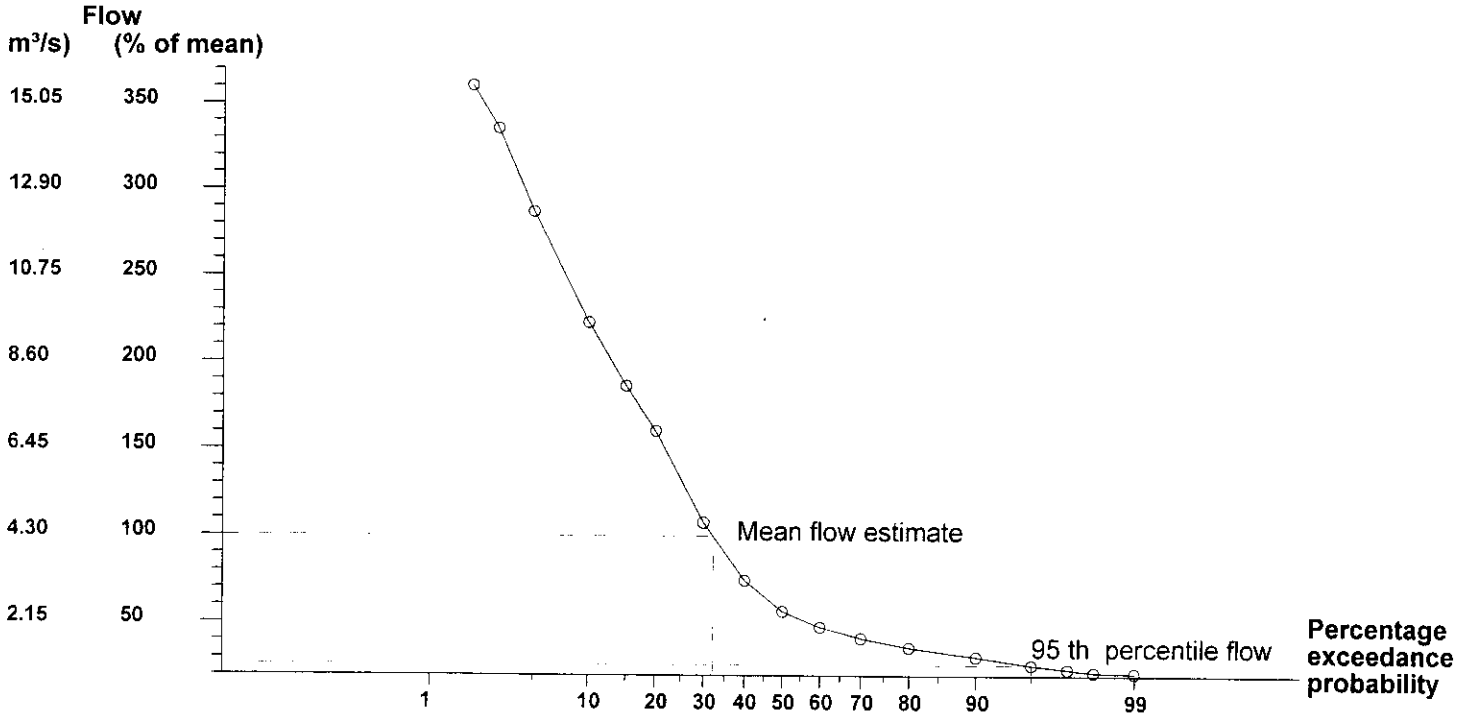
Run date / time: Monday, February 10, 2003 at 14:28

Catchment Characteristics

Total area:	232.3 km²
Rainfall (average annual):	-1 mm
Potential evaporation (average annual):	-1 mm
Runoff (average annual):	587 mm

Flow Regime Results

Mean flow estimate:	4.30 m³/s
Q95 (% of mean):	26.0 %
Q95 (absolute):	1.12 m³/s



Power Potential Report
Ghami Khola, Mustang, Nepal

Run Date / Time:	Monday, February 10, 2003 at 15:49
Flow Results file:	a:\jicash~1\surendra\hydrar~1\ghami.frr
Mean flow estimate:	4.30 m^3/s
Provisional rated flow:	1.90 m^3/s
Residual flow:	0.86 m^3/s
Rated Flow:	1.04 m^3/s
Turbine Rated Flow:	0.35 m^3/s
Gross head:	157.0 m
Rated nett head:	141.3 m

Operable Turbines

Marginally-operable turbines signified by '(mgnl)'

Pelton

	Per Turbine	Site Total (3 turbines)
Gross average annual output:	2946.7 MWh	8840.2 MWh
Nett average annual output:	2866.0 MWh	8598.0 MWh
Maximum power:	422.9 kW	1268.6 kW
Rated capacity:	401.7 kW	1205.2 kW
Minimum flow:	0.03 m^3/s	0.96 m^3/s

Turgo

	Per Turbine	Site Total (3 turbines)
Gross average annual output:	2882.4 MWh	8647.1 MWh
Nett average annual output:	2803.4 MWh	8410.2 MWh
Maximum power:	415.7 kW	1247.0 kW
Rated capacity:	394.9 kW	1184.6 kW
Minimum flow:	0.03 m^3/s	0.96 m^3/s

Crossflow

	Per Turbine	Site Total (3 turbines)
Gross average annual output:	2409.5 MWh	7228.5 MWh
Nett average annual output:	2343.5 MWh	7030.5 MWh
Maximum power:	384.4 kW	1153.3 kW
Rated capacity:	328.7 kW	986.1 kW
Minimum flow:	0.05 m^3/s	1.02 m^3/s

MIP METHOD

Catchment Name	Ghami
Catchment location	Mustang
Hydrological region	1
Basin Area	232.32 Km^2
Area below 5000 meter	16.87
Area below 3000 meter	0
Monsoon wetnex index	250
Flow measured	2.8 m^3

Flood flows

Return period(Yrs)	Instantaneous flood Discharge (m3/s)
2	2
5	4
10	6
20	8
50	12
100	15

Flow duration curve

Probability of Exceedance (%)		Discharge (m3/s)
0		3.45
5		2.24
20		10.49
40		3.73
60		1.88
80		0.16
95		0.09
100		0.06

Long tern average discharge

Month		Long Term Average Discharge (m^3/s)
January		0.24
February		0.20
March		0.18
April		0.16
May		0.20
June		6.70
July		1.57
August		1.91
September		1.42
October		0.67
November		2.86
December		1.96

Estamating the hydrograph of mean monthly flows

Month	Non-Dimensional Hydrograph	Measured flow (m^3/s)	Predicted Januaryflow (m^3/S)	Predicted Hydrograph (m^3/s)
January	2.4		1.17	2.8
February	1.8	2.8	1.17	2.1
March	1.3		1.17	1.5
April	1		1.17	1.2
May	2.6		1.17	3.0
June	6		1.17	7.0
July	14.5		1.17	16.9
August	25		1.17	29.2
September	16.5		1.17	19.3
October	8		1.17	9.3
November	4.1		1.17	4.8
December	3.1		1.17	3.6

METHODOLOGIES FOR ESTIMATING
HYDROLOGIC CHARACTERISTICS
OF
UNGAUGED LOCATIONS IN NEPAL

by The Water and Energy Commission Secretariat and
The Department of Hydrology and Meteorology

RIVER NAME : Ghami

LOCATION : Near San, Mustang district

DRAINAGE BASIN AREA : 232.32 km^2

AREA OF BASIN BELOW 5000 m ELEVATION : 16.87 km^2

AREA OF BASIN BELOW 3000 m ELEVATION : 0 km^2

MONSOON WETNESS INDEX AT BASIN CENTROID : 250

Ghami
Khola near San
Mustang district

LOW FLOW STATISTICS

Return Period (yrs)	Duration	Low Flow Discharge (m^3/s)
2	1	0.1164
	7	0.1286
	30	0.1975
	monthly	0.235
10	1	0.0203
	7	0.0369
	30	0.0918
	monthly	0.1232
20	1	0.0062
	7	0.0226
	30	0.0736
	monthly	0.1021

Ghami
Khola near San
Mustang district

FLOOD FLOW STATISTICS

Return Period (yrs)	Flood Discharge (m^3/s)		Comment
	Daily	Instantaneous	
2	1	2	based on regression results
5	1	4	1
10	2	6	1
20	3	8	1
50	3	12	1
100	4	15	based on regression results
200	5	18	1
500	6	24	1
1000	7	29	) not
5000	10	43	) very
10000	11	50	) reliable

1 : calculated assuming
a 2-parameter lognormal
distribution

|::

Ghami
Khola near San
Mustang district

aqqnclowflowfreq

LONG TERM AVERAGE DISCHARGES
****

Month	Long Term Average Discharge (m^3/s)
January	0.24
February	0.20
March	0.18
April	0.16
May	0.20
June	6.70
July	1.57
August	1.91
September	1.42
October	0.67
November	2.86
December	1.96
Annual	1.51

FLOW DURATION CURVE
****

Probability of Exceedance (%)	Discharge (m^3/s)
0	3.45
5	2.24
20	10.49
40	3.73
60	1.88
80	0.16
95	0.09
100	0.06

MHSP METHOD OF ESTIMATING HYDROLOGICAL PARAMETERS
NEA 1997

INPUT PARAMETERS

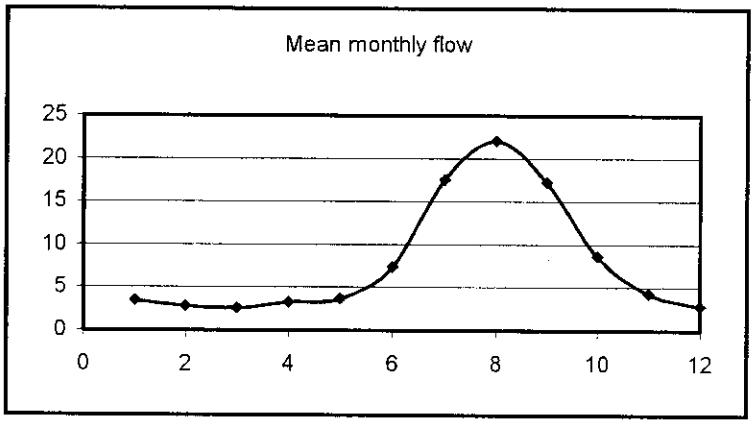
Project: **Ghami Khola SHP**
Location: **Mustang, Nepal**

Total drainage area	A	km^2	**232.32**
Mean monsoon precipitation	MMP	mm	**250**
Monsoon wetness index	MWI		**250**
Region			**Western**

RESULTS

Mean monthly flows

Month	flow m^3/s
January	3.46
February	2.84
March	2.62
April	3.26
May	3.72
June	7.43
July	17.50
August	22.03
September	17.21
October	8.62
November	4.28
December	2.84



Flood flows

Return period	flow m^3/s			Remarks
	Western	Central	Eastern	
5	225	324	536	
20	339	507	794	Flood flows
50	424	645	981	are valid for
100	494	759	1136	the specified
1000	782	1250	1778	region only
10000	1169	1946	2678	

Flow duration curves

Dependent varaible	flow m^3/s
Maximum flow Qo	97.56
25% exceedance	10.14
45% exceedance	4.17
65% exceedance	3.43
85% exceedance	2.24
95% exceedance	1.56
Minimum flow	0.43

DESIGN CALCULATION

HYDRAULIC DESIGN

1. Hydraulic Calculation of Structure

1.1 Depth of Foundation of Weir

The depth of the foundation is adopted considering the soil condition as well as the depth of scour in dam axis.

Scour Depth Calculation

Data:

Flood discharge Q_{100} = 200 m^3 /sec

Waterway = 41.50 m

Specific discharge q $= \frac{200}{41.50} = 5m^3 / \text{sec}/ m$

(A) Formula: d_{sm} = 1.34 $(q^2/K_{sf})^{1/3}$

Where d_{sm} = Mean scour depth in m

q = Specific discharge

K_{sf} = Silt factor = 1.76 $\sqrt{d_m}$

Adopted particle size d_{50} = 5 mm

$\therefore$ K_{sf} = 1.76 $\sqrt{5} = 3.94$

d_{sm} = 1.34 $\left(\frac{5^2}{3.94}\right)^{1/3} = 2.50m$

Calculated depth of scour d_{sm} = 2.50 m from HFL

As depth of foundation should be below the depth of scour. According to Cross Section of dam site the level of d_{max} = 3729.00

Therefore, adopted foundation of weir at Elevation 3728.80 m

1.2 Determination of Bottom Rack Length

The bottom rack of intake structure has been designed to insure to have design discharge as 2.55 m^3/sec even during low flow of the river.

Adopted

a. Hydrological parameters

Intake design discharge Q = 1.40 m^3/sec

Flood discharge Q_{100} = 200 m^3/sec

b. Hydrological parameters

Roughness coefficient for concrete n = 0.018

Adopted slope of trash rack $\beta = 10^o$

Clear gap between trapezoidal shape bars of trash rack a = 15 mm

Adopted width of bottom galley B = 1.0 m

Design formula for non-pressure flow

$$L = \left[\frac{Q}{1.93 \times \mu \times \ell \times k\sqrt{Q^{2/3}}}\right]^{3/2}$$

Where Q = discharge through trash rack = 1.40 m³/sec

μ = discharge coefficient depend on the shape of trash rack bar for trapezoidal section = 0.62

ℓ = coefficient of net gap area $\frac{a}{d+a}$

d = bar size = 20 mm

= $\frac{15mm}{35mm} = 0.428$

k = coefficient of slope for 10° slope = 0.910

$$L = \left[\frac{1.40}{1.93 \times 0.62 \times 6.428 \times 0.91 \times 1.0\sqrt{1.4^{2/3}}}\right]^{3/2}$$

= 5 m

As we know during operation the trash rack gaps are obstructed by stones and gravel. Considering the obstruction caused by gravel and leaves the length should be increased by 50%.

Adopted length, L = 1.5 x 5 = 8 m (say)

Considering the pattern of flow adopted the rack to the left side of weir.

Alternative Calculation for Checking

Formula $Q = \frac{2}{3} c\mu bl\sqrt{2gh}$

Where $c = 0.6\ \frac{a}{d}\cos^{2/3}\beta = 0.6\frac{10mm}{30mm} \times \cos^{3/2} 10^{o}$

μ = discharge coefficient = 0.62

b = 1.0 m

L = 8 m

h = water depth = 0.25 m

$$Q = \frac{2}{3} \times 0.25 \times 0.62 \times 1.0 \times 8\sqrt{2 \times 9.81 \times 0.25}$$

= 1.83 m³/sec > 1.40 m³/sec

Therefore the adopted width B = 1.0 m and length L = 8 is sufficient for design discharge.

1.3 Design of Collection Gallery

Discharge Formula

$$Q = Bh \times Ks \left(\frac{Bh}{B+2h}\right)^{2/3} I^{2/3} m^3/\text{sec}$$

Where B = 1.0 m

Q = 1.40 m^3/sec

I = gallery slope = 0.05 = 1:20

$K_s = \frac{1}{n} = 55$

h = water depth in gallery

Introducing the value, we have

$1.40 = 1.0 \times h \times 55 \left(\frac{1.0}{1.0+2h}\right)^{2/3} (0.05)^{1/2}$

or $1.40 = 12.298h \left(\frac{1.3h}{1.3+2h}\right)^{2/3}$

Solving the equation

h = 0.33 m

Considering the requirement for free board adopted gallery height of 0.60 m

Size of bottom intake gallery

Length	L = 8 m
Width	B = 1.0 m
Height	H = 0.60 m
Slope	I = 0.05 = 1:20

Inclination of rack = 10°

Head Over the Weir

Given data

Flood discharge	Q100	= 200 m3/sec
Weir length	L	= 41.5 m
Formula	Q	= $\mu L\sqrt{2g}H^{3/2}$

Where μ = discharge coefficient depends upon the shape = 0.70

$\therefore 200 = 0.70 \times 41.5 \sqrt{2 \times 9.81} \times H^{3/2} = 200 = 128.6H^{3/2}$

H = 1.35 m

Maximum water depth during HF = 1.35 m

1.17 Design of Desanding Basin

Design Condition

Design particle size = 0.20 mm

Basin discharge = Q = 1.40 m^3/sec

Sinking time t_s should be shorter than translation time t_d through the basin

Formula

a. $V_d = a\sqrt{d}\,cm/\sec$

d = particle diameter = 0.20 mm

a = 44 for d = 0.1 mm to 1 mm

$V_d = a\sqrt{0.20} = 20.0cm/\sec = 0.20m/\sec$

Where Vd = velocity of flow, equal or less than this value the particle of size up to 0.20 mm will tend to settle in the basin.

Provide setting depth h = 2.5 m.

Two numbers of setting chamber of width = B each

b. $L = \dfrac{V_d h}{V_s - 0.04V_d}$ in m

Where L = effective length of basin

h = setting depth = 2.50 m

V_d = sinking velocity of the particle

According to the Table and Stokes low V_s = 2.5 cm/sec for particle size of 0.2 mm at 10° C water temperature.

$$L = \frac{0.20 \times 2.5}{0.025 - 0.04 \times 0.2} = \frac{0.50}{0.017} = 30m$$

c. Determination of B

$B = \dfrac{Q \times t_d}{Lh}$ where t_d = sinking time = $\dfrac{L}{V_d} = \dfrac{30}{0.20}$

where t_d = sinking time = $\dfrac{L}{V_d} = \dfrac{30}{0.20} = 150\sec$

$$B = \frac{0.70 \times 150}{30 \times 2.5} = 1.5m$$

Width of each chamber B = 3.50 m

Adopted the size of setting basin

L = 30 m

B = 2 x 1.50 m

h = 2.50 m

Transition Length L = 8.0 m

Alternate method of calculation

Sinking velocity of particle of size d = 0.20 mm is w = 0.025 m/sec.

Setting time $t_{set} = \dfrac{effectivetime}{w} = \dfrac{2.50}{0.025} = 100\sec$

Mean velocity of flow basin = t_{set} x V_{mean}

L = 100 x 0.20 = 20.0 m

Adopted length L = 30 m is enough

Design of Free Flow Rectangular Headrace Canal

Roughness Coefficient n = 0.016 1/n= 62.5
Slope = s = 1/250 $0.004\ s^{1/2}$= 0.06325
Discharge= Q= 1.0
Thickness of wall t= 0.3
Area = A = b x h
Wetted perimeter = P = 2 x h + b
Hydraulic radius = R = A/P
Velocity of flow = V = Q/A

S.No.	Q(m^3/s)	b (m)	h (m)	A (m^2)	P (m)	R (m)	V m/sec	Vol m^3/m
1	1.000	0.500	1.420	0.710	3.340	0.213	1.408	1.182
2	1.000	0.600	1.104	0.662	2.808	0.236	1.509	1.022
3	1.000	0.750	0.832	0.624	2.413	0.258	1.604	0.904
4	1.000	0.900	0.674	0.606	2.247	0.270	1.650	0.854
5	1.000	1.000	0.601	0.601	2.202	0.273	1.663	0.841
6	1.000	1.250	0.482	0.603	2.214	0.272	1.660	0.844
7	1.000	1.400	0.435	0.608	2.269	0.268	1.644	0.861
8	1.000	1.500	0.409	0.614	2.318	0.265	1.629	0.875
9	1.000	1.600	0.387	0.620	2.375	0.261	1.614	0.892
10	1.000	1.700	0.368	0.626	2.437	0.257	1.598	0.911

Based on above table adopted size of canal
Width = b = 1.0 m
Wall height = h = 0.601 m + free board = 0.90 m
Flow velocity = V = 1.67 m/sec.

WATER HAMMER CALCULATION

Static head = 85 m
Traveling velocity of pressure wave = a

$$a = \frac{1}{\sqrt{\frac{w}{g}\left(\frac{1}{k}+\frac{1}{E}\cdot\frac{D}{t}\right)}}$$

Where a = Pressure wave velocity
w = Unit weight of water = 1.0 t/m^3
g = Acceleration of gravity (9.81 m/sec^2)
k = Volumetric elasticity of water i.e. young's modulus of elasticity of water
= 2×10^5 t/m^2
E = Young's modulus of elasticity of steel
= 2.1×10^7 t/m^2
D = Pipe inner diameter = 0.70 m
t = Thickness of pipe = 0.007 m

$$a = \frac{1}{\sqrt{\frac{1}{9.81}\left(\frac{1}{2.0\times10^5}+\frac{1}{2.1\times10^7}\cdot\frac{0.70}{7\times10^{-3}}\right)}} = \frac{1}{9.975\times10^{-4}} = 1002 \text{ m/sec}$$

a = 1002 m/sec.

Required round trip time of water hammer wave

$$T_o = \frac{2L}{a} = \frac{2 \times 400}{1002} = 0.80 \text{ sec.}$$

a. In case of closing time T = 2 sec. > T_o

Water hammer pressure $h = \frac{H_0\left(n + \sqrt{n^2 + 4n}\right)}{2}$

Where, $n = \left(\frac{L\upsilon_0}{gTH_0}\right)^2$

$$n = \left(\frac{400 \times 2.60}{9.81 \times 2 \times 85}\right)^2 = 0.3889$$

Hence n = 0.3889

Water hammer pressure, $h = \frac{85\left(0.3889 + \sqrt{(0.3889)^2 + 4 \times 0.3889}\right)}{2} = 72 \text{ m}$

If closing time T = 2 sec.

b. In case of closing time T = 3 sec.

$$n = \left(\frac{400 \times 2.60}{9.81 \times 3 \times 85}\right)^2 = 0.1728$$

$$h = \frac{85\left(0.1728 + \sqrt{0.1728^2 + 4 \times 0.1728}\right)}{2} = 43 \text{ m}$$

h = 43 m = water hammer pressure

DESIGN PENSTOCK

During the selection of the diameter of a penstock pipe the following factors are considered.

a. Friction loss along the penstock
b. Abrasion due to water conveyed
c. Governing conditions of the turbine
d. Cost of penstock

As recommended by Prof. Mosonyl in his book "Water Power Development II" permissible velocity for a steel pipe for properly settled water v = 3 to 5 m/sec. Higher velocity of water in penstock decreases the size of penstock and its cost but increases friction loss which ultimately effect to the power generation.

Penstock Diameter

Method - 1

Economical Diameter of Penstock

$$D = \left(\frac{5 \times 78.4 \times 8760 \times C_p f \eta \phi \sigma_a}{a C_c \tau g \pi^3 P(1 + \varepsilon)}\right)^{\frac{1}{7}}$$

Where

D = Economical diameter of the pipe
t = Thickness of pipe plate = 10 mm (say)
C_p = Power rate per unit kWh = Rs. 3.0
f = Coefficient of friction loss of pipe = 0.012
η = Combined efficiency of turbine, generator = 0.80
a = Ratio of annual expense to construction cost including O/M cost = 0.12
C_c = Unit price of penstock construction = Rs. 200,000 /ton
τ = Unit weight of steel = 7.85 (t/m^3)
g = 9.81 (m/sec^2)
ε = Ratio of increased weight of pipe due to flange etc. = 0.1
α = Power discharge = 1.0 m^3/sec
ϕ = Efficiency of pipe joints = 0.85
σ_a = Allowable tensile stress of pipe = 1150 (kg/cm^2)
P = Design water pressure = H+WHP = 85+43 = 128 T/m^2 = 0.1 x 128 kg/cm^2
= 12.8 kg/cm^2

The diameter for the penstock pipe is:

$$D = \left(\frac{5 \times 78.4 \times 8760 \times 3.0 \times 0.012 \times 0.80 \times 0.85 \times 1150}{0.12 \times 200000 \times 7.85 \times 9.81 \times \pi^3 \times 12.8(1+0.1)} \right)^{\frac{1}{7}} = 0.690\,\text{m say } 0.70\,\text{m}$$

Method - 2

$$D = \left(\frac{5.2Q^3}{H} \right)^{1/7}$$

Where D = Diameter of penstock (m)
Q = Discharge in m^3/sec = 1.0 m^3/sec
H = Waterhead in (m) = 85 m

$$D = \left(\frac{5.2 \times 1.0^3}{85} \right)^{1/7} = 0.671m$$

On the basis of the above result adopted penstock diameter as D = 700 m = 0.70 m

Than area of pipe = A = 0.385 m^2

Velocity $V = \frac{Q}{A} = \frac{1.0}{\pi \times \frac{(0.70)^2}{4}} = 2.60m/\text{sec}.$

The velocity of flow lies within the permissible range.

Thickness of Penstock Pipe

Formula : $\delta = \frac{0.1HD}{2(c)\phi} mm$

Where H = H + ΔH = Total head including surge pressure
= 85 + 43 = 128 m
D = Diameter of pipe = 0.700 m
δ = Allowable stress of steel = 1200 kg/cm^2
ϕ = Efficiency of welding = 0.80

$$\delta = \frac{0.1 \times 128 \times 0.70}{2 \times 1200 \times 0.80} = 5mm$$

Adding corrosive thickness t_1 = 2 mm
Thickness at penstock pipe t = $\delta + t_1 = 7mm$

Weight of Penstock Pipe

wt = $\pi.D.t \times r_s$

= $\pi \times 0.70 \times 0.007 \times 7.85t/m^3 = 0.121t/m$

wt of pipe per meter length = 0.121 Ton/m (Net).

Weight of pipe including flanges nut bolts etc. = 0.121 + 10% x 0.121 = 0.133 t/m.

Diameter of Branch Pipe

As the velocity of flow in the main pipe is V = 2.60 m/sec

Adopting same velocity in branch pipe diameter of pipe D = $2.\left(\frac{q}{V\pi}\right)^{\frac{1}{2}}$

D = $2.\left(\frac{0.50}{2.60 \times \pi}\right)^{\frac{1}{2}} = 0.50m$

Diameter of branch pipe for each unit is D = 0.50 m

- Thickness of pipe $\delta = \frac{0.1 \times 128 \times 0.50}{2 \times 1200 \times 0.80} = 3.50mm$
  Adding safely for corrosion, adopted thickness = 5.0 mm

- Weight of branch pipe per meter
  = $\pi \times 0.50 \times 0.005 \times 7.85t/m^3$
  = 0.062 t/m = 62 kg/m
  Adding 10%, the weight of branch pipe
  = 1.1 x 62 = 68.20 kg/m

1. CALCULATION

1.1 Power output

$P = gQH\eta_T$ [kW]

Where,

g = Acceleration due to gravity of earth (m/sec^2)
Q = Flow rate (m^3/ sec)
H = Water head (m)
ηT = Turbine efficiency

Thus,

P = 9.81 x 0.5 x 80 x 0.85 kW
or P = 335.54 kW
P (selected) = 335 kW

1.2 Rotation speed

From the Figure ..... the range of specific speed for Turgo turbine is 20 – 80 m – kW unit.

Hence,

Rotational speed $N_{max} = \frac{N_{s\max} H^{\frac{5}{4}}}{P^{\frac{1}{2}}}$

$= \frac{80 \times 80^{\frac{5}{4}}}{300^{\frac{1}{2}}}$

Rotational speed $N_{max} = \frac{N_{s\max} \times H^{\frac{5}{4}}}{P^{\frac{1}{2}}}$

$= \frac{20 \times 80^{\frac{5}{4}}}{300^{\frac{1}{2}}}$

= 276.27 m-kg

In order to avoid erosion of runner of self water runner speed of 750 RPM has been selected.

1.3 Specific Speed

$Ns = \frac{N \times 1^{\frac{1}{2}}}{H^{\frac{5}{4}}}$ $= \frac{750 \times 300^{\frac{1}{2}}}{80^{\frac{5}{4}}}$ = 54.29 m-kW

Which is within the range of 20 – 80 as specified for a Turgo turbine.

1.4 Runner Diameter

Jet speed

$V_{jet} = \sqrt{2gH \times C_v}$

Where, C_v = Coefficient of velocity of nozzle

Bucket speed

V_{back} $= 0.46\ V_{jet}$

$= 0.46\sqrt{2gH} \times C_v$

$= 0.46\sqrt{2g} \times C_v \times \sqrt{H}$

$= 2.0375 \times 0.98 \times \sqrt{H}$

$= 2\sqrt{H}$

$$D_{run} = \frac{V_{back}}{N \times \frac{\pi}{60}}$$

Where, η_t = Shaft speed of the Turbine (rpm)

Hence,

$$D_{run} = \frac{2\sqrt{H}}{N_t \times \frac{\pi}{60}}$$

$$= \frac{2\sqrt{80}}{750 \times \frac{\pi}{60}}$$

$= 0.456$ m

1.5 Nozzle Diameter

Q = Jet speed x nozzle area

$$= \sqrt{2gH} \times \frac{\pi D_{noz}^{\ 2}}{4}$$

Rearranging,

$$D_{noz} = 0.54 \times \frac{Q^{0.5}}{H^{0.25}}$$

$$= 0.54 \times \frac{0.5}{80^{0.25}}$$

$= 12.77$ cm

Hence, only one nozzle is selected.

COST ESTIMATE

- Total Project Cost
- Summary of Unit Rates
- Basic Rates of Labour and Materials of Mustang District
- Rate Analysis

Rural Electrification through Small Hydropower Development

Ghami Khola Small Hydropower, Mustang

Total Project Cost

S.N.	Description	Amount (NRs)	Remarks
I	**Civil Work**		
	General Item	4,950,000.00	
	Intake Structure	17,081,049.08	
	Disilting Basin	8,086,998.72	
	Power Canal	17,398,434.48	
	Forebay	14,786,033.82	
	Penstock Pipe	16,014,746.38	
	Powerhouse and Tailrace	9,078,336.58	
	Total	**87,395,599.05**	
II	**Electro - mechanical equipment**		
	Total	**48,268,350.00**	
III	**Transmission and Distribution**		
	Total	**24,000,000.00**	
	Grand Total	159,663,949.05	
	Contingencies @ 10%	15,966,394.91	Total Cost in US $
	Total Project Cost	**175,630,343.96**	**2,251,671.08**

Rural Electrification through Small Hydropower Development
Ghami khola hydropower
Cost Estimate

A. General

I. No.	Description	Unit	Unit Rate NRs.	Quantity	Amount NRs.
a.	Insurance of works and contractor's eqipment.	Ls	800,000.00		800,000.00
b.	Third party insurance	Ls	50,000.00		50,000.00
c.	Insurance of Contractor's workmen and employees	Ls	200,000.00		200,000.00
d.	Provision and maintenace of camp, office, stores, Equipment yards and workshops.	Ls	500,000.00		500,000.00
e.	Protection and reinstatment of enviornment/ work area.	Ls	200,000.00		200,000.00
f.	Supply and maintain laboratory/ field testing apparatus/ equipment including all necessary accessories	Ls	400,000.00		400,000.00
g.	Provide and maintain survey equipment	Ls	200,000.00		200,000.00
h.	New construction of office building and guest house	Ls	2,000,000.00		2,000,000.00
i.	Supply of office building and guest house furniture all complete	Ls	600,000.00		600,000.00
	Total				**4,950,000.00**

B. Intake Structure

I.No	Description	Unit	Unit Rate NRs.	Quantity	Amount (NRs)
1	Site clearance including removal of roots, bushes and trees (up to 30cm) more than 15 nos. per 100 m2 area lead up to 25 m.	m^2	11.47	220.000	2,523.40
2a	Earth work excavation in hard cley, soft boulder mixed soil including haulage up to 30 m.	m^3	298.11	937.200	279,393.34
2b	Earth work excavation in boulder and gravel for structures in under water including haulage up to 30 m.	m^3	1,129.40	937.200	1,058,470.92
2c	Earth work excavation in medium hard rock without blasting including haulage up to 30 m.	m^3	928.74	234.300	217,604.43
3a	Backfilling with common materials lead up to 30 m.	m^3	212.12	652.484	138,405.08
3b	Backfilling with graded filter materials.	m^3	2,817.76	57.640	162,415.67
4a	Supply and place of dry stone soling.	m^3	2,019.16	93.375	188,538.65
4c	Supply and place of Rip-Rap protection works with stone 20-200 kgs.	m^3	4,088.93	207.500	848,453.62
5a	Supply and place lean concrete 1:3:6 (M10)	m^3	11,803.88	7.493	88,446.45
5c	Supply and place concrete 1:1.5:3 (M20)	m^3	17,444.08	306.938	5,354,251.36
5d	Supply and place concrete 1:1:2 (M25)	m^3	23,368.18	10.163	237,490.85
5e	Supply and place plum concrete (70% Boulder & 30% 1:1.5:3 Concrete)	m^3	14,090.19	435.153	6,131,386.42
6	Supply and Place Wooden Form Work for Concrete Work	m^2	609.94	329.940	201,242.14
7	Supply and placing reinforcement including cutting, bending, binding all complete.	MT	80,760.89	6.946	560,965.14
8a	Gabion Works of (2X1X1) box mesh size 100mmX120mm, mesh wire 10 SWG, selvedge wire 7 SWG and binding wire 12 SWG manufacturing, placing including boulder and binding.	m^3	2,671.82	283.500	757,461.61
17	Supply and fixing of Trash rack (Size 8000 mm * 1300 mm).	m^2	10,000.00	10.400	104,000.00
18	Supply and fixing of Lifting device for Sluice gate capacity 2.5 T.	LS	300,000.00		300,000.00
19	Supply and fixing of Sluice gate size 1300 mm * 1250 mm all complete.	no.	150,000.00	1.000	150,000.00
20	River diversion work including coffer dam.	LS	300,000.00		300,000.00
	Total				**17,081,049.08**

Rural Electrification through Small Hydropower Development
Ghami Khola hydropower
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C. Disilting Basin

I.No.	Description	Unit	Unit Rate NRs.	Quantity	Amount NRs.
1	Site clearance including removal of roots, bushes and trees (up to 30cm) more than 15 nos. per 100 m2 area lead up to 25 m.	m^2	11.47	466.000	5,345.02
2a	Earth work excavation in hard cley, soft boulder (up to 30cm) mixed soil including haulage up to 30 m.	m^3	298.11	1178.496	351,327.29
2c	Earth work excavation in medium hard rock without blasting including haulage up to 30 m.	m^3	928.74	147.312	136,814.95
2d	Earth work excavation in hard rock without blasting (without chisel) including haulage up to 30 m.	m^3	1,502.04	147.312	221,268.63
3a	Backfilling with common materials lead up to 30 m.	m^3	212.12	611.960	129,809.11
3b	Backfilling with graded filter materials.	m^3	2,817.76	57.640	162,415.67
4b	Supply and place of dry stone masonary including hammer dressing.	m3	2,440.48	121.160	295,688.25
5c	Supply and place concrete 1:1.5:3 (M20)	m^3	17,444.08	182.674	3,186,580.07
6	Supply and Place Wooden Form Work for Concrete Work	m^2	609.94	449.120	273,934.26
7	Supply and placing reinforcement including cutting, bending, binding all complete.	MT	80,760.89	0.800	64,608.71
9a	Supply and Place Coursed Stone Masonry in 1:4 Cement Sand Mortar including hammer dressing	m3	9,598.70	284.331	2,729,206.75
21	Supply and fixing of flushing steel gate size 700 mm * 600 mm.	no.	80,000.00	2.000	160,000.00
22	Supply and fixing of Stoplog.	no.	30,000.00	4.000	120,000.00
23	Supply and fixing of Motor for gate operation.	no.	150,000.00	1.000	150,000.00
24	Supply and fixing of right angular steel gate.	no.	100,000.00	1.000	100,000.00
	Total				**8,086,998.72**

D. Canal

I.No.	Description	Unit	Unit Rate NRs.	Quantity	Amount NRs.
1	Site clearance including removal of roots, bushes and trees (up to 30cm) more than 15 nos. per 100 m2 area lead up to 25 m.	m2	11.47	1662.750	19,071.74
2a	Earth work excavation in hard cley, soft boulder (up to 30cm) mixed soil including haulage up to 30 m.	m3	298.11	4637.647	1,382,551.95
2c	Earth work excavation in medium hard rock without blasting including haulage up to 30 m.	m3	928.74	662.521	615,311.58
2d	Earth work excavation in hard rock without blasting (without chisel) including haulage up to 30 m.	m3	1,502.04	1325.042	1,990,267.09
3a	Backfilling with common materials lead up to 30 m.	m3	212.12	943.020	200,033.65
4a	Supply and place of dry stone soling	m3	11,803.88	171.740	2,027,197.74
5a	Supply and place lean concrete 1:3:6 (M10)	m3	17,444.08	39.732	693,088.23
5c	Supply and place concrete 1:1.5:3 (M20)	m3	9,598.70	954.050	9,157,635.66
6	Supply and Place Wooden Form Work for Concrete Work	m2	609.94	133.564	81,465.43
7	Supply and placing reinforcement including cutting, bending, binding all complete.	MT	80,760.89	2.781	224,596.04
9a	Supply and Place Coursed Stone Masonry in 1:4 Cement Sand Mortar including hammer dressing	m3	2,019.16	498.830	1,007,215.37
	Total				**17,398,434.48**

E. Forebay

I.No.	Description	Unit	Unit Rate NRs.	Quantity	Amount NRs.
1	Site clearance including removal of roots, bushes and trees (up to 30cm) more than 15 nos. per 100 m2 area lead up to 25 m.	m^2	11.47	325.500	3,733.49
2a	Earth work excavation in hard cley, soft boulder (up to 30cm) mixed soil including haulage up to 30 m.	m^3	298.11	3168.622	944,613.62
2c	Earth work excavation in medium hard rock without blasting including haulage up to 30 m.	m^3	928.74	528.104	490,472.77
2d	Earth work excavation in hard rock without blasting (without chisel) including haulage up to 30 m.	m^3	1,502.04	1584.311	2,379,699.70
3a	Backfilling with common materials lead up to 30 m.	m^3	212.12	692.508	146,894.98
5c	Supply and place concrete 1:1.5:3 (M20)	m^3	17,444.08	100.840	1,759,061.14
6	Supply and Place Wooden Form Work for Concrete Work	m^2	609.94	45.004	27,449.54
7	Supply and placing reinforcement including cutting, bending, binding all complete.	MT	80,760.89	0.154	12,437.18
9a	Supply and Place Coursed Stone Masonry in 1:4 Cement Sand Mortar including hammer dressing	m3	9,598.70	862.840	8,282,138.62
10a	12.5 mm thick plaster in 1:4 Cement Sand Mortar.	m^2	289.72	240.000	69,532.80
17	Supply and fixing of Trash rack (Size 4000 mm * 4000 mm).	m^2	10,000.00	16.000	160,000.00
21	Supply and fixing of Flushing steel gate	no.	80,000.00	1.000	80,000.00
22	Supply and fixing of Stoplog.	no.	30,000.00	1.000	30,000.00
23	Supply and fixing of motar for gate operation	Ls.	150,000.00		150,000.00
25	Supply and fixing of Sluice gate size 1500 mm * 750 mm all complete.	Ls.	200,000.00		200,000.00
26	Supply and fixing of Air vent pipe.	no.	50,000.00	1.000	50,000.00
	Total				**14,786,033.82**

Rural Electrification through Small Hydropower Development
Ghami Khola hydropower
Cost Estimate

F. Penstock

I.No.	Description	Unit	Unit Rate NRs.	Quantity	Amount NRs.
	Saddle Support				
2a	Earth work excavation in hard cley, soft boulder (up to 30cm) mixed soil including haulage up to 30	m3	298.11	24.948	7,437.37
2d	Earth work excavation in hard rock without blasting (without chisel) including haulage up to 30 m.	m3	1,502.04	2.772	4,163.66
9a	Supply and Place Coursed Stone Masonry in 1:4 Cement Sand Mortar including hammer dressing	m3	9,598.70	19.500	187,174.57
	Anchor Blocks.				
2a	Earth work excavation in hard cley, soft boulder (up to 30cm) mixed soil including haulage up to 30	m3	298.11	47.250	14,085.93
2d	Earth work excavation in hard rock without blasting (without chisel) including haulage up to 30 m.	m3	1,502.04	5.250	7,885.71
5c	Supply and place concrete 1:1.5:3 (M20)	m3	17,444.08	101.500	1,770,574.23
6	Supply and Place Wooden Form Work for Concrete Work	m2	609.94	187.250	114,210.43
7	Supply and placing reinforcement including cutting, bending, binding all complete.	MT	80,760.89	7.105	573,806.12
	Penstock.				
1	Site clearance including removal of roots, bushes and trees (up to 30cm) more than 15 nos. per 100 m2 area lead up to 25 m.	m2	11.47	439.350	5,039.34
2a	Earth work excavation in hard cley, soft boulder (up to 30cm) mixed soil including haulage up to 30 m.	m3	298.11	593.112	176,815.56
2d	Earth work excavation in hard rock without blasting (without chisel) including haulage up to 30 m.	m3	1,502.04	65.902	98,987.49
3a	Backfilling with common materials lead up to 30 m.	m3	212.12	105.440	22,365.96
27	Supply and fixing of Penstock steel pipe 700 mm dia. 10 mm thich all complete.	mton	200,000.00	58.433	11,686,600.00
28	Supply and fixing of Penstock steel pipe 405 mm dia. 8 mm thich all complete (Branch pipe).	mton	200,000.00	2.728	545,600.00
29	Supply and fixing of Expansion joint complete set.	nos.	100,000.00	7.000	700,000.00
30	Supply and fixing of Bifurcation.	Ls	100,000.00		100,000.00
	Total				**16,014,746.38**

G. Powerhouse and Tailrance

I.No.	Description	Unit	Unit Rate NRs.	Quantity	Amount NRs.
1	Site clearance including removal of roots, bushes and trees (up to 30cm) more than 15 nos. per 100 m2 area lead up to 25 m.	m^2	11.47	316.250	3,627.39
2a	Earth work excavation in hard cley, soft boulder (up to 30cm) mixed soil including haulage up to 30 m.	m^3	298.11	923.360	275,267.43
2d	Earth work excavation in hard rock without blasting (without chisel) including haulage up to 30 m.	m^3	1,502.04	102.600	154,109.38
3a	Backfilling with common materials lead up to 30 m.	m^3	212.12	115.539	24,508.16
4a	Supply and place of dry stone soling	m^3	2,019.16	72.175	145,732.55
9a	Supply and Place Coursed Stone Masonry in 1:4 Cement Sand Mortar including hammer dressing	m^3	9,598.70	341.090	3,274,019.13
5c	Supply and place concrete 1:1.5:3 (M20)	m^3	17,444.08	164.322	2,866,446.29
6	Supply and Place Wooden Form Work for Concrete Work	m^2	609.94	426.745	260,286.95
7	Supply and placing reinforcement including cutting, bending, binding all complete.	mt	80,760.89	11.902	961,216.11
16	Supply and erection of Steel Truss for roofing work all complete	kg	160.00	2000.000	320,000.00
15	Supply and application of enamel paint two coats over one coat of primer all complete.	m^2	173.76	20.000	3,475.20
14	24 Guage C.G.I. Sheet rofing all complete.	m^2	586.21	258.750	151,681.84
12	38 mm*75 mm woden frame with 4 mm Glass with all fitting	m^2	3,317.08	40.000	132,683.20
13a	100 mm*75 mm woden frame work for door and window.	m^3	65,218.01	0.716	46,696.10
13b	38 mm panelled shutter	m^2	5,579.70	10.500	58,586.85
31	Supply and fixing of Monorail crane of 5 ton capacity.	no.	400,000.00	1.000	400,000.00
	Total				**9,078,336.58**

Rural Electrification through Small Hydropower Development
SUMMARY OF UNIT RATES

I.No.	Description	Unit	Unit Rate NRs.
2a	Earth work excavation in hard cley, soft boulder (up to 30cm) mixed soil including haulage up to 30 m.	m3	298.11
2b	Earth work excavation in boulder and gravel for structures in under water (up to 3m depth and 4m lift) including haulage up to 30 m.	m3	1,129.40
2c	Earth work excavation in medium hard rock without blasting including haulage up to 30 m.	m3	928.74
2d	Earth work excavation in hard rock with chisel including haulage up to 30 m.	m3	7,005.70
2e	Earth work excavation in hard rock without blasting (without chisel) including haulage up to 30 m.	m3	1,502.04
1	Site clearance including removal of roots, bushes and trees (up to 30cm) more than 15 nos. per 100 m2 area lead up to 25 m.	m2	11.47
9a	Supply and Place Coursed Stone Masonry in 1:4 Cement Sand Mortar including hammer dressing	m3	9,598.70
9b	Supply and Place Coursed Stone Masonry in 1:6 Cement Sand Mortar including hammer dressing	m3	8,167.45
8a	Gabion Works of (2X1X1) box mesh size 100mmX120mm, mesh wire 10 SWG, selvedge wire 7 SWG and binding wire 12 SWG manufacturing, placing including boulder and binding.	m3	2,671.82
5a	Supply and place lean concrete 1:3:6 (M10)	m3	11,803.88
8b	Gabion Works of (2X1X0.5) box mesh size 100mmX120mm, mesh wire 10 SWG, selvedge wire 7 SWG and binding wire 12 SWG manufacturing, placing including boulder and binding.	m3	3,071.74
5b	Supply and place concrete 1:2:4 (M15)	m3	15,221.30
5d	Supply and place concrete 1:1:2 (M25)	m3	23,368.18
6	Supply and Place Wooden Form Work for Concrete Work	m2	609.94
3b	Backfilling with graded filter materials.	m3	2,817.76
3a	Backfilling with common materials lead up to 30 m.	m3	212.12
7	Supply and placing reinforcement including cutting, bending, binding all complete.	MT	80,760.89
10b	12.5 mm thick plaster in 1:6 Cement Sand Mortar.	m2	264.91
10a	12.5 mm thick plaster in 1:4 Cement Sand Mortar.	m2	289.72
16	Supply and erection of Steel Truss for roofing work all complete.	kg.	160.00
4d	Supply and place of dry stone pitching.	m3	2,210.09
4c	Supply and place of Rip-Rap protection works with stone 20-200 kgs.	m3	4,088.93
4a	Supply and place of dry stone soling	m3	2,019.16
4b	Supply and place of dry stone masonary including hammer dressing.	m3	2,440.48
15	Supply and application of enamel paint two coats over one coat of primer all complete.	m2	173.76
14	24 Guage C.G.I. Sheet rofing all complete.	m2	586.21
12	38 mm*75 mm woden frame with 4 mm Glass with all fitting	m2	3,317.08
13a	100 mm*75 mm woden frame work for door and window.	m3	65,218.01
13b	38 mm panelled shutter	m2	5,579.70
5e	Supply and place plum concrete	m3	14,090.19
5c	Supply and place concrete 1:1.5:3 (M20)	m3	17,444.08

Note: The above mentioned rates are based on Mustang District Rates.

BASIC RATES OF LABOUR AND MATERIALS OF MUSTANG DISTRICT

S.N.	Description	Unit	Unit Rate (NRs.)
1	Un skilled Labour	Md.	220.00
2	Skilled Labour	Md.	315.00
3	Foreman/Headman	Md.	315.00
4	Welder	Md.	320.00
5	Welder Helper	Md.	220.00
6	Bar Bender	Md.	315.00
7	Porter	Md.	220.00
8	Plumber	Md.	315.00
9	Petrol	Ltr.	80.00
10	Kerosene	Ltr.	50.00
11	Diesel	Ltr.	60.00
12	Mobile	Ltr.	300.00
13	Enamel Paint	Ltr.	350.00
14	Primer Paint	Ltr.	300.00
15	Nails	Kg.	55.00
16	Timber	m^3	34,300.00
17	Cement	MT	22,400.00
18	Mild Steel Rebar	MT	54,000.00
19	Binding Wire	Kg.	53.00
20	G. I. Wire (Avg.for all sizes)	Kg.	50.00
21	Boulder stone	m^3	1,046.89
22	Sand	m^3	2,788.99
23	Aggregate	m^3	2,091.52

Note :-

The rates are for Ghami Khola Site of Mustang District for fiscal year 2059/60.

Rural Electrification through Small Hydropower Development
RATE ANALYSIS (Ghami khola hydropower, Mustang)

NORMS Ref. HMG NORMS 2 (2), 22(1) Ka ii
BOQ Item No. 2a
Item Description Earth work excavation in hard cley, soft boulder (up to 30cm) mixed soil including haulage up to 30 m.
Unit m^3

Labour (A)					Material (B)					Equipment (C)				
Catagory	Unit	Qty.	Rate (NRs.)	Amount (NRs.)	Type	Unit	Qty.	Rate (NRs.)	Amount (NRs.)	Type	Unit	Qty.	Rate (NRs.)	Amount (NRs.)
Labour Unskilled	m.d.	1.04	220.00	228.80						Tools and Plant @ 3% of Labour Cost				6.86
Total of Labour (A)				228.80	Total of Material (B)				-	Total of Equipment (C)				6.86

Direct Cost (A+B+C) =	235.66
Constractor's Overhead (15%) =	35.35
Sub Total =	271.01
VAT (10%) =	27.10
Total =	298.11
Unit Rate in NRs. =	**298.11/m3**

NORMS Ref. HMG NORMS 2 (24) Ga, 22(1) Ka ii
BOQ Item No. 2b
Item Description Earth work excavation in boulder and gravel for structures in under water (up to 3m depth and 4m lift) including haulage up to 30 m.
Unit m^3

Labour (A)					Material (B)					Equipment (C)				
Catagory	Unit	Qty.	Rate (NRs.)	Amount (NRs.)	Type	Unit	Qty.	Rate (NRs.)	Amount (NRs.)	Type	Unit	Qty.	Rate (NRs.)	Amount (NRs.)
Labour Unskilled	m.d.	3.94	220.00	866.80						Tools and Plant @ 3% of Labour Cost				26.00
Total of Labour (A)				866.80	Total of Material (B)				-	Total of Equipment (C)				26.00

Direct Cost (A+B+C) =	892.80
Constractor's Overhead (15%) =	133.92
Sub Total =	1,026.72
VAT (10%) =	102.67
Total =	1,129.40
Unit Rate in NRs. =	**1,129.40/m3**

NORMS Ref. HMG NORMS 2 (4), 22(1) Ka ii
BOQ Item No. 2c
Item Description Earth work excavation in medium hard rock without blasting including haulage up to 30 m.
Unit m^3

Labour (A)					Material (B)					Equipment (C)				
Catagory	Unit	Qty.	Rate (NRs.)	Amount (NRs.)	Type	Unit	Qty.	Rate (NRs.)	Amount (NRs.)	Type	Unit	Qty.	Rate (NRs.)	Amount (NRs.)
Labour Unskilled	m.d.	3.24	220.00	712.80						Tools and Plant @ 3% of Labour Cost				21.38
Total of Labour (A)				712.80	Total of Material (B)				-	Total of Equipment (C)				21.38

Direct Cost (A+B+C) =	734.18
Constractor's Overhead (15%) =	110.13
Sub Total =	844.31
VAT (10%) =	84.43
Total =	928.74
Unit Rate in NRs. =	**928.74/m3**

NORMS Ref. HMG NORMS 2 (6) Kha, 22(1) Ka ii
BOQ Item No. 2d
Item Description Earth work excavation in hard rock with chisel including haulage up to 30 m.
Unit m^3

Labour (A)					Material (B)					Equipment (C)				
Catagory	Unit	Qty.	Rate (NRs.)	Amount (NRs.)	Type	Unit	Qty.	Rate (NRs.)	Amount (NRs.)	Type	Unit	Qty.	Rate (NRs.)	Amount (NRs.)
Labour Unskilled	m.d.	24.44	220.00	5,376.80						Tools and Plant @ 3% of Labour Cost				161.30
Total of Labour (A)				5,376.80	Total of Material (B)				-	Total of Equipment (C)				161.30

Direct Cost (A+B+C) =	5,538.10
Constractor's Overhead (15%) =	830.72
Sub Total =	6,368.82
VAT (10%) =	636.88
Total =	7,005.70
Unit Rate in NRs. =	**7,005.70/m3**

NORMS Ref. HMG NORMS 2 (6) Ka , 22(1) Ka ii
BOQ Item No. 2e
Item Description Earth work excavation in hard rock without blasting (without chisel) including haulage up to 30 m.
Unit m^3

Labour (A)					Material (B)					Equipment (C)				
Catagory	Unit	Qty.	Rate (NRs.)	Amount (NRs.)	Type	Unit	Qty.	Rate (NRs.)	Amount (NRs.)	Type	Unit	Qty.	Rate (NRs.)	Amount (NRs.)
Labour Unskilled	m.d.	5.24	220.00	1,152.80						Tools and Plant @ 3% of Labour Cost				34.58
Total of Labour (A)				1,152.80	Total of Material (B)				-	Total of Equipment (C)				34.58

Direct Cost (A+B+C) =	1,187.38
Constractor's Overhead (15%) =	178.11
Sub Total =	1,365.49
VAT (10%) =	136.55
Total =	1,502.04
Unit Rate in NRs. =	**1,502.04/m3**

NORMS Ref. HMG NORMS 1 (3) , 22(1) Ka ii
BOQ Item No. 1
Item Description Site clearance including removal of roots, bushes and trees (up to 30cm) more than 15 nos. per 100 m^2 area lead up to 25 m.
Unit m^2

Labour (A)					Material (B)					Equipment (C)				
Catagory	Unit	Qty.	Rate (NRs.)	Amount (NRs.)	Type	Unit	Qty.	Rate (NRs.)	Amount (NRs.)	Type	Unit	Qty.	Rate (NRs.)	Amount (NRs.)
Labour Unskilled	m.d.	0.04	220.00	8.80						Tools and Plant @ 3% of Labour Cost				0.26
Total of Labour (A)				8.80	Total of Material (B)				-	Total of Equipment (C)				0.26

Direct Cost (A+B+C) =	9.06
Constractor's Overhead (15%) =	1.36
Sub Total =	10.42
VAT (10%) =	1.04
Total =	11.47
Unit Rate in NRs. =	**11.47 /m^2**

NORMS Ref. HMG NORMS 6 (1) Ka 2.
BOQ Item No. 9a
Item Description Supply and Place Coursed Stone Masonry in 1:4 Cement Sand Mortar including hammer dressing
Unit m^3

Labour (A)					Material (B)					Equipment (C)				
Catagory	Unit	Qty.	Rate (NRs.)	Amount (NRs.)	Type	Unit	Qty.	Rate (NRs.)	Amount (NRs.)	Type	Unit	Qty.	Rate (NRs.)	Amount (NRs.)
Skilled	m.d.	1.5	315.00	472.50	Boulder	m^3	1.1	1,046.89	1,151.58					
Unskilled	m.d.	5	220.00	1,100.00	Cement	MT	0.159	22,400.00	3,561.60	Tools and Plant				
					Sand	m^3	0.45	2,788.99	1,255.05	@ 3% of Labour Cost				47.18
Total of Labour (A)				1,572.50	Total of Material (B)				5,968.23	Total of Equipment (C)				47.18

Direct Cost (A+B+C) =	7,587.90
Constractor's Overhead (15%) =	1,138.19
Sub Total =	8,726.09
VAT (10%) =	872.61
Total =	9,598.70
Unit Rate in NRs. =	**9,598.70/m3**

NORMS Ref. HMG NORMS 6 (1) Ka 3.
BOQ Item No. 9b
Item Description Supply and Place Coursed Stone Masonry in 1:6 Cement Sand Mortar including hammer dressing
Unit m^3

Labour (A)					Material (B)					Equipment (C)				
Catagory	Unit	Qty.	Rate (NRs.)	Amount (NRs.)	Type	Unit	Qty.	Rate (NRs.)	Amount (NRs.)	Type	Unit	Qty.	Rate (NRs.)	Amount (NRs.)
Skilled	m.d.	1.5	315.00	472.50	Boulder	m^3	1.1	1,046.89	1,151.58					
Unskilled	m.d.	5	220.00	1,100.00	Cement	MT	0.106	22,400.00	2,374.40	Tools and Plant				
					Sand	m^3	0.47	2,788.99	1,310.83	@ 3% of Labour Cost				47.18
Total of Labour (A)				1,572.50	Total of Material (B)				4,836.81	Total of Equipment (C)				47.18

Direct Cost (A+B+C) =	6,456.48
Constractor's Overhead (15%) =	968.47
Sub Total =	7,424.95
VAT (10%) =	742.50
Total =	8,167.45
Unit Rate in NRs. =	**8,167.45/m3**

NORMS Ref. HMG NORMS 16(5) Ka, 16 (7) Ka & 16 (11)
BOQ Item No. 8a
Item Description Gabion Works (2X1X1) mesh size 100mmX120mm, mesh wire 10 SWG, selvedge wire 7 SWG and binding wire 12 SWG manufacturing, placing including boulder and binding.
Unit per box.

Labour (A)					Material (B)					Equipment (C)				
Catagory	Unit	Qty.	Rate (NRs.)	Amount (NRs.)	Type	Unit	Qty.	Rate (NRs.)	Amount (NRs.)	Type	Unit	Qty.	Rate (NRs.)	Amount (NRs.)
Skilled	m.d.	0.45	315.00	141.75	10 SWG G.I. Wire	Kg.	24.15	50.00	1,207.50	Tools and Plant				
Unskilled	m.d.	0.20	220.00	44.00	7 SWG G.I. Wire	Kg.	3.15	50.00	157.50	@ 3% of Labour Cost				14.81
Unskilled	m.d.	0.40	220.00	88.00	12 SWG G.I. Wire	Kg.	0.95	50.00	47.50					
Unskilled	m.d.	1.00	220.00	220.00	Stone boulder	m^3	2.20	1,046.89	2,303.16					
Total of Labour (A)				493.75	Total of Material (B)				3,715.66	Total of Equipment (C)				14.81

Direct Cost (A+B+C) =	4,224.22
Constractor's Overhead (15%) =	633.63
Sub Total =	4,857.86
VAT (10%) =	485.79
Total =	5,343.64 per box (2X1X1)
Unit Rate in NRs. =	**2,671.82/m3**

NORMS Ref. HMG NORMS 16(5) Ga, 16 (7) Ga , 16 (11)
BOQ Item No. 8b
Item Description Gabion Works(2X1X0.5)mesh size 100mmX120mm, mesh wire 10 SWG, selvedge wire 7 SWG and binding wire 12 SWG manufacturing, placing including boulder and binding.
Unit per box

Labour (A)					Material (B)					Equipment (C)				
Catagory	Unit	Qty.	Rate (NRs.)	Amount (NRs.)	Type	Unit	Qty.	Rate (NRs.)	Amount (NRs.)	Type	Unit	Qty.	Rate (NRs.)	Amount (NRs.)
Skilled	m.d.	0.32	315.00	100.80	10 SWG G.I. Wire	Kg.	16.45	50.00	822.50	Tools and Plant				
Unskilled	m.d.	0.14	220.00	30.80	7 SWG G.I. Wire	Kg.	2.50	50.00	125.00	@ 3% of Labour Cost				8.57
Unskilled	m.d.	0.20	220.00	44.00	12 SWG G.I. Wire	Kg.	0.70	50.00	35.00					
Unskilled	m.d.	0.50	220.00	110.00	Stone boulder	m^3	1.10	1,046.89	1,151.58					
Total of Labour (A)				285.60	Total of Material (B)				2,134.08	Total of Equipment (C)				8.57

Direct Cost (A+B+C) =	2,428.25
Constractor's Overhead (15%) =	364.24
Sub Total =	2,792.49 per box (2X1X0.5)
VAT (10%) =	279.25
Total =	3,071.74
Unit Rate in NRs. =	**3,071.74/m3**

NORMS Ref. HMG NORMS 7 (4) Ka
BOQ Item No. 5b
Item Description Supply and place concrete 1:2:4 (M15)
Unit m^3

Labour (A)					Material (B)					Equipment (C)				
Catagory	Unit	Qty.	Rate (NRs.)	Amount (NRs.)	Type	Unit	Qty.	Rate (NRs.)	Amount (NRs.)	Type	Unit	Qty.	Rate (NRs.)	Amount (NRs.)
Skilled	m.d.	0.8	315.00	252.00	Cement	MT	0.32	22,400.00	7,168.00	Tools and Plant				
Unskilled	m.d.	7.00	220.00	1,540.00	Aggregate	m^3	0.85	2,091.52	1,777.79	@ 3% of Labour Cost				53.76
					Sand	m^3	0.445	2,788.99	1,241.10					
									-					
									-					
Total of Labour (A)				1,792.00	Total of Material (B)				10,186.89	Total of Equipment (C)				53.76

Direct Cost (A+B+C) =	12,032.65
Constractor's Overhead (15%) =	1,804.90
Sub Total =	13,837.55
VAT (10%) =	1,383.75
Total =	15,221.30
Unit Rate in NRs. =	**15,221.30/m3**

NORMS Ref. HMG NORMS 7 (4) Ga
BOQ Item No. 5d
Item Description Supply and place concrete 1:1:2 (M25)
Unit m^3

Labour (A)					Material (B)					Equipment (C)				
Catagory	Unit	Qty.	Rate (NRs.)	Amount (NRs.)	Type	Unit	Qty.	Rate (NRs.)	Amount (NRs.)	Type	Unit	Qty.	Rate (NRs.)	Amount (NRs.)
Skilled	m.d.	0.8	315.00	252.00	Cement	MT	0.61	22,400.00	13,664.00	Tools and Plant				
Unskilled	m.d.	7.0	220.00	1,540.00	Aggregate	m^3	0.85	2,091.52	1,777.79	@ 3% of Labour Cost				53.76
					Sand	m^3	0.425	2,788.99	1,185.32					
Total of Labour (A)				1,792.00	Total of Material (B)				16,627.11	Total of Equipment (C)				53.76

Direct Cost (A+B+C) =	18,472.87
Constractor's Overhead (15%) =	2,770.93
Sub Total =	21,243.80
VAT (10%) =	2,124.38
Total =	23,368.18
Unit Rate in NRs. =	**23,368.18/m3**

NORMS Ref. HMG NORMS 7 (4) Kha
BOQ Item No. 5c
Item Description Supply and place concrete 1:1.5:3 (M20)
Unit m^3

Labour (A)					Material (B)					Equipment (C)				
Catagory	Unit	Qty.	Rate (NRs.)	Amount (NRs.)	Type	Unit	Qty.	Rate (NRs.)	Amount (NRs.)	Type	Unit	Qty.	Rate (NRs.)	Amount (NRs.)
Skilled	m.d.	0.8	315.00	252.00	Cement	MT	0.4	22,400.00	8,960.00	Tools and Plant				
Unskilled	m.d.	7.0	220.00	1,540.00	Aggregate	m^3	0.86	2,091.52	1,798.71	@ 3% of Labour Cost				53.76
					Sand	m^3	0.425	2,788.99	1,185.32					
Total of Labour (A)				1,792.00	Total of Material (B)				11,944.03	Total of Equipment (C)				53.76

Direct Cost (A+B+C) =	13,789.79
Constractor's Overhead (15%) =	2,068.47
Sub Total =	15,858.26
VAT (10%) =	1,585.83
Total =	17,444.08
Unit Rate in NRs. =	**17,444.08/m3**

NORMS Ref. HMG NORMS 7 (2) Ga
BOQ Item No. 5a
Item Description Supply and place lean concrete 1:3:6 (M10)
Unit m^3

Labour (A)					Material (B)					Equipment (C)				
Catagory	Unit	Qty.	Rate (NRs.)	Amount (NRs.)	Type	Unit	Qty.	Rate (NRs.)	Amount (NRs.)	Type	Unit	Qty.	Rate (NRs.)	Amount (NRs.)
Skilled	m.d.	1.0	315.00	315.00	Cement	MT	0.22	22,400.00	4,928.00	Tools and Plant				
Unskilled	m.d.	4.0	220.00	880.00	Aggregate	m^3	0.89	2,091.52	1,861.45	@ 3% of Labour Cost				35.85
					Sand	m^3	0.47	2,788.99	1,310.83					
Total of Labour (A)				1,195.00	Total of Material (B)				8,100.28	Total of Equipment (C)				35.85

Direct Cost (A+B+C) =	9,331.13
Constractor's Overhead (15%) =	1,399.67
Sub Total =	10,730.80
VAT (10%) =	1,073.08
Total =	11,803.88
Unit Rate in NRs. =	**11,803.88/m3**

NORMS Ref. HMG NORMS 8 (2) (Ka)
BOQ Item No. 6
Item Description Supply and Place Wooden Form Work for Concrete Work
Unit 10 m^2

Labour (A)					Material (B)					Equipment (C)				
Catagory	Unit	Qty.	Rate (NRs.)	Amount (NRs.)	Type	Unit	Qty.	Rate (NRs.)	Amount (NRs.)	Type	Unit	Qty.	Rate (NRs.)	Amount (NRs.)
Skilled	m.d.	1.72	315.00	541.80	Timber	m^3	0.526	34,300.00	18,041.80					
Unskilled	m.d.	2.57	220.00	565.40	Nails (1" to 4")	Kg.	2.5	55.00	137.50					
Total of Labour (A)				1,107.20	Total of Material (B)				18,179.30	Total of Equipment (C)				

Direct Cost (A+B+C) =	19,286.50
Constractor's Overhead (15%) =	2,892.98
Sub Total =	22,179.48
VAT (10%) =	2,217.95
Total =	24,397.42 for 10sq. m. and 4 times use
Unit Rate in NRs. =	**609.94** per sq.m.

NORMS Ref. HMG NORMS 7(1)Kha
BOQ Item No. 5e
Item Description Supply and place plum concrete
Unit m^3

Labour (A)					Material (B)					Equipment (C)				
Catagory	Unit	Qty.	Rate (NRs.)	Amount (NRs.)	Type	Unit	Qty.	Rate (NRs.)	Amount (NRs.)	Type	Unit	Qty.	Rate (NRs.)	Amount (NRs.)
Skilled	m.d.	0.3	315.00	94.50	Cement	MT	0.32	22,400.00	7,168.00	Tools and Plant				
Unskilled	m.d.	4.0	220.00	880.00	Aggregate	m^3	0.76	2,091.52	1,589.55	@ 3% of Labour Cost				29.24
					Sand	m^3	0.445	2,788.99	1,241.10					
					Boulder	m^3	0.13	1,046.89	136.10					
Total of Labour (A)				974.50	Total of Material (B)				10,134.75	Total of Equipment (C)				29.24

Direct Cost (A+B+C) =	11,138.49
Constractor's Overhead (15%) =	1,670.77
Sub Total =	12,809.26
VAT (10%) =	1,280.93
Total =	14,090.19
Unit Rate in NRs. =	**14,090.19/m3**

NORMS Ref. HMG NORMS 2(39) Gha
BOQ Item No. 3b
Item Description Backfilling with graded filter materials.
Unit m^3

Labour (A)					Material (B)					Equipment (C)				
Catagory	Unit	Qty.	Rate (NRs.)	Amount (NRs.)	Type	Unit	Qty.	Rate (NRs.)	Amount (NRs.)	Type	Unit	Qty.	Rate (NRs.)	Amount (NRs.)
Unskilled	m.d.	####	220.00	132.00	Gravel	m3	1.0	2,091.52	2,091.52	@ 3% of Labour Cost				3.96
Total of Labour (A)				132.00	Total of Material (B)				2,091.52	Total of Equipment (C)				3.96

Direct Cost (A+B+C) =	2,227.48
Constractor's Overhead (15%) =	334.12
Sub Total =	2,561.60
VAT (10%) =	256.16
Total =	2,817.76
Unit Rate in NRs. =	**2,817.76/m3**

NORMS Ref. HMG NORMS 2(25) Ka , 22(1) Ka ii
BOQ Item No. 3a
Item Description Backfilling with common materials lead up to 30 m.
Unit m^3

Labour (A)					Material (B)					Equipment (C)				
Catagory	Unit	Qty.	Rate (NRs.)	Amount (NRs.)	Type	Unit	Qty.	Rate (NRs.)	Amount (NRs.)	Type	Unit	Qty.	Rate (NRs.)	Amount (NRs.)
Unskilled	m.d.	####	220.00	162.80						@ 3% of Labour Cost				4.88
Total of Labour (A)				162.80	Total of Material (B)				-	Total of Equipment (C)				4.88

Direct Cost (A+B+C) =	167.68
Constractor's Overhead (15%) =	25.15
Sub Total =	192.84
VAT (10%) =	19.28
Total =	212.12
Unit Rate in NRs. =	**212.12/m3**

NORMS Ref. HMG NORMS 7(5)
BOQ Item No. 7
Item Description Supply and placing reinforcement including cutting, bending, binding all complete.
Unit MT

Labour (A)					Material (B)					Equipment (C)				
Catagory	Unit	Qty.	Rate (NRs.)	Amount (NRs.)	Type	Unit	Qty.	Rate (NRs.)	Amount (NRs.)	Type	Unit	Qty.	Rate (NRs.)	Amount (NRs.)
Skilled	m.d.	12	315.00	3,780.00	M.S.Bar	MT	1.050	54,000.00	56,700.00	@ 3% of Labour Cost				192.60
Unskilled	m.d.	12	220.00	2,640.00	Binding Wire	Kg.	10.000	53.00	530.00					
Total of Labour (A)				6,420.00	Total of Material (B)				57,230.00	Total of Equipment (C)				192.60

Direct Cost (A+B+C) =	63,842.60
Constractor's Overhead (15%) =	9,576.39
Sub Total =	73,418.99
VAT (10%) =	7,341.90
Total =	80,760.89
Unit Rate in NRs. =	**80,760.89 /MT**

NORMS Ref. HMG NORMS 12(1) Gha
BOQ Item No. 10b
Item Description 12.5 mm thick plaster in 1:6 Cement Sand Mortar.
Unit m^2

Labour (A)					Material (B)					Equipment (C)				
Catagory	Unit	Qty.	Rate (NRs.)	Amount (NRs.)	Type	Unit	Qty.	Rate (NRs.)	Amount (NRs.)	Type	Unit	Qty.	Rate (NRs.)	Amount (NRs.)
Skilled	m.d.	0.12	315.00	37.80	Cement	MT	0.004	22,400.00	89.60	@ 3% of Labour Cost				2.19
Unskilled	m.d.	0.16	220.00	35.20	Sand	m^3	0.016	2,788.99	44.62					
Total of Labour (A)				73.00	Total of Material (B)				134.22	Total of Equipment (C)				2.19

Direct Cost (A+B+C) =	209.41
Constractor's Overhead (15%) =	31.41
Sub Total =	240.83
VAT (10%) =	24.08
Total =	264.91
Unit Rate in NRs. =	**264.91/m3**

NORMS Ref. HMG NORMS 12(1) Ga
BOQ Item No. 10a
Item Description 12.5 mm thick plaster in 1:4 Cement Sand Mortar.
Unit m^2

Labour (A)					Material (B)					Equipment (C)				
Catagory	Unit	Qty.	Rate (NRs.)	Amount (NRs.)	Type	Unit	Qty.	Rate (NRs.)	Amount (NRs.)	Type	Unit	Qty.	Rate (NRs.)	Amount (NRs.)
Skilled	m.d.	0.12	315.00	37.80	Cement	MT	0.005	22,400.00	112.00	Tools and Plants @ 3% of Labour Cost				2.19
Unskilled	m.d.	0.16	220.00	35.20	Sand	m^3	0.015	2,788.99	41.83					
Total of Labour (A)				73.00	Total of Material (B)				153.83	Total of Equipment (C)				2.19

Direct Cost (A+B+C) =	229.02
Constractor's Overhead (15%) =	34.35
Sub Total =	263.38
VAT (10%) =	26.34
Total =	289.72
Unit Rate in NRs. =	**289.72/m3**

NORMS Ref. HMG NORMS 10(18)
BOQ Item No.
Item Description Wooden Truss work all complete
Unit m^3

Labour (A)					Material (B)					Equipment (C)				
Catagory	Unit	Qty.	Rate (NRs.)	Amount (NRs.)	Type	Unit	Qty.	Rate (NRs.)	Amount (NRs.)	Type	Unit	Qty.	Rate (NRs.)	Amount (NRs.)
Skilled	m.d.	17.65	315.00	5,559.75	Timber	m^3	1.05	34,300.00	36,015.00	Tools and Plants @ 3% of Labour Cost				338.39
Unskilled	m.d.	#####	220.00	5,720.00	Nut Bolt	L.S.			1,000.00					
					Iron Plate	L.S.			1,000.00					
					Nails	L.S.			1,000.00					
Total of Labour (A)				11,279.75	Total of Material (B)				39,015.00	Total of Equipment (C)				338.39

Direct Cost (A+B+C) =	50,633.14
Constractor's Overhead (15%) =	7,594.97
Sub Total =	58,228.11
VAT (10%) =	5,822.81
Total =	64,050.93
Unit Rate in NRs. =	**64,050.93/m3**

NORMS Ref. DoR approved CHRP norms 24311.1
BOQ Item No. 4d
Item Description Supply and place of dry stone pitching.
Unit m^3

Labour (A)					Material (B)					Equipment (C)				
Catagory	Unit	Qty.	Rate (NRs.)	Amount (NRs.)	Type	Unit	Qty.	Rate (NRs.)	Amount (NRs.)	Type	Unit	Qty.	Rate (NRs.)	Amount (NRs.)
Skilled	m.d.	0.60	315.00	189.00	Stone	m^3	1.05	1,046.89	1,099.24	Tools and Plant				18.87
Unskilled	m.d.	2.00	220.00	440.00						@ 3% of Labour Cost				
Total of Labour (A)				629.00	Total of Material (B)				1,099.24	Total of Equipment (C)				18.87

Direct Cost (A+B+C) =	1,747.11
Constractor's Overhead (15%) =	262.07
Sub Total =	2,009.17
VAT (10%) =	200.92
Total =	2,210.09
Unit Rate in NRs. =	**2,210.09/m3**

NORMS Ref. DoR approved CHRP norms 24301.10
BOQ Item No. 4c
Item Description Supply and place of Rip-Rap protection works with stone 20-200 kgs.
Unit m^3

Labour (A)					Material (B)					Equipment (C)				
Catagory	Unit	Qty.	Rate (NRs.)	Amount (NRs.)	Type	Unit	Qty.	Rate (NRs.)	Amount (NRs.)	Type	Unit	Qty.	Rate (NRs.)	Amount (NRs.)
Skilled	m.d.	0.70	315.00	220.50	Stone	m^3	1.10	1,046.89	1,151.58	Tools and Plant				29.12
Unskilled	m.d.	2.10	220.00	462.00	Petrol	lit.	0.01	80.00	0.80	@ 3% of Labour Cost				
Operator	m.d.	0.90	320.00	288.00	Hydraulic Oil	lit.	0.002	181.00	0.36	Hydraulic Jack	hr.	0.45	1,200.00	540.00
										Power Winch	hr.	0.45	1,200.00	540.00
Total of Labour (A)				970.50	Total of Material (B)				1,152.74	Total of Equipment (C)				1,109.12

Direct Cost (A+B+C) =	3,232.36
Constractor's Overhead (15%) =	484.85
Sub Total =	3,717.21
VAT (10%) =	371.72
Total =	4,088.93
Unit Rate in NRs. =	**4,088.93/m3**

NORMS Ref. HMG NORMS 6(5)
BOQ Item No. 4a
Item Description Supply and place of dry stone soling
Unit m^3

Labour (A)					Material (B)					Equipment (C)				
Catagory	Unit	Qty.	Rate (NRs.)	Amount (NRs.)	Type	Unit	Qty.	Rate (NRs.)	Amount (NRs.)	Type	Unit	Qty.	Rate (NRs.)	Amount (NRs.)
Unskilled	m.d.	1.50	220.00	330.00	Stone	m^3	1.20	1,046.89	1,256.27	Tools and Plant @ 3% of Labour Cost				9.90
Total of Labour (A)				330.00	Total of Material (B)				1,256.27	Total of Equipment (C)				9.90

Direct Cost (A+B+C) =	1,596.17
Constractor's Overhead (15%) =	239.43
Sub Total =	1,835.60
VAT (10%) =	183.56
Total =	2,019.16
Unit Rate in NRs. =	**2,019.16/m3**

NORMS Ref. HMG NORMS 6(2) 1
BOQ Item No. 4b
Item Description Supply and place of dry stone masonary including hammer dressing.
Unit m^3

Labour (A)					Material (B)					Equipment (C)				
Catagory	Unit	Qty.	Rate (NRs.)	Amount (NRs.)	Type	Unit	Qty.	Rate (NRs.)	Amount (NRs.)	Type	Unit	Qty.	Rate (NRs.)	Amount (NRs.)
Skilled	m.d.	1.00	315.00	315.00	Stone	m^3	1.10	1,046.89	1,151.58	Tools and Plant @ 3% of Labour Cost				22.65
Unskilled	m.d.	2.00	220.00	440.00										
Total of Labour (A)				755.00	Total of Material (B)				1,151.58	Total of Equipment (C)				22.65

Direct Cost (A+B+C) =	1,929.23
Constractor's Overhead (15%) =	289.38
Sub Total =	2,218.62
VAT (10%) =	221.86
Total =	2,440.48
Unit Rate in NRs. =	**2,440.48/m3**

NORMS Ref. HMG NORMS 13(5) Ka, Kha, Ga
BOQ Item No. 15
Item Description Supply and application of enamel paint two coats over one coat of primer all complete.
Unit m^2

Labour (A)					Material (B)					Equipment (C)				
Catagory	Unit	Qty.	Rate (NRs.)	Amount (NRs.)	Type	Unit	Qty.	Rate (NRs.)	Amount (NRs.)	Type	Unit	Qty.	Rate (NRs.)	Amount (NRs.)
Skilled	m.d.	0.12	315.00	37.80	Primer	lit.	0.081	300.00	24.30	Tools and Plant @ 3% of Labour Cost				1.66
Unskilled	m.d.	0.08	220.00	17.60	Enamel Paint	lit.	0.16	350.00	56.00					
Total of Labour (A)				55.40	Total of Material (B)				80.30	Total of Equipment (C)				1.66

Direct Cost (A+B+C) =	137.36
Constractor's Overhead (15%) =	20.60
Sub Total =	157.97
VAT (10%) =	15.80
Total =	173.76
Unit Rate in NRs. =	**173.76/m3**

NORMS Ref. HMG NORMS 9(1)
BOQ Item No. 14
Item Description 24 Guage C.G.I. Sheet rofing all complete.
Unit m^2

Labour (A)					Material (B)					Equipment (C)				
Catagory	Unit	Qty.	Rate (NRs.)	Amount (NRs.)	Type	Unit	Qty.	Rate (NRs.)	Amount (NRs.)	Type	Unit	Qty.	Rate (NRs.)	Amount (NRs.)
Skilled	m.d.	0.11	315.00	34.65	24 Guage C.G.I.Sh	m^2	1.20	280.12	336.14	Tools and Plant @ 3% of Labour Cost				1.86
Unskilled	m.d.	0.125	220.00	27.50	8 mm size Nut Bolt	no.	3.00	11.00	33.00					
					J Hook	no.	2.50	11.00	27.50					
					Bitumin Washer	no.	5.50	0.50	2.75					
Total of Labour (A)				62.15	Total of Material (B)				399.39	Total of Equipment (C)				1.86

Direct Cost (A+B+C) =	463.41
Constractor's Overhead (15%) =	69.51
Sub Total =	532.92
VAT (10%) =	53.29
Total =	586.21
Unit Rate in NRs. =	**586.21/m3**

NORMS Ref. HMG NORMS 10(4)
BOQ Item No. 12
Item Description 38 mm*75 mm woden frame with 4 mm Glass with all fitting
Unit m^2

Labour (A)					Material (B)					Equipment (C)				
Catagory	Unit	Qty.	Rate (NRs.)	Amount (NRs.)	Type	Unit	Qty.	Rate (NRs.)	Amount (NRs.)	Type	Unit	Qty.	Rate (NRs.)	Amount (NRs.)
Skilled	m.d.	4.04	315.00	1,272.60	Timber	m^3	0.02	34,300.00	754.60	Tools and Plant				40.84
Unskilled	m.d.	0.403	220.00	88.66	Glass	m^2	0.487	500.00	243.50	@ 3% of Labour Cost				
					Hings	no.	4.00	25.00	100.00					
					100 mm Cheskini	no.	2.00	45.00	90.00					
					HANDLE	no.	1.00	32.00	32.00					
Total of Labour (A)				1,361.26	Total of Material (B)				1,220.10	Total of Equipment (C)				40.84

Direct Cost (A+B+C) =	2,622.20
Constractor's Overhead (15%) =	393.33
Sub Total =	3,015.53
VAT (10%) =	301.55
Total =	3,317.08
Unit Rate in NRs. =	**3,317.08/m3**

NORMS Ref. HMG NORMS 10(1)
BOQ Item No. 13a
Item Description 100 mm*75 mm woden frame work for door and window.
Unit m^3

Labour (A)					Material (B)					Equipment (C)				
Catagory	Unit	Qty.	Rate (NRs.)	Amount (NRs.)	Type	Unit	Qty.	Rate (NRs.)	Amount (NRs.)	Type	Unit	Qty.	Rate (NRs.)	Amount (NRs.)
Skilled	m.d.	34.00	315.00	10,710.00	Timber	m^3	1.10	34,300.00	37,730.00	Tools and Plant				343.74
Unskilled	m.d.	3.40	220.00	748.00	Holefast 250 mm	no.	92.0	20.00	1,840.00	@ 3% of Labour Cost				
					Screw Nail	no.	184.00	1.00	184.00					
Total of Labour (A)				11,458.00	Total of Material (B)				39,754.00	Total of Equipment (C)				343.74

Direct Cost (A+B+C) =	51,555.74
Constractor's Overhead (15%) =	7,733.36
Sub Total =	59,289.10
VAT (10%) =	5,928.91
Total =	65,218.01
Unit Rate in NRs. =	**65,218.01/m3**

NORMS Ref. HMG NORMS 10(2)
BOQ Item No. 13b
Item Description 38 mm panelled shutter
Unit m^2

Labour (A)					Material (B)					Equipment (C)				
Catagory	Unit	Qty.	Rate (NRs.)	Amount (NRs.)	Type	Unit	Qty.	Rate (NRs.)	Amount (NRs.)	Type	Unit	Qty.	Rate (NRs.)	Amount (NRs.)
					Timber	m^3	0.04	34,300.00	1,372.00					
Skilled	m.d.	4.73	315.00	1,489.95	150 mm Cheskini	no.	1.0	45.00	45.00	Tools and Plant				47.82
Unskilled	m.d.	0.473	220.00	104.06	Hings	no.	3.00	70.00	210.00	@ 3% of Labour Cost				
					300 mm Cheskini	no.	1.00	110.00	110.00					
					Handle	no.	1.00	32.00	32.00					
					200 mm Door Luck	no.	1.00	1000.00	1,000.00					
Total of Labour (A)				1,594.01	Total of Material (B)				2,769.00	Total of Equipment (C)				47.82

Direct Cost (A+B+C) =	4,410.83
Constractor's Overhead (15%) =	661.62
Sub Total =	5,072.45
VAT (10%) =	507.25
Total =	5,579.70
Unit Rate in NRs. =	**5,579.70/m3**

Rural Electrification through Small Hydropower Development

RATE ANALYSIS

NORMS Ref. : Based on Market Price Survey
BOQ Item No. : NA
Item Description : Cement Cost including Transportation
Unit : MT

Labour (A)					Material (B)					Equipment (C)				
Catagory	Unit	Qty.	Rate (NRs.)	Amount (NRs.)	Type	Unit	Qty.	Rate (NRs.)	Amount (NRs.)	Type	Unit	Qty.	Rate (NRs.)	Amount (NRs.)
Cement transportation from Beni Bazar to Ghami site (90 km)	MT	1	90 km * 1000kg * 0.18NRs	16,200.00	Cement Price at Beni Bazar/Myagdi	MT	1	6,200.00	6,200.00					
Total of Labour (A)				16,200.00	Total of Material (B)				6,200.00	Total of Equipment (C)				

Direct Cost (A+B+C) = 22,400.00

NORMS Ref. : Based on Market Price Survey
BOQ Item No. : NA
Item Description : Gabion Wire Cost including Transportation
Unit : Kg.

Labour (A)					Material (B)					Equipment (C)				
Catagory	Unit	Qty.	Rate (NRs.)	Amount (NRs.)	Type	Unit	Qty.	Rate (NRs.)	Amount (NRs.)	Type	Unit	Qty.	Rate (NRs.)	Amount (NRs.)
Transportation from Beni Bazar to Ghami Khola site	Kg.	1	90 km*1kg.*0.20NRs	18.00	Gabion Wire in Beni Bazar	Kg.	1	32.00	32.00					
Total of Labour (A)				18.00	Total of Material (B)				32.00	Total of Equipment (C)				

Direct Cost (A+B+C) = 50.00

NORMS Ref. : Based on Market Price Survey
BOQ Item No. : NA
Item Description : Mild Steel Re-bar Cost including Transportation
Unit : MT

Labour (A)					Material (B)					Equipment (C)				
Catagory	Unit	Qty.	Rate (NRs.)	Amount (NRs.)	Type	Unit	Qty.	Rate (NRs.)	Amount (NRs.)	Type	Unit	Qty.	Rate (NRs.)	Amount (NRs.)
Transportation from Beni Bazar to Ghami Khola site	MT	1	90 km* 1000kg * 0.30NRs	27,000.00	Mild Steel Re-bar in Beni Bazar. (Avg. Cost)	MT	1	27,000.00	27,000.00					
Total of Labour (A)				27,000.00	Total of Material (B)				27,000.00	Total of Equipment (C)				-

Direct Cost (A+B+C) = 54,000.00

NORMS Ref. : Based on Market Price Survey
BOQ Item No. : NA
Item Description : Cost of Binding Wire including Transportation
Unit : Kg.

Labour (A)					Material (B)					Equipment (C)				
Catagory	Unit	Qty.	Rate (NRs.)	Amount (NRs.)	Type	Unit	Qty.	Rate (NRs.)	Amount (NRs.)	Type	Unit	Qty.	Rate (NRs.)	Amount (NRs.)
Transportation from Beni Bazar To Ghami Khola site	Kg.	1	90 km * 1 kg * 0.20NRs	18.00	Cost of Binding Wire at Beni Bazar	Kg.	1	35.00	35.00					
Total of Labour (A)				18.00	Total of Material (B)				35.00	Total of Equipment (C)				

Direct Cost (A+B+C) = 53.00

NORMS Ref. : HMG 22 (4) kha
BOQ Item No. : NA
Item Description : Collection of boulder including stacking and supply on Site (up to 1km haulage)
Unit : m^3

Labour (A)					Material (B)					Equipment (C)				
Catagory	Unit	Qty.	Rate (NRs.)	Amount (NRs.)	Type	Unit	Qty.	Rate (NRs.)	Amount (NRs.)	Type	Unit	Qty.	Rate (NRs.)	Amount (NRs.)
Labours Unskilled	m.d.	4.62	220.00	1,016.40						Tools and plants @ 3% of Labour cost.				30.49
Total of Labour (A)				1,016.40	Total of Material (B)					Total of Equipment (C)				30.49

Direct Cost (A+B+C) = 1,046.89

NORMS Ref. : HMG 22 (4) (Ka)
BOQ Item No. : NA
Item Description : Sand Collection including Transportation (up to 4 km haulage)
Unit : m^3

Labour (A)					Material (B)					Equipment (C)				
Catagory	Unit	Qty.	Rate (NRs.)	Amount (NRs.)	Type	Unit	Qty.	Rate (NRs.)	Amount (NRs.)	Type	Unit	Qty.	Rate (NRs.)	Amount (NRs.)
Labour Unskilled	m.d.	12.308	220.00	2,707.76						Tools and plants @ 3% of Labour cost.				81.23
Total of Labour (A)				2,707.76	Total of Material (B)					Total of Equipment (C)				81.23

Direct Cost (A+B+C) = 2,788.99

NORMS Ref. : HMG 3 (2) (Gha)
BOQ Item No. : NA
Item Description :Normal aggregate collection and sieving including Transportation (up to 1 km haulage)
Unit : m^3

Labour (A)					Material (B)					Equipment (C)				
Catagory	Unit	Qty.	Rate (NRs.)	Amount (NRs.)	Type	Unit	Qty.	Rate (NRs.)	Amount (NRs.)	Type	Unit	Qty.	Rate (NRs.)	Amount (NRs.)
Labour Unskilled	m.d.	9.23	220.00	2,030.60						Tools and plants @ 3% of Labour cost.				60.92
Total of Labour (A)				2,030.60	Total of Material (B)					Total of Equipment (C)				60.92

Direct Cost (A+B+C) = 2,091.52

NORMS Ref. : Based on District Rates
BOQ Item No. : NA
Item Description : Timber including Transportation
Unit : m^3

Labour (A)					Material (B)					Equipment (C)				
Catagory	Unit	Qty.	Rate (NRs.)	Amount (NRs.)	Type	Unit	Qty.	Rate (NRs.)	Amount (NRs.)	Type	Unit	Qty.	Rate (NRs.)	Amount (NRs.)
Transportation from Jomsom to Ghami Khola site	m3	1	45 km.* 900 kg.* 0.6NRs	24,300.00	Timber	m^3	1	10,000.00	10,000.00					
Total of Labour (A)				24,300.00	Total of Material (B)				10,000.00					

Direct Cost (A+B+C) = 34,300.00

SOCIO ECONOMIC TABLES

Table 1: Existing Infrastructure in Project Area

VDCs	Primary	L. Secondary	Secondary	Health Post	Post Office	Shops	Agri. Service Center	Police Station	Forest Office	Vetenary Service	Hotels Lodges	HH Number	HH/Comm Centre	HH/Service Centre
Ghami	3			3	1	3		1			10	178	13.7	35.6
Chharan	1	1		1	1	7	1		1		5	142	11.8	35.5
Lomanthang	1		1	1	1	13	1	1		1	2	180	12.0	36.0
Total	5	1	1	5	3	23	2	2	1	1	17	500	12.5	35.7

Table 2: Household Income Distribution

VDC	Low 16	Medium 32	High 17	Average 65
Charan	3441	7753	21719	10971
Chhusang	3477	7802	11196	7492
Ghami	4447	8633	17157	10079
Lomangthan	3713	8945	13568	8742
Average	3788	8063	16691	9514

Table 3: Average Household Size

VDC	1 - 4	5 - 8	> 8	
Charan	3.1	6.2	9.3	6.20
Chhusang	3.5	5.8	9.1	6.13
Ghami	4	6.3	10.3	6.87
Lomangthan	3.2	7.8	-	5.50
				6.18

Table 4: Willingness to Pay by Income Level

	Rupees per month			
Income Level	Rs. 150	Rs. 250	Rs. 350	Rs.450
Low 16	5 (31)	10 (63)	1 (6)	0 (0)
Medium 34	4 (12)	29 (85)	1 (3)	0 (0)
High 15	3 (20)	10 (67)	1 (7)	1 (6)
Total 65	12	49	3	1

Table 5: Willingness to Pay by Land Holding Size

	Frequency (Percent)				
	Sample	Rs. 150	Rs. 250	Rs. 350	Rs.450
Low Income	16				
up to 1.02 ha	14	6 (43)	8 (57)	0 (0)	0 (0)
1.02 to 2.71 ha	2	1 (50)	1 (50)	0 (0)	0 (0)
Medium Income	32				
up to 1.02 ha	25	2 (8)	23 (92)	0 (0)	0 (0)
1.02 to 2.71 ha	7	2 (29)	5 (71)	0 (0)	0 (0)
Hjgh	17				
up to 1.02 ha	12	2 (17)	9 (75)	1 (8)	0 (0)
1.02 to 2.71 ha	5	2 (40)	2 (40)	1 (10)	1 (0)

Table 6: Willingness to Pay by Floor Area

	Frequency (Percent)				
	Sample	Rs. 150	Rs. 250	Rs. 350	Rs.450
Low Income	16				
up to 28 sq.m	4	1 (25)	3 (75)	0 (0)	0 (0)
28.1 54 sq.m	4	2 (50)	2 (50)	0 (0)	0 (0)
> 54 sq. m	8	4 (50)	4 (50)	0 (0)	0 (0)
Medium Income	32				
up to 28 sq.m	8	1 (12)	7 (88)	0 (0)	0 (0)
28.1 54 sq.m	2	0 (0)	2 (100)		
> 54 sq. m	22	4 (18)	18 (82)	0 (0)	0 (0)
Hjgh Income	17				
up to 28 sq.m	0	0 (0)	0 (0)	0 (0)	0 (0)
28.1 54 sq.m	0	0 (0)	0 (0)	0 (0)	0 (0)
> 54 sq. m	17	4 (23)	11 (65)	2 (12)	0 (0)

Table 7: Willingness to Pay by Expenditure on Energy

	Frequency (Percent)				
	Sample	Rs. 150	Rs. 250	Rs. 350	Rs.450
Low Income	16				
Fuelwood		0 (0)	0 (0)	0 (0)	0 (0)
Kerosene	16	7 (43)	9 (57)	0 (0)	0 (0)
Others		0 (0)	0 (0)	0 (0)	0 (0)
Medium Income	32				
Fuelwood		0 (0)	0 (0)	0 (0)	0 (0)
Kerosene	32	5 (16)	27 (84)		
Others		0 (0)	0 (0)	0 (0)	0 (0)
Hjgh Income	17				
Fuelwood		0 (0)	0 (0)	0 (0)	0 (0)
Kerosene	17	4 (24)	11 (65)	2 (11)	
Others		0 (0)	0 (0)	0 (0)	0 (0)

Table 8: Literacy Status

Literacy Level		Total	
		No.	%
Illiterate		234	58%
LiterateUp to class 10		83	21%
SLC - I. A.		85	21%
Total		402	100

Table 9A: Affordability by Income Status

(Rs. per Month)

VDC	Low 16	Medium 32	High 17	Average 65
Charan	172.1	387.7	1086.0	548.6
Chhusang	173.9	390.1	559.8	374.6
Ghami	222.4	431.7	857.9	504.0
Lomangthan	185.7	447.3	678.4	437.1
Average	189.4	403.1	834.5	475.7

Table 9B: Energy Consumption Pattern by Household

(Per hh per year in natural units)

	Fuelwood	Agri	Animal	Kerosenr	Dry Cell
		Residue	Dung	Average	Battery
End Uses	kg	kg	kg	Ltr.	Units
Cooking Food	2924.0	48.0	1088.0	8.8	0
Cooking Animal Food	0.0	36.0	976.0	0.0	0.0
Agro Processing	0.0	156.0	0.0	0.0	0.0
Heating	740.0	0.0	0.0	0.0	0.0
Lighting	0.0	0.0	0.0	25.0	2
Total	3664.0	240.0	2064.0	33.8	2.0

Table 10: Energy Consumption Pattern by Household

(Unit in GG per hh per year)

Fuelwood		Agri	Animal	Kerosone	Dry Cell	
Residue			Dung	Average	Battery	
End Uses	kg	kg	kg	Ltr.	Units	Total
Cooking Food	49.0	0.6	11.8	0.3	0	61.7
Cooking Animal Food	0.0	0.5	10.6	0.0	0.0	11.1
Agro Processing	0.0	2.0	0.0	0.0	0.0	2.0
Heating	12.4	0.0	0.0	0.0	0.0	12.4
Lighting	0.0	0.0	0.0	0.9	0	0.9
Total	61.4	3.0	22.5	1.2	0.0	88.1

Conversion Factord	16.75	12.56	10.89	36.3

Table 11: Type of End Use & Energy use by Household

(HH number)

Fuelwood		Agri	Animal	Kerosenr	Solar
		Residue	Dung	Average	Battery
End Uses	HH	HH	HH	HH	HH
Cooking Food	65.0	1.0	59.0	2.0	0
Cooking Animal Food	65.0	0.0	0.0	0.0	0.0
Agro Processing	1.0	2.0	0.0	0.0	0.0
Heating	17.0	0.0	0.0	1.0	0.0
Lighting	0.0	0.0	0.0	62.0	52
Total	148.0	3.0	59.0	65.0	52.0

Table 12: Energy Source by Income Level

		Fuel Type				
	Sample	Fuelwood	Agri.Res.	Animal W	Kerosene	Others
Low Income	16					
Energy Source		0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
Collected		16 (100)	0 (0)	0 (0)	0 (0)	0 (0)
Purchased		0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
Medium Income	32					
Energy Source		0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
Collected		5 (16)	27 (84)			
Purchased		0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
Hjgh Income	17					
Energy Source		0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
Collected		11 (65)	2 (11)			
Purchased		0 (0)	0 (0)	0 (0)	0 (0)	0 (0)

Table 13: Energy by End Use Activities

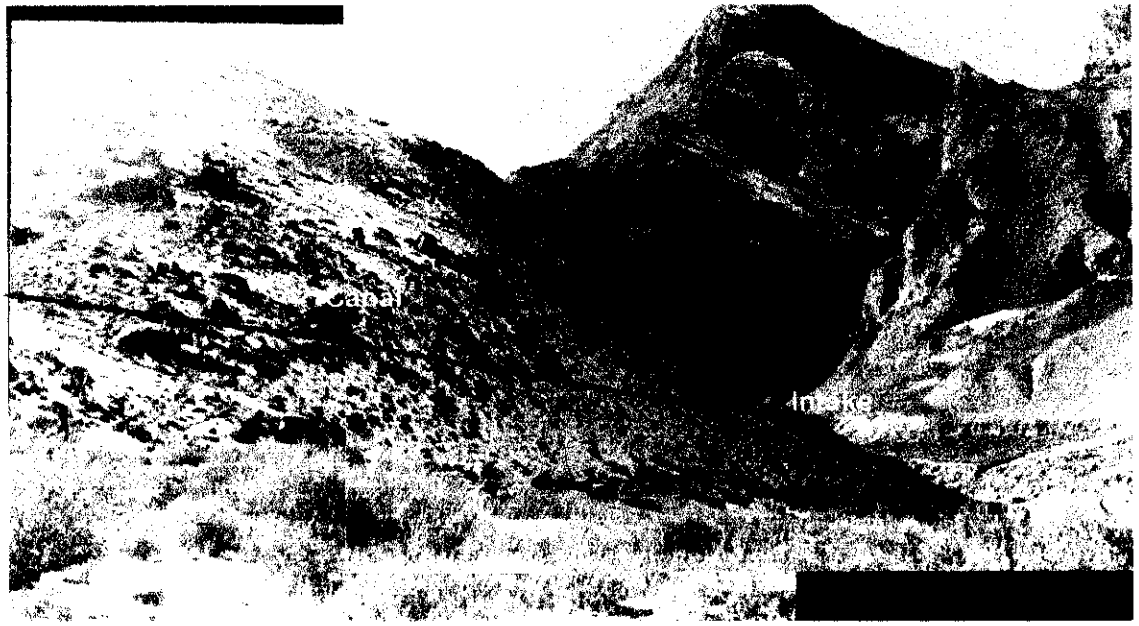
(HH Number)

End-Use Activities	Income Level			
	Low	Medium	High	Total
Cooking				
Animal Feed	16	32	17	65
Water Boiling	16	32	17	65
Agro Processing	1	2		3
Space Heating	0	3	0	3
Lighting	16	32	17	65

Ghami Khola SHP Photographs

View of Intake Site

View of Desilting Basin



View of Intake Canal Alignment

View of forebay, penstock alignment and powerhouse site

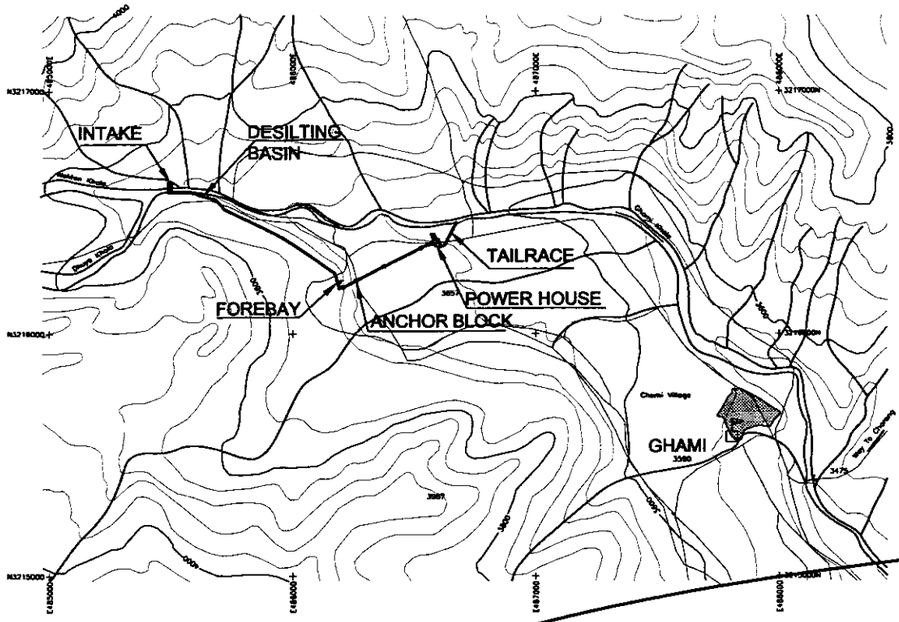
DRAWINGS

- List of Drawings
- Project Location Map
- General Layout Plan
- Section of Intake
- Plan, Section of Desilting Basin and Canal Section
- Longitudinal Profile of Canal
- Plan and Section of Forbay
- Profile of Penstock Line
- Plan and Section of Powerhouse
- Plan of Powerhouse with Switchyard
- Electrical Diagram
- Transmission Line
- Geological Map of Project Area
- Geological Section of Intake
- Geological Profile from Intake to Forbay
- Geological Profile from Forbay to Powerhouse

LIST OF DRAWINGS

S. NO.	D.1 ENGINEERING	Drawing No.	Sheet No.
1.	Project Location Map	D.1.1	1/13
2.	General Layout Plan	D.1.2	2/13
3.	Plan of Intake	D.1.3	3/13
4.	Section of Intake	D.1.4	4/13
5.	Plan, Section of Desilting Basin and Typical Section of Canal	D.1.5	5/13
6.	Longitudinal Profile of Canal	D.1.6	6/13-7/13
7.	Plan and Section of Forebay	D.1.7	8/13
8.	Profile of Penstock Pipe Line	D.1.8	9/13
9.	Plan and Section of Powerhouse	D.1.9	10/13
9.	Plan of Powerhouse with Switchyard	D.1.10	11/13
10.	Single Line Diagram of Generation/Switchyard/Transmission System	D.1.11	12/13
11.	Transmission Line	D.1.12	13/13
	D.2 GEOLOGICAL		
12.	Geological Map of Project Area	D.2.1	1/5
13.	Geological Section of Intake Site	D.2.2	2/5-3/5
13.	Geological Profile from Intake to Forebay	D.2.3	4/5
15.	Geological Profile from Forebay to Powerhouse	D.2.4	5/5

Japan International Co-operation Agency (JICA) and Nepal Electricity Authority (NEA)	Basic Study for the Rural Electrification Through Small Hydropower Development in Rural Hilly Areas in Nepal	GHAMI KHOLA SHP Mustang, WDR, Nepal LIST OF DRAWINGS	Scale	ITECO NEPAL (P) LTD. P. O.Box No. 2137, Min Bhawan, Kathmandu Email: iteco@mos.com.np, Tel: 493764, Fax 482298 Web site: www.scaef.com/iteconepal Butwal Power Company Ltd. P. O.Box No. 13728, Kumaripati, Lalitpur Tel: 535595, Fax 527901 Email: bpc@hydroconsult.com.np	Prepared: Checked: Drawn:



NEPAL

INDIA

CHINA

INDIA

MT.EVEREST

DARCHULA
BAITADI
BAJHANG
BAJURA
HUMLA
MUGU
DADELDHURA
DOTI
ACHHAM
KALIKOT
JUMLA
DOLPA
KANCHANPUR
KAILALI
DAILEKH
JAJARKOT
RUKUM
MUSTANG
MANANG
SURKHET
BARDIYA
SALYAN
ROLPA
BAGLUNG
MYAGDI
KASKI
LAMJUNG
GORAKHA
BANKE
PYUTHAN
GULMI
PARBAT
SYANJA
TANAHUN
RASUWA
DANG-DEUKHURI
ARGHAKHANCHI
PALPA
NUWAKOT
SINDHUPALANCHOK
DHADING
KTM
KAPILBASTU
RUPANDEHI
NAWALPARASI
CHITWAN
MAKWANPUR
KAVRE
RAMECHHAP
DOLAKHA
SOLUKHUMBU
SANKHUWASAVA
TAPLEJUNG
PARSA
BARA
RAUTAHAT
SARLAHI
MOHOTTARI
SINDHULI
OKHALDHUNGA
KHOTANG
BHOJPUR
DHANKUTA
TEHRATHUM
PANCHTHAR
DHANUSHA
UDAYAPUR
SIRAHA
SAPTARI
SUNSARI
MORANG
JHAPA
ILAM

CHHONDUP
LOMATHANG
CHHOSER
CHARAN
GHAMI
SURKHANG
CHHUSANG
KAGBENI
JHONG
MUKTINATH
MARPHA
JOMSOM
TUKUCHE
KOWANG
KUNJO
LETE

N

0 40 80 120 160 KM.
Scale

LEGEND

PROPOSED LOAD CENTER

POSSIBLE FUTURE EXTENSION

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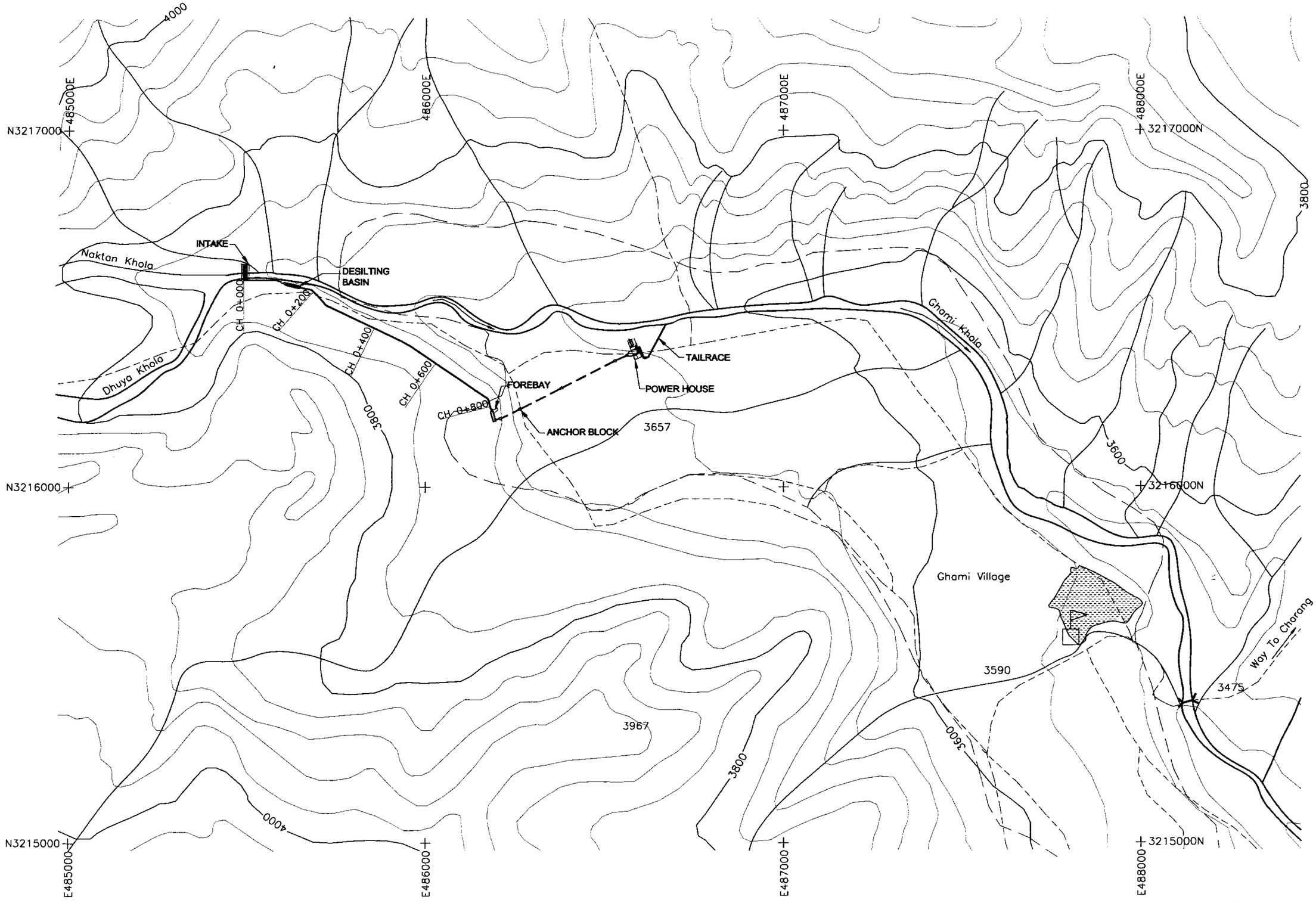

Japan International Co-operation Agency (JICA) and Nepal Electricity Authority (NEA)	Basic Study for the Rural Electrification Through Small Hydropower Development in Rural Hilly Areas in Nepal	GHAMI KHOLA SHP Mustang, WDR, Nepal	Scale (m) 0 100 200 300 400	ITECO NEPAL (P) LTD. P. O.Box No. 2147, Min Bhawan, Kathmandu Email: iteco@mos.com.np, Tel: 493764, Fax 482298 Web site: www.scaef.com/iteconepal	Butwal Power Company Ltd. P. O.Box No. 11728, Kumaripati, Lalitpur Tel: 535595, Fax 527901 Email: bpc@hydroconsult.com.np	Prepared:	Drawing No. D.1.2
		GENERAL LAYOUT PLAN	1:10000			Checked:	Sheet No. 2/13
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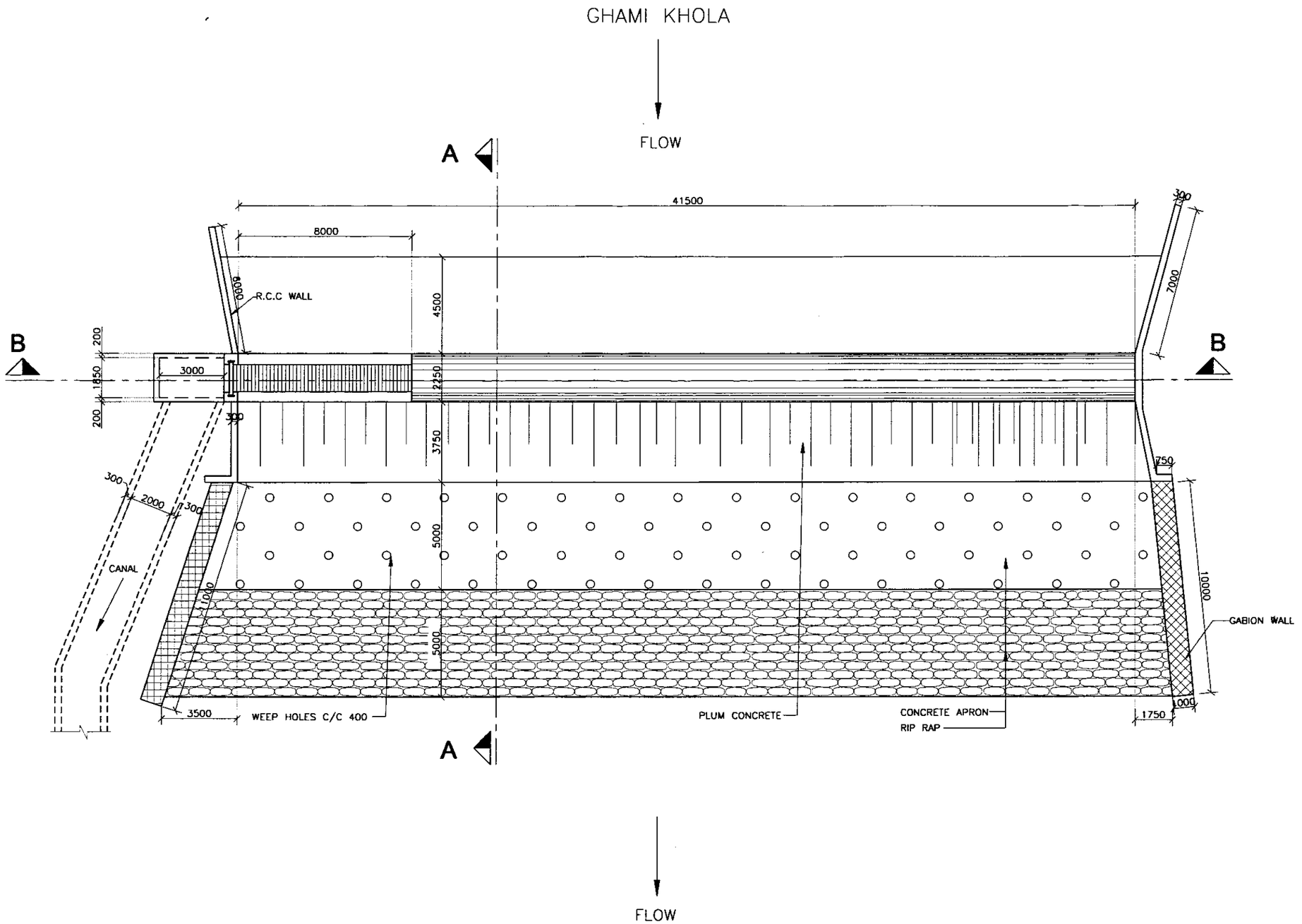
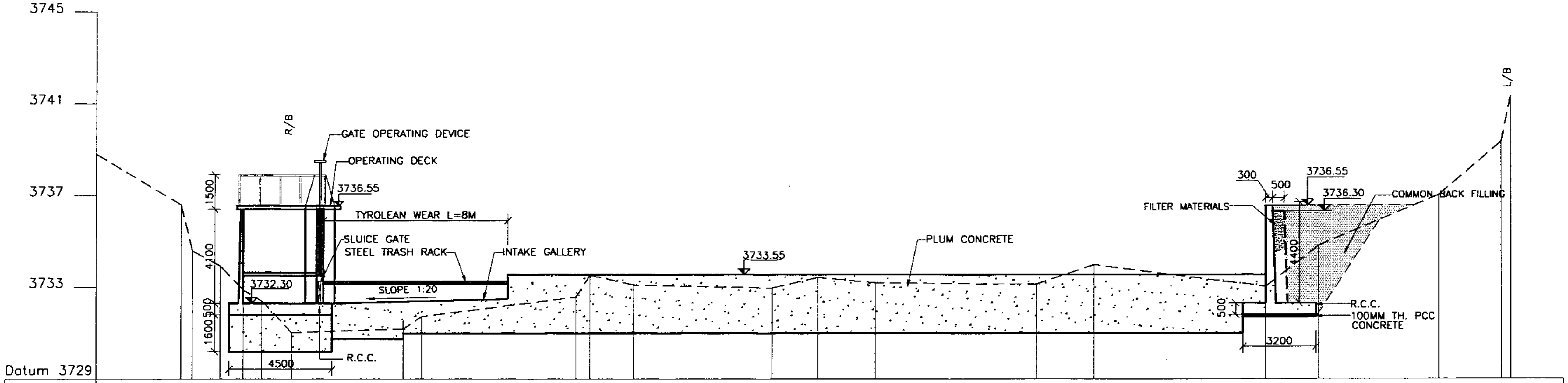


NOTE:

ALL DIMENSIONS ARE IN MM

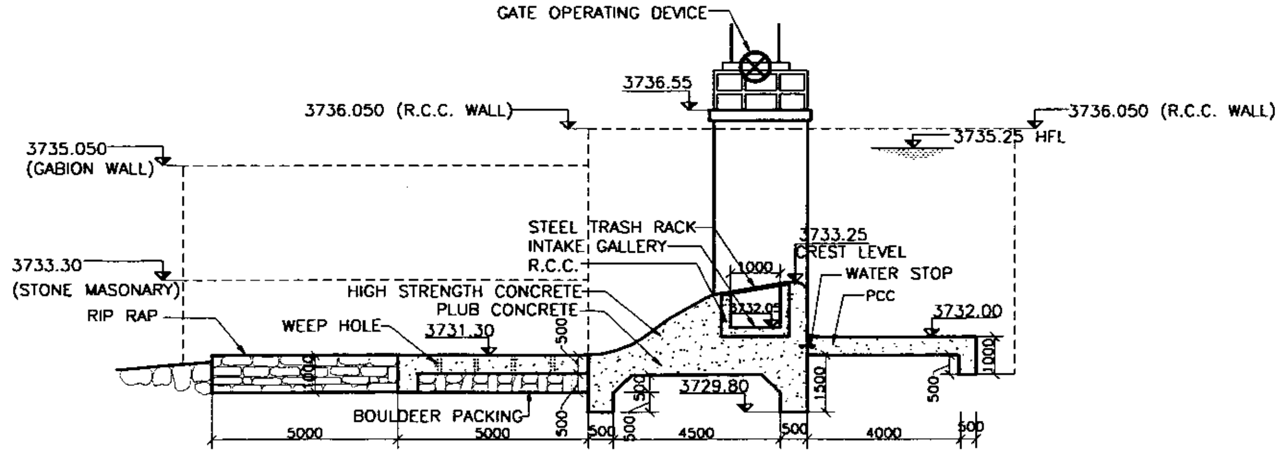
UNLESS OTHERWISE STATED

Japan International Co-operation Agency (JICA) and Nepal Electricity Authority (NEA)	Basic Study for the Rural Electrification Through Small Hydropower Development in Rural Hilly Areas in Nepal	GHAMI KHOLA SHP Mustang, WDR, Nepal PLAN OF INTAKE	Scale (m) 0 2 4 6 1:200 HORIZONTAL & VERTICAL	ITECO NEPAL (P) LTD. P. O.Box No. 2147, Min Bhawan, Kathmandu Email: iteco@mos.com.np, Tel: 493764, Fax 482298 Web site: www.scaef.com/iteconepal Butwal Power Company Ltd. P. O.Box No. 11726, Kumaripati, Lalitpur Tel: 535595, Fax 527901 Email: bpc@hydroconsult.com.np	Prepared: Checked: Drawn:	Drawing No. D.1.3 Sheet No. 3/13



Design Level(m)																								
Existing Ground Level(m)	3738.80	3736.597	3734.597	3733.935	3732.882	3732.401	3731.402	3731.832	3731.201	3731.832	3731.735	3732.575	3733.524	3733.103	3732.967	3733.430	3733.195	3733.133	3733.975	3733.042	3734.802	3737.002	3739.302	3741.302
Offset Distance (m)	-13.40	-9.70	-9.20	-8.00	-7.00	-6.20	-4.90			0.00	.80	7.50	8.10	10.00	16.00	18.00	20.50	27.50	30.00	37.50	39.80	45.10	47.80	48.20

SECTION B.B



SECTION A.A

Japan International Co-operation Agency (JICA)
and
Nepal Electricity Authority (NEA)

Basic Study for the Rural Electrification Through Small Hydropower Development in Rural Hilly Areas in Nepal

GHAMI KHOLA SHP
Mustang, WDR, Nepal

SECTIONS OF INTAKE

Scale
0 2 4 6m
HORIZONTAL & VERTICAL

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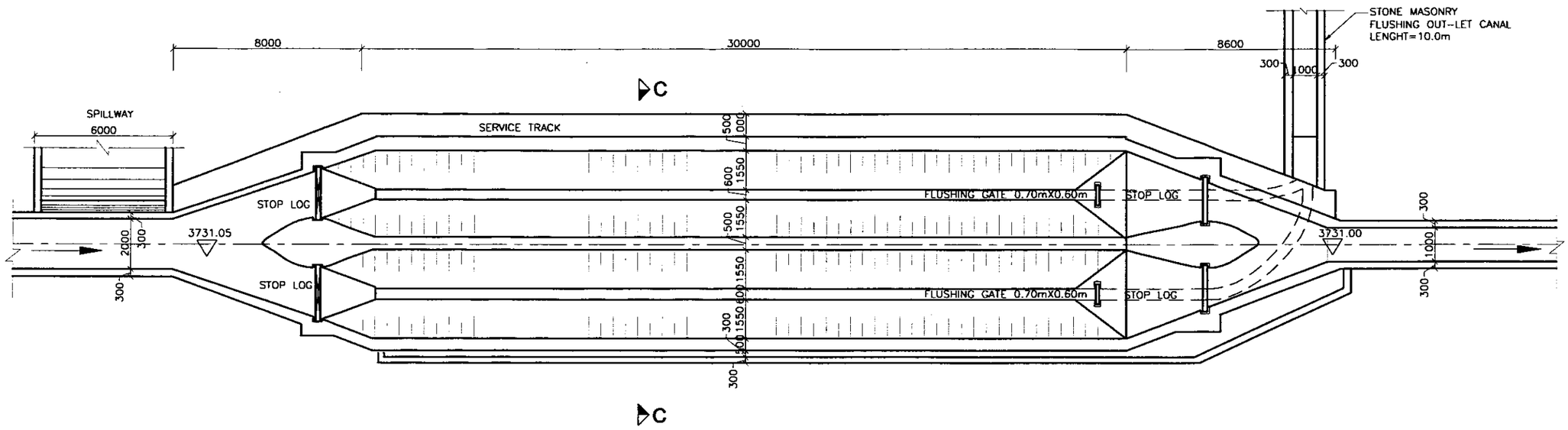
Drawing No.
D.1.4
Sheet No.
4/13



PLAN OF DESILTING BASIN

SCALE
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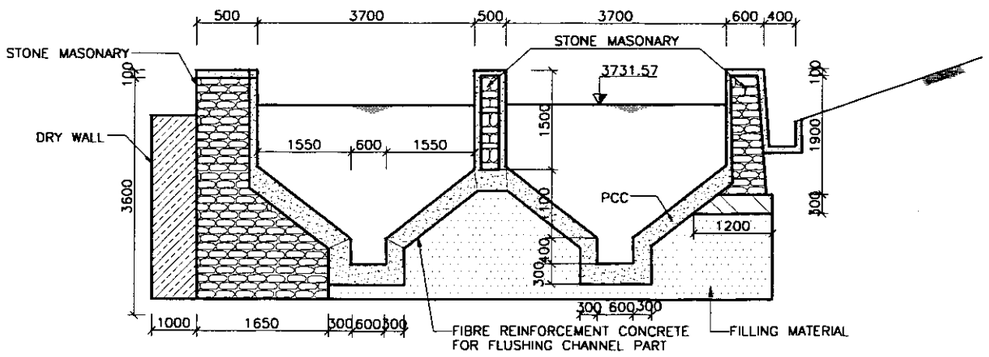

SECTION C.C

SCALE
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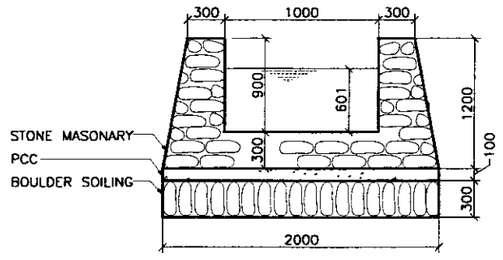
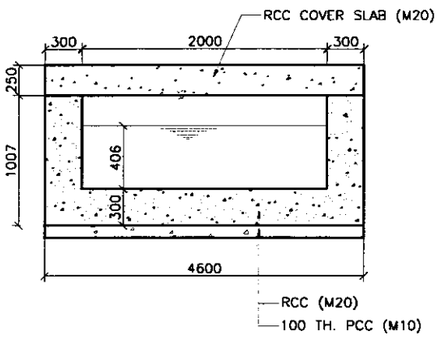


TYPICAL CANAL SECTION TYPE- A

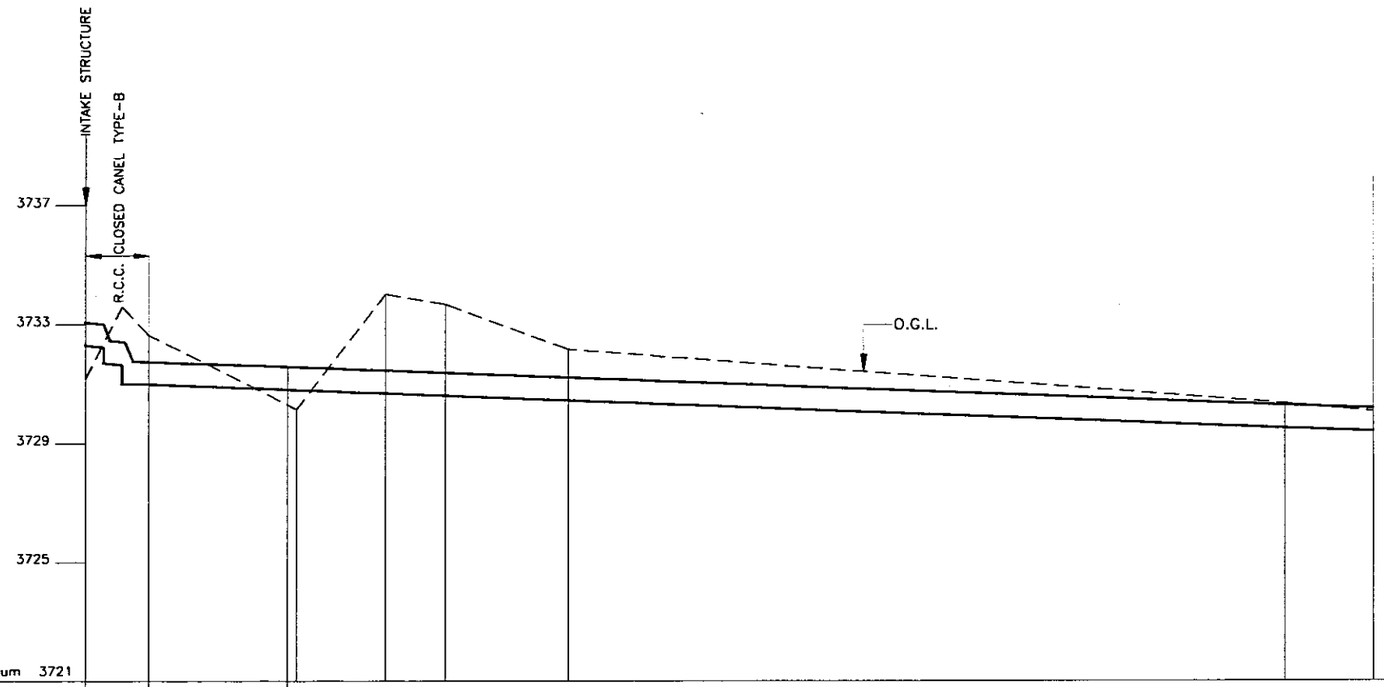
SCALE
0 1 2m



TYPICAL CANAL SECTION TYPE- B

SCALE
0 2 4m

Japan International Co-operation Agency (JICA) and Nepal Electricity Authority (NEA)	Basic Study for the Rural Electrification Through Small Hydropower Development in Rural Hilly Areas in Nepal	GHAMI KHOLA SHP Mustang, WDR, Nepal PLAN, SECTION OF DESILTING BASIN AND CANAL SECTION	Scale As Shown	ITECO NEPAL (P) LTD. P. O.Box No. 2147, Min Bhawan, Kathmandu Email: iteco@mos.com.np, Tel: 493764, Fax 482296 Web site: www.scaef.com/iteconepal	Butwal Power Company Ltd. P. O.Box No. 11728, Kumaripati, Lalitpur Tel: 535595, Fax 527901 Email: bpc@hydroconsult.com.np	Prepared: Checked: Drawn:	Drawing No. D.1.5 Sheet No. 5/13



Datum 3721

Existing Ground Level(m)	3731.20	3733.60	3732.64	3730.16	3734.01	3733.68	3732.17	3730.35	3730.07
Chainage (km+m)	0+00.0	0+012.0	0+021.0	0+070.0	0+100.0	0+120.0	0+161.0	0+401.0	0+431.0
Bed Slope	1:100		DESILTING BASIN	1:250 OPEN CANAL TYPE-A					
Water Level (m)				3731.508	3731.388	3731.308	3731.144	3730.184	3730.064
Bed Level(m)	3732.30 3732.24	3731.71 3731.65	3731.05	3731.00	3730.868	3730.788	3730.624	3729.664	3729.544

Japan International Co-operation Agency (JICA)
and
Nepal Electricity Authority (NEA)

Basic Study for the Rural Electrification Through Small Hydropower Development in Rural Hilly Areas in Nepal

GHAMI KHOLA SHP
Mustang, WDR, Nepal

LONGITUDINAL PROFILE OF CANAL

Scale
0 20 40 60 80m
HORIZONTAL
0 2 4 6 8m
VERTICAL

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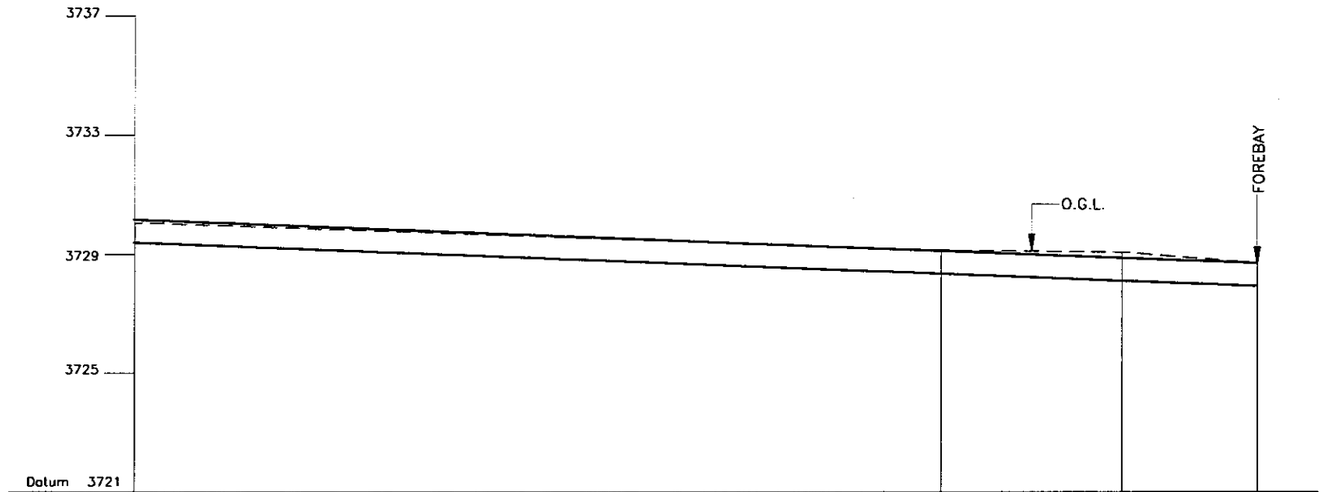
Prepared:
Checked:
Drawn:

Drawing No.
D.1.6

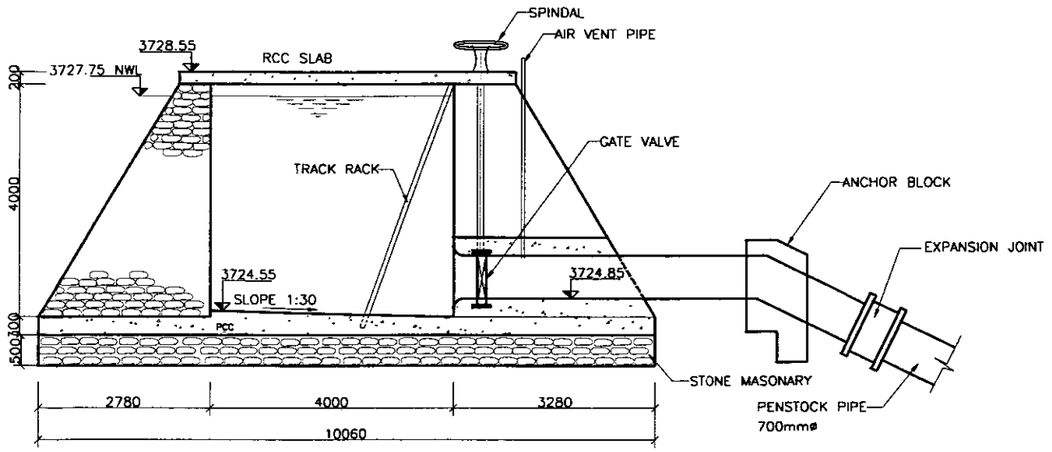
Sheet No.
6/13



Datum 3721

Existing Ground Level(m)	3730.07	3729.15	3729.08	3728.718
Chainage (km+m)	0+431.0	0+701.0	0+761.8	0+807.0
Bed Slope	1:250 OPEN CANAL TYPE-A			
Water Level (m)	3730.064	3728.984	3728.741	
Bed Level(m)	3729.544	3728.464	3728.221	

Japan International Co-operation Agency (JICA) and Nepal Electricity Authority (NEA)	Basic Study for the Rural Electrification Through Small Hydropower Development in Rural Hilly Areas in Nepal	GHAMI KHOLA SHP Mustang, WDR, Nepal	Scale 0 20 40 60 80m HORIZONTAL 0 2 4 6 8m VERTICAL	ITECO NEPAL (P) LTD. P. O.Box No. 2147, Min Bhawan, Kathmandu Email: iteco@mos.com.np, Tel: 493764, Fax 482298 Web site: www.scaef.com/iteconepal Butwal Power Company Ltd. P. O.Box No. 11728, Kumaripati, Lalitpur Tel: 535595, Fax 527901 Email: bpc@hydroconsult.com.np	Prepared: / Checked: / Drawn: — Drawing No. D.1.6 — Sheet No. 7/13
		LONGITUDINAL PROFILE OF CANAL			



SECTION Z.Z

SCALE
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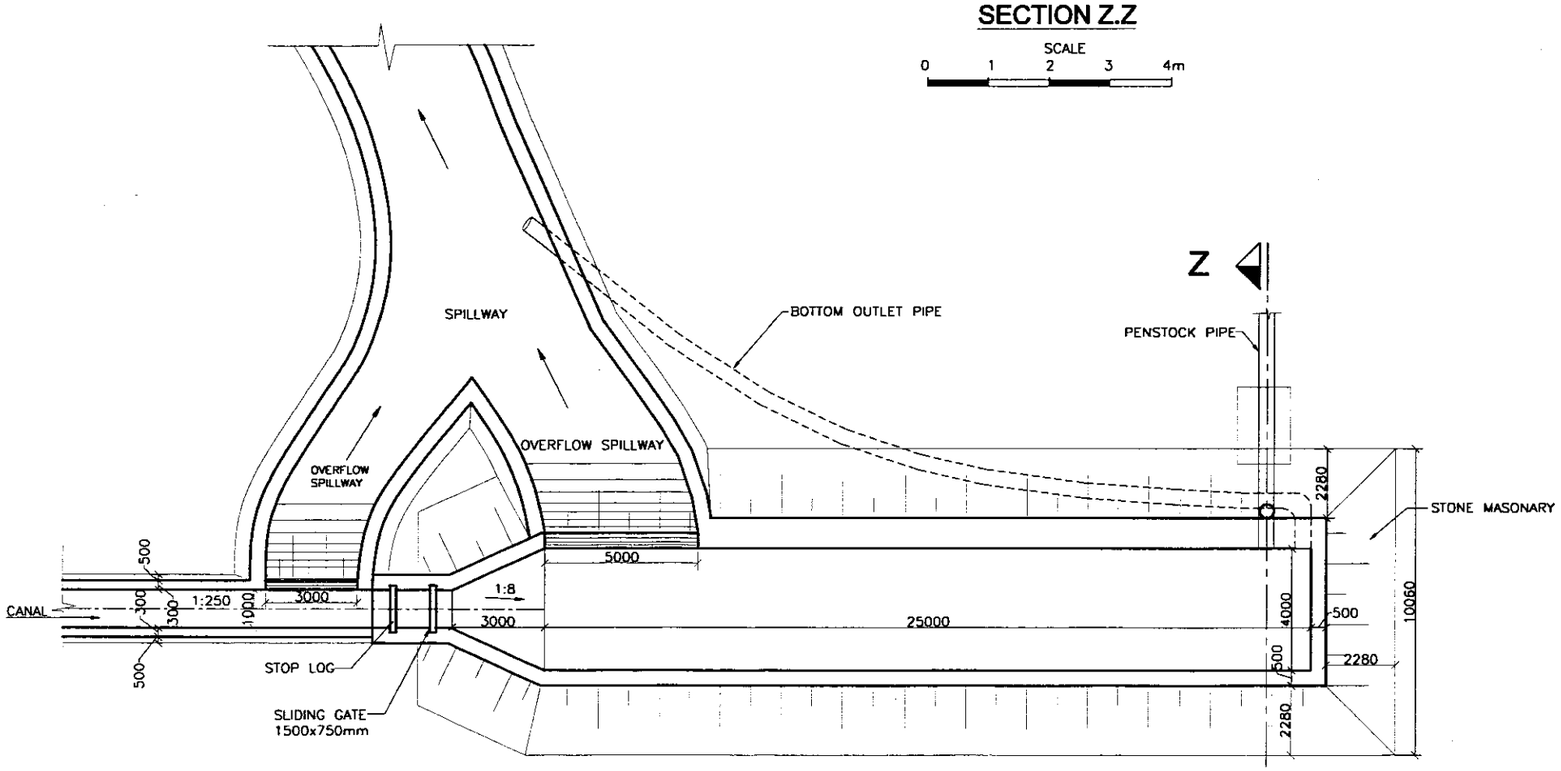
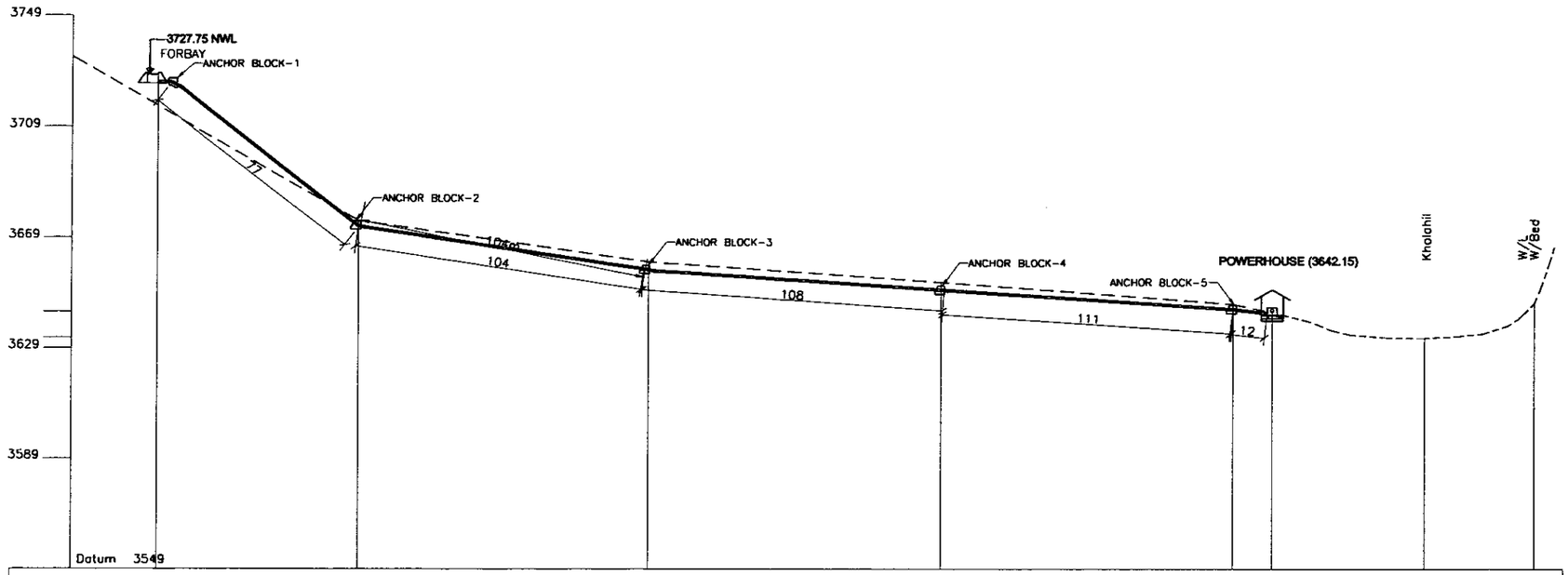


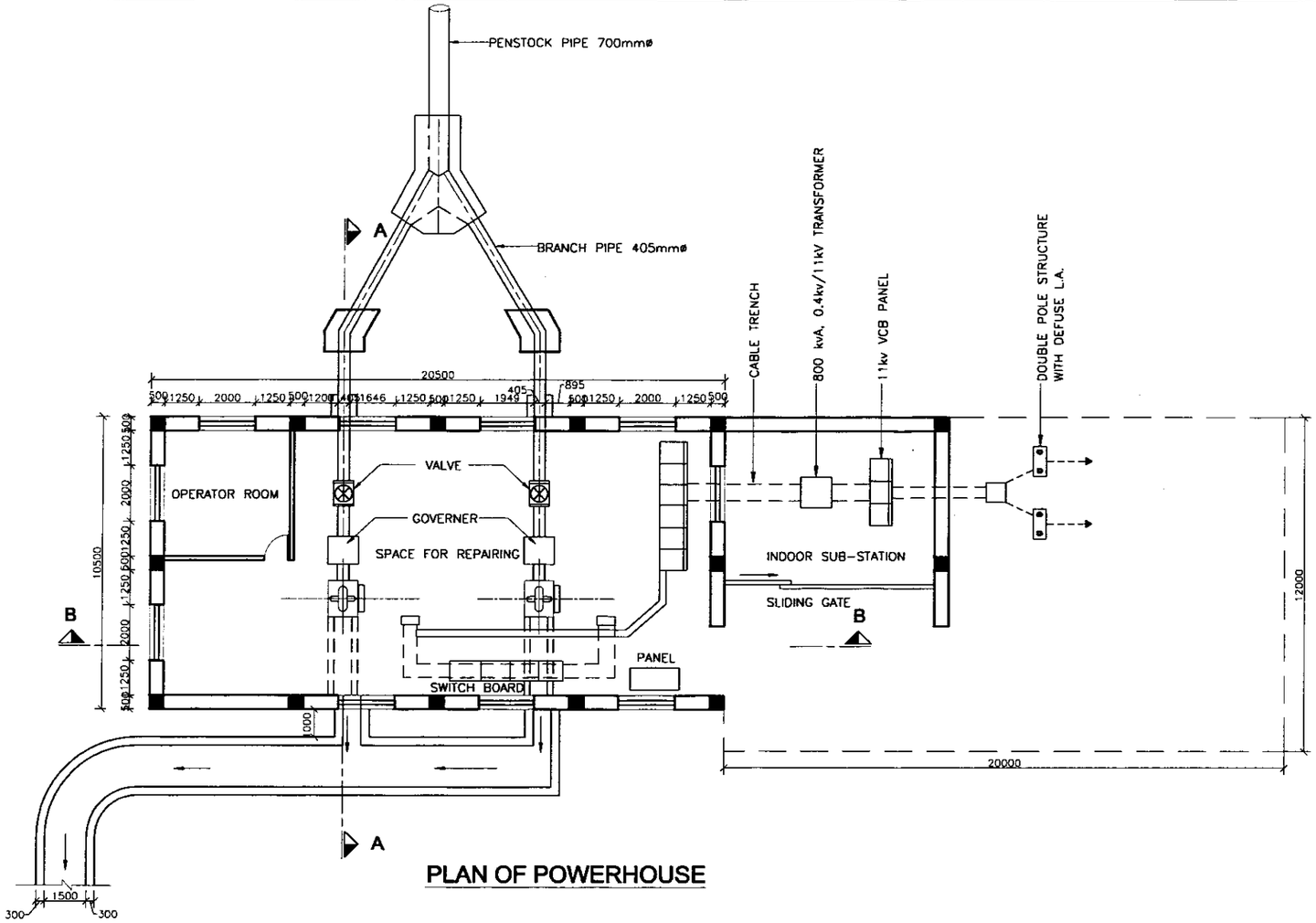
PLAN OF FOREBAY

SCALE
0 2 4m

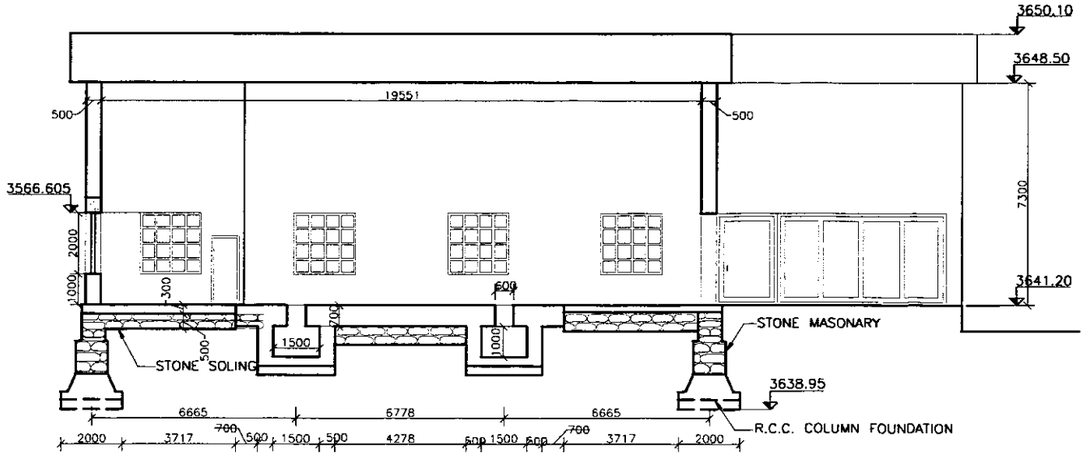
Japan International Co-operation Agency (JICA) and Nepal Electricity Authority (NEA)	Basic Study for the Rural Electrification Through Small Hydropower Development in Rural Hilly Areas in Nepal	GHAMI KHOLA SHP Mustang, WDR, Nepal PLAN AND SECTION OF FOREBAY	Scale As Shown	ITECO NEPAL (P) LTD. P. O.Box No. 2147, Min Bhawan, Kathmandu Email: iteco@mos.com.np, Tel: 493764, Fax 482298 Web site: www.scaef.com/iteconepal	Butwal Power Company Ltd. P. O.Box No. 11728, Kumaripati, Lalitpur Tel: 535595, Fax 527901 Email: bpc@hydroconsult.com.np	Prepared: Checked: Drawn:	Drawing No. D.1.7 Sheet No. 8/13



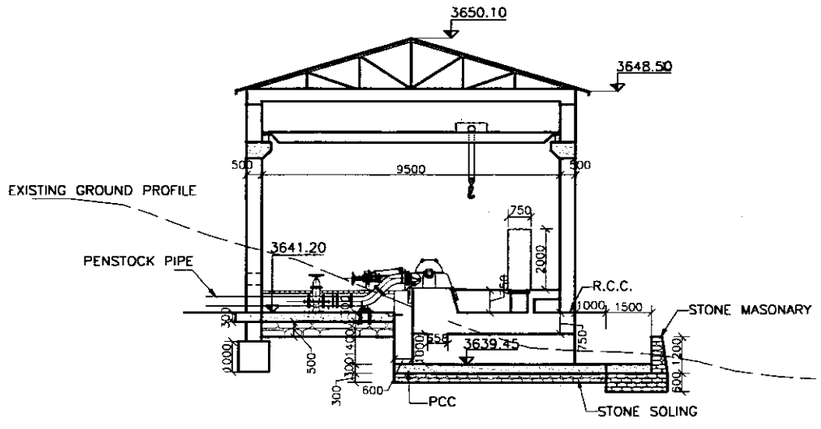
Japan International Co-operation Agency (JICA) and Nepal Electricity Authority (NEA)	Basic Study for the Rural Electrification Through Small Hydropower Development in Rural Hilly Areas in Nepal	GHAMI KHOLA SHP Mustang, WDR, Nepal	Scale 0 20 40 60 80m	ITECO NEPAL (P) LTD. P. O.Box No. 2147, Min Bhawan, Kathmandu Email: iteco@mos.com.np, Tel: 493764, Fax 482298 Web site: www.scaef.com/iteconepal	Butwal Power Company Ltd. P. O.Box No. 11728, Kumaripati, Lalitpur Tel: 535595, Fax 527901 Email: bpc@hydroconsult.com.np	Prepared: / Checked: / Drawn:	Drawing No. D.1.8
		PROFILE OF PENSTOCK LINE	HORIZONTAL & VERTICAL				Sheet No. 9/13



PLAN OF POWERHOUSE

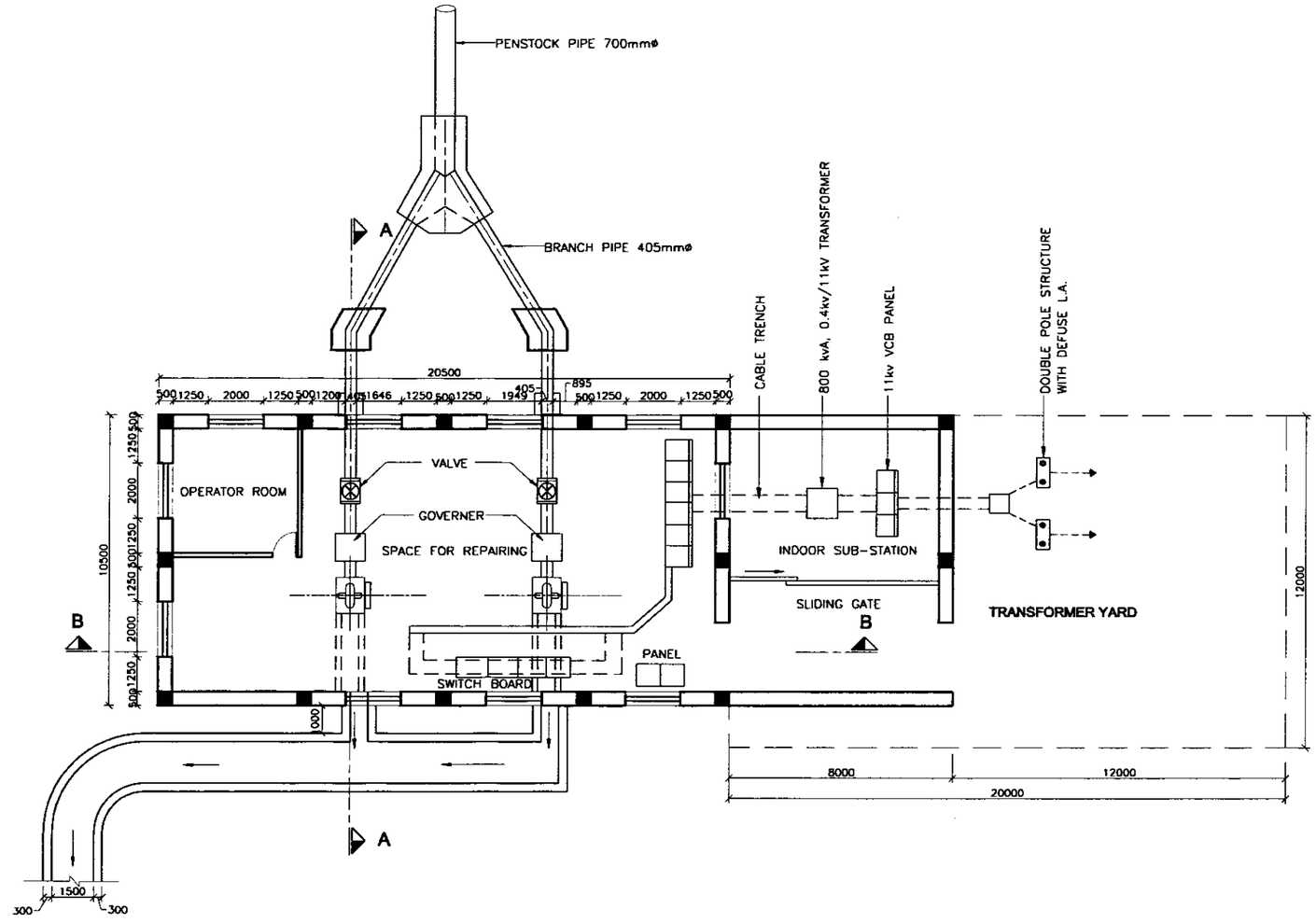


SECTION B.B



SECTION A.A

Japan International Co-operation Agency (JICA) and Nepal Electricity Authority (NEA)	Basic Study for the Rural Electrification Through Small Hydropower Development in Rural Hilly Areas in Nepal	GHAMI KHOLA SHP Mustang, WDR, Nepal PLAN AND SECTION OF POWERHOUSE	Scale 0 2 4 6m	ITECO NEPAL (P) LTD. P. O.Box No. 2147, Min Bhawan, Kathmandu Email: iteco@mos.com.np, Tel: 493764, Fax 482298 Web site: www.scaef.com/iteconepal	Butwal Power Company Ltd. P. O.Box No. 11728, Kumaripati, Lalitpur Tel: 535595, Fax 527901 Email: bpc@hydroconsult.com.np	Prepared: Checked: Drawn:	Drawing No. D.1.9 Sheet No. 10/13



Japan International Co-operation Agency (JICA) and Nepal Electricity Authority (NEA)	Basic Study for the Rural Electrification Through Small Hydropower Development in Rural Hilly Areas in Nepal	GHAMI KHOLA SHP Mustang, WDR, Nepal PLAN OF POWERHOUSE WITH SUBSTATION	Scale 0 2 4 6m	ITECO NEPAL (P) LTD. P. O.Box No. 2147, Min Bhawan, Kathmandu Email: iteco@mos.com.np, Tel: 493764, Fax 482296 Web site: www.scaef.com/iteconepal Butwal Power Company Ltd. P. O.Box No. 11728, Kumaripati, Lalitpur Tel: 535595, Fax 527901 Email: bpc@hydroconsult.com.np	Prepared: Checked: Drawn:	Drawing No. D.1.10 Sheet No. 11/13

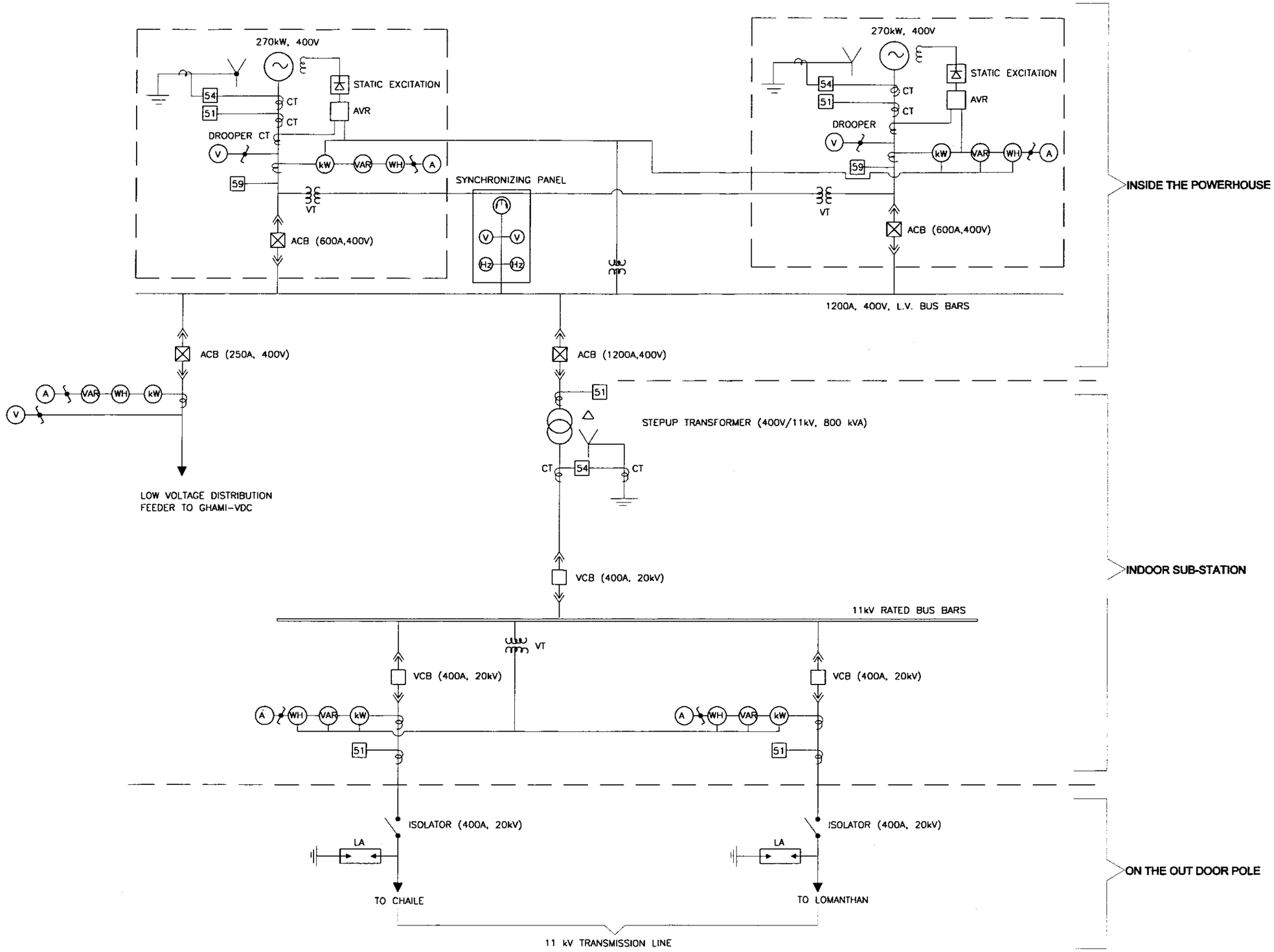
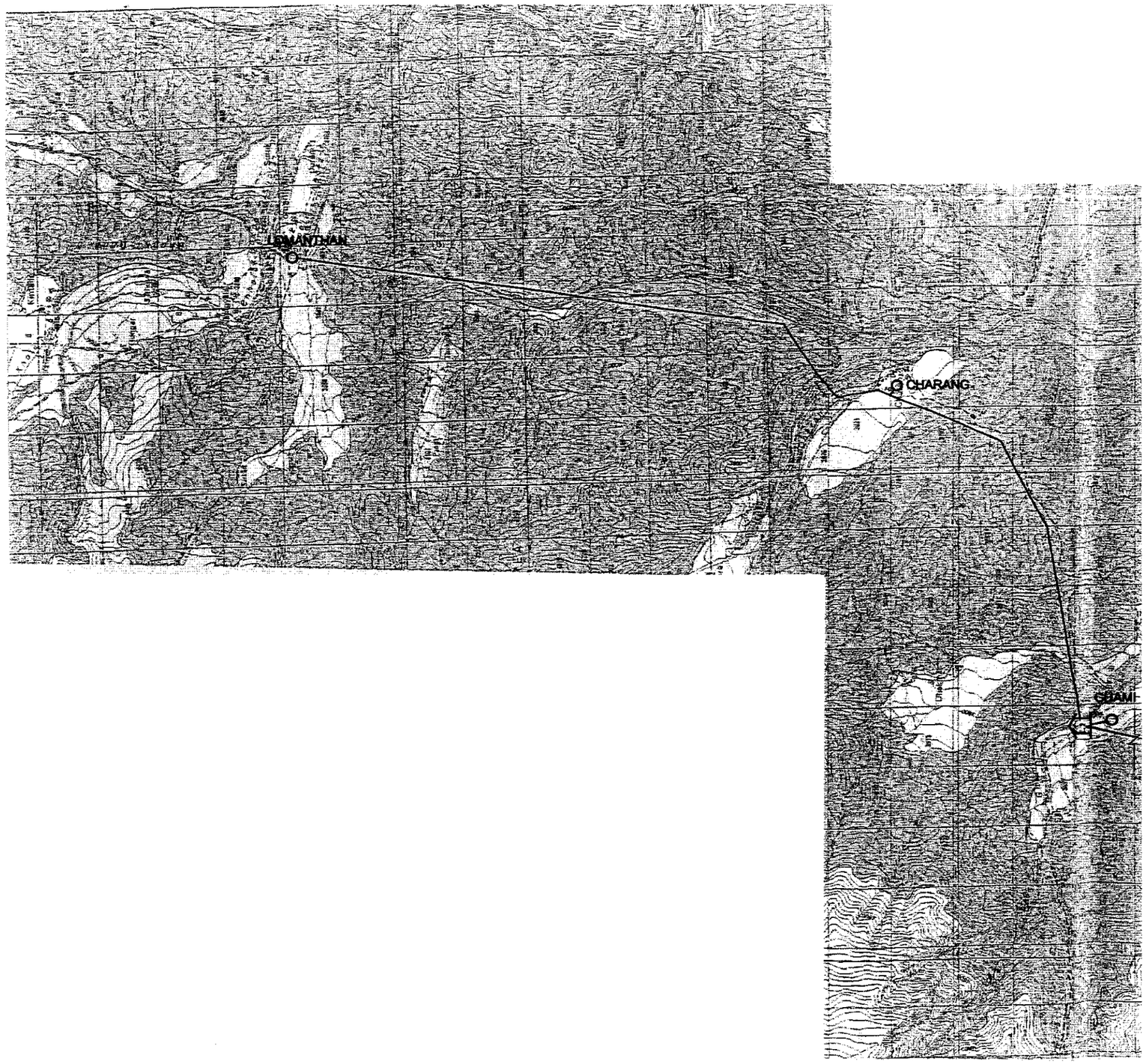
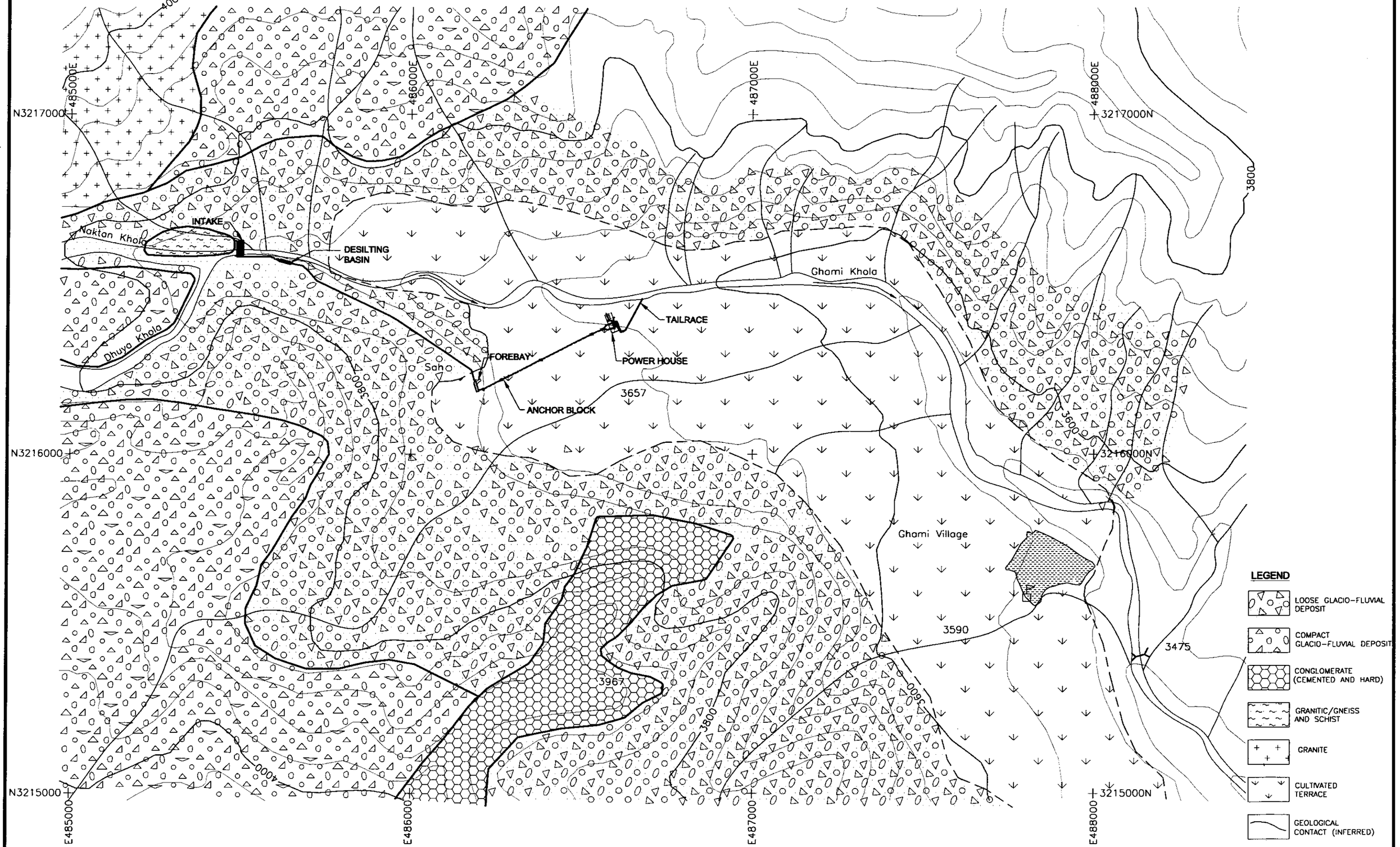


Fig. SINGLE LINE DIAGRAM OF GENERATION/ SWITCHYARD/TRANSMISSION SYSTEM

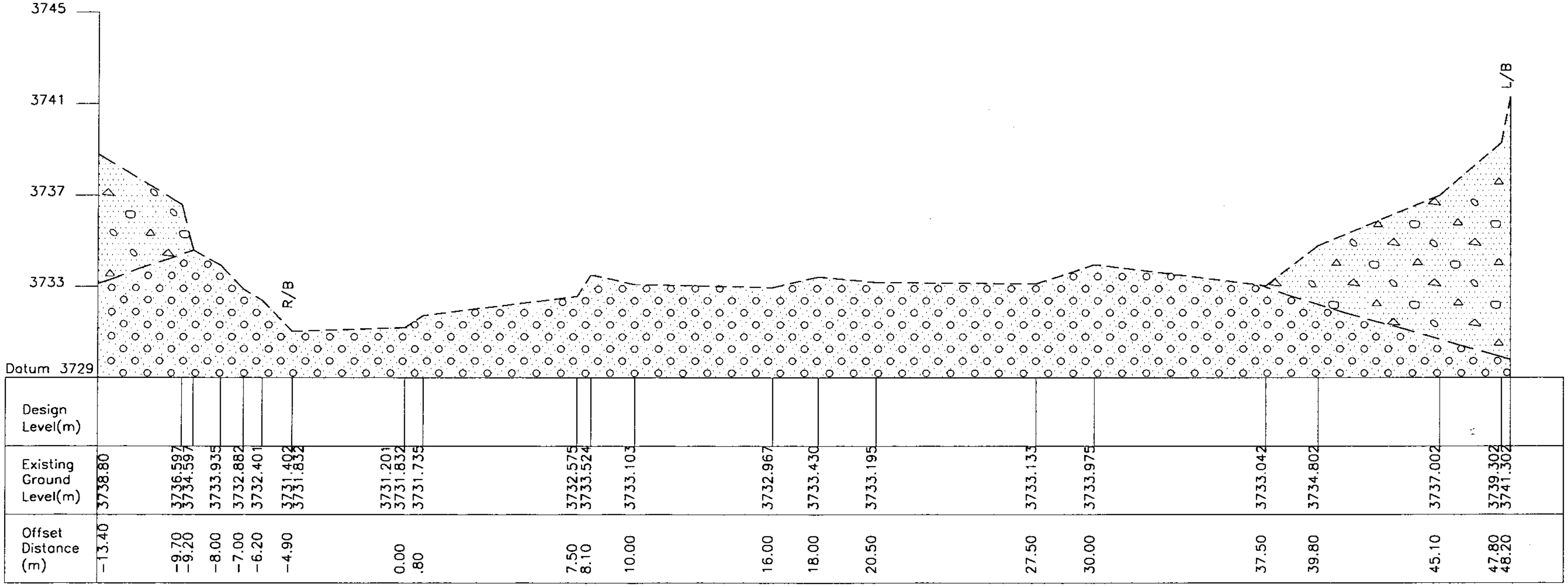
Japan International Co-operation Agency (JICA) and Nepal Electricity Authority (NEA)	Basic Study for the Rural Electrification Through Small Hydropower Development in Rural Hilly Areas in Nepal	GHAMI KHOLA SHP Mustang, WDR, Nepal ELECTRICAL DIAGRAM	Scale	ITECO NEPAL (P) LTD. P. O.Box No. 2147, Min Bhawan, Kathmandu Email: iteco@mos.com.np, Tel: 493764, Fax 482298 Web site: www.scaef.com/iteconepal	Butwal Power Company Ltd. P. O.Box No. 11728, Kumaripati, Lalitpur Tel: 535595, Fax 527901 Email: bpc@hydroconsult.com.np	Prepared: Checked: Drawn:	Drawing No. D.1.11 Sheet No. 12/13



Japan International Co-operation Agency (JICA) and Nepal Electricity Authority (NEA)	Basic Study for the Rural Electrification Through Small Hydropower Development in Rural Hilly Areas in Nepal	GHAMI KHOLA SHP Mustang, WDR, Nepal TRANSMISSION LINE	Scale	ITECO NEPAL (P) LTD. P. O.Box No. 2147, Min Bhawan, Kathmandu Email: iteco@mos.com.np, Tel: 493764, Fax 482298 Web site: www.scaef.com/iteconepal	Butwal Power Company Ltd. P. O.Box No. 11728, Kumaripati, Lalitpur Tel: 535595, Fax 527901 Email: bpc@hydroconsult.com.np	Prepared: Checked: Drown:	Drawing No. D.1.12 Sheet No. 13/13



Japan International Co-operation Agency (JICA) and Nepal Electricity Authority (NEA)	Basic Study for the Rural Electrification Through Small Hydropower Development in Rural Hilly Areas in Nepal	GHAMI KHOLA SHP Mustang, WDR, Nepal	Scale (m) 0 100 200 300 400 1:10000	ITECO NEPAL (P) LTD. P. O.Box No. 2147, Min Bhawan, Kathmandu Email: iteco@mos.com.np, Tel: 493764, Fax 482298 Web site: www.scaef.com/iteconepal	Butwal Power Company Ltd. P. O.Box No. 11728, Kumaripati, Lalitpur Tel: 535595, Fax 527901 Email: bpc@hydroconsult.com.np	Prepared:	Drawing No. D.2.1
		GEOLOGICAL MAP OF PROJECT AREA				Checked:	Sheet No. 1/5
						Drawn:	



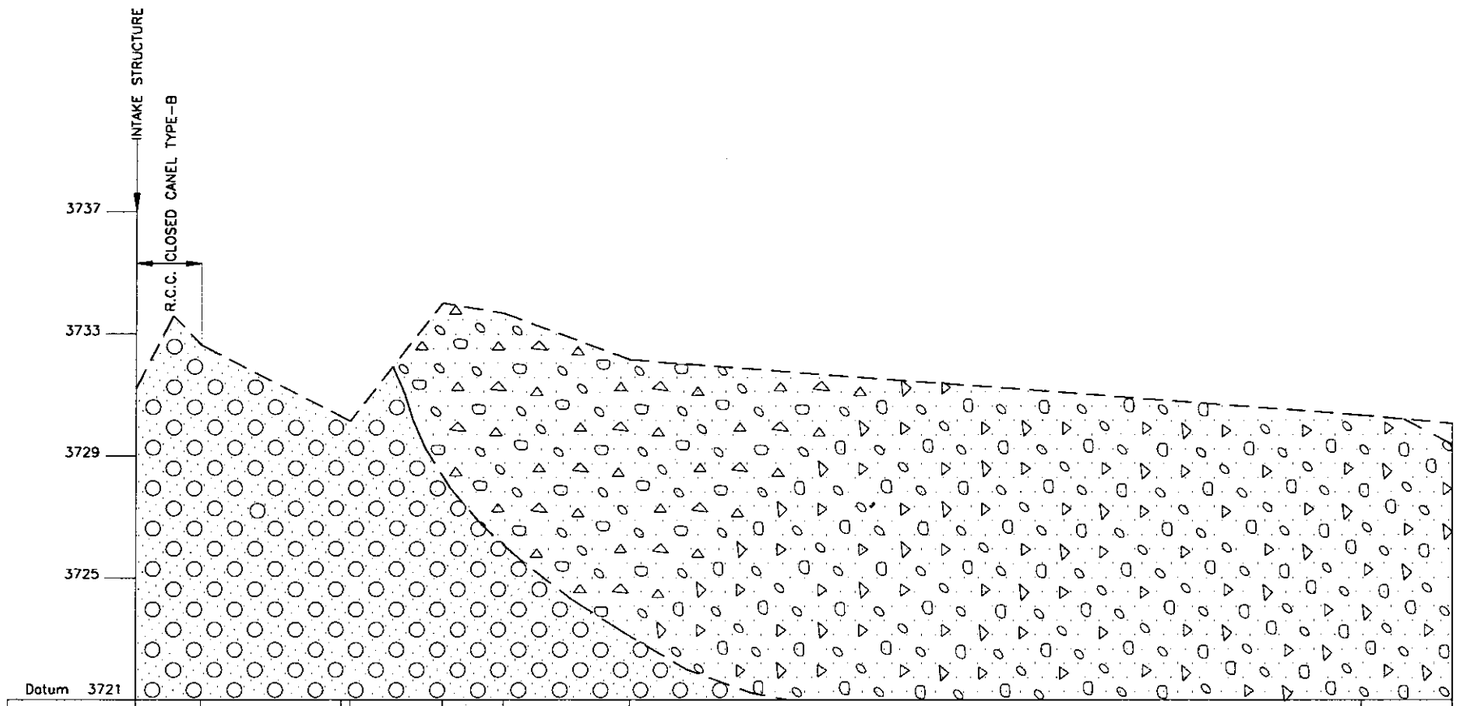
LEGENDS

▨ ALLUVIAL DEPOSIT

▨ LOOSE GLACIO-FLUVIAL DEPOSIT

⌿ GEOLOGICAL BOUNDARY (INFERRED)

Japan International Co-operation Agency (JICA) and Nepal Electricity Authority (NEA)	Basic Study for the Rural Electrification Through Small Hydropower Development in Rural Hilly Areas in Nepal	GHAMI KHOLA SHP Mustang, WDR, Nepal GEOLOGICAL SECTION OF INTAKE SITE	Scale 0 2 4 6m HORIZONTAL & VERTICAL	*ITECO NEPAL (P) LTD.* P. O.Box No. 2147, Min Bhawan, Kathmandu Email: iteco@mos.com.np, Tel: 493764, Fax 482298 Web site: www.scaef.com/iteconepal	*Butwal Power Company Ltd.* P. O.Box No. 11728, Kumaripati, Lalitpur Tel: 535595, Fax 527901 Email: bpc@hydroconsult.com.np	Prepared: Checked: Drawn:	Drawing No. D.2.2 Sheet No. 2/5



Existing Ground Level(m)	3731.20	3733.60	3732.64	3730.16	3734.01	3733.68	3732.17	3730.35	3730.07
Chainage (km+m)	0+00.0	0+012.0	0+021.0	0+070.0	0+100.0	0+120.0	0+161.0	0+401.0	0+431.0
Bed Slope	1:100		DESILTING BASIN	1:250 OPEN CANAL TYPE-A					
Water Level (m)				3731.508	3731.388	3731.308	3731.144	3730.184	3730.064
Bed Level(m)	3732.30 3732.24 3731.71 3731.65 3731.05			3731.00	3730.868	3730.788	3730.624	3729.664	3729.544

LEGEND

- LOOSE TO MEDIUM COMPACT GLACIO-FLUVIAL DEPOSIT
- LOOSE GLACIO-FLUVIAL DEPOSIT
- ALLUVIAL DEPOSIT
- GEOLOGICAL BOUNDARY (INFERRED)

Japan International Co-operation Agency (JICA)
and
Nepal Electricity Authority (NEA)

Basic Study for the Rural Electrification Through Small Hydropower Development in Rural Hilly Areas in Nepal

GHAMI KHOLA SHP
Mustang, WDR, Nepal

GEOLOGICAL PROFILE FROM INTAKE TO FOREBAY

Scale
0 20 40 60 80m
HORIZONTAL
0 2 4 6 8m
VERTICAL

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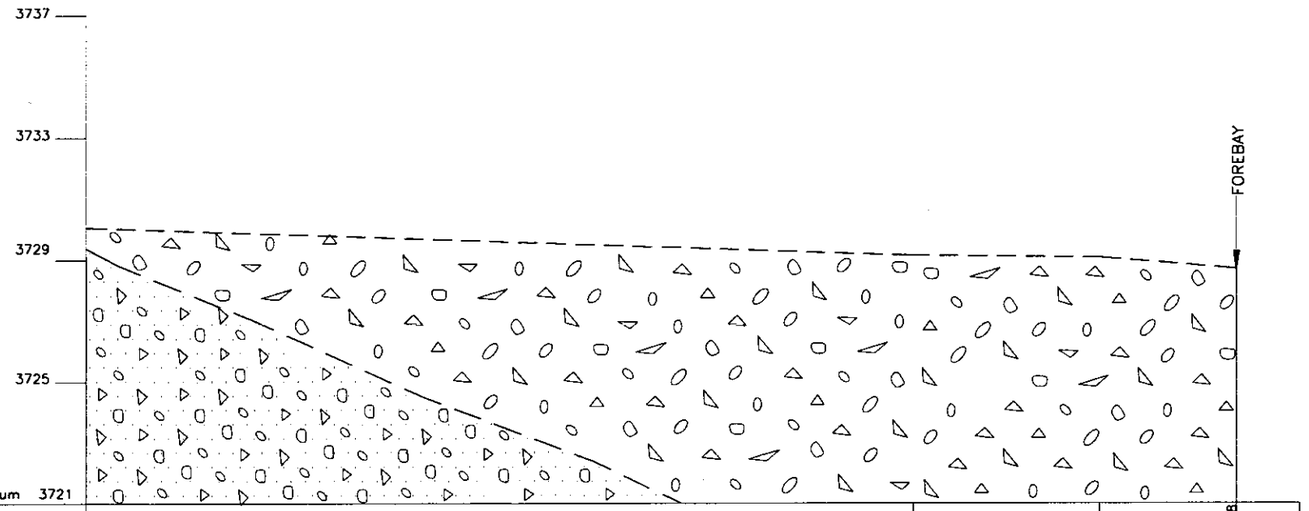
D.2.3
Sheet No.
3/5



Existing Ground Level(m)	3730.07	3729.15	3729.08	3728.718
Chainage (km+m)	0+431.0	0+701.0	0+761.8	0+807.0
Bed Slope	1:250 OPEN CANAL TYPE-A			
Water Level (m)	3730.064	3728.984	3728.741	
Bed Level(m)	3729.544	3728.464	3728.221	

LEGEND

- LOOSE TO MEDIUM COMPACT GLACIO-FLUVIAL DEPOSIT
- LOOSE GLACIO-FLUVIAL DEPOSIT
- ALLUVIAL DEPOSIT
- GEOLOGICAL BOUNDARY (INFERRED)

Japan International Co-operation Agency (JICA)
and
Nepal Electricity Authority (NEA)

Basic Study for the Rural Electrification Through Small Hydropower Development in Rural Hilly Areas in Nepal

GHAMI KHOLA SHP
Mustang, WDR, Nepal

GEOLOGICAL PROFILE FROM INTAKE TO FOREBAY

Scale
0 20 40 60 80m
HORIZONTAL
0 2 4 6 8m
VERTICAL

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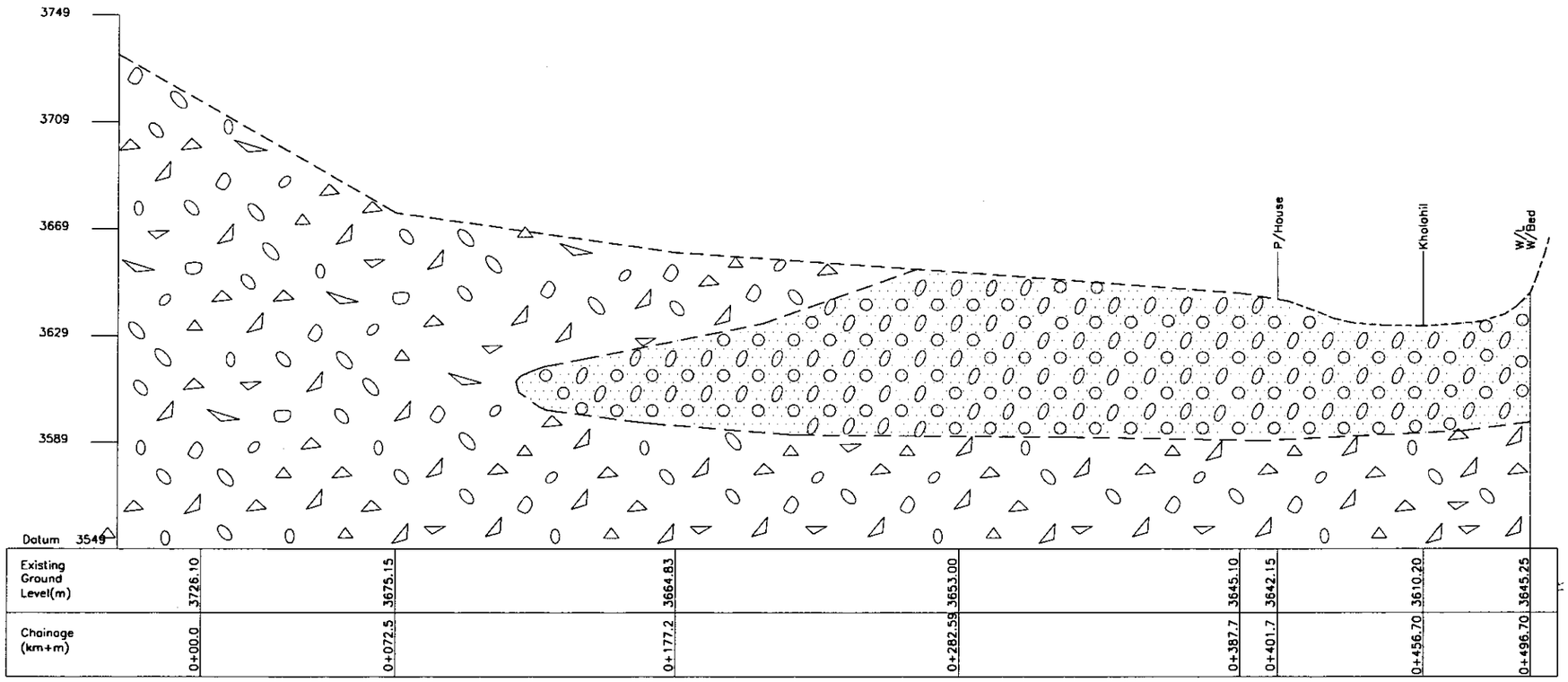
Drawing No.
D.2.4
Sheet No.
4/5



Existing Ground Level(m)	3726.10	3675.15	3664.83	3653.00	3645.10	3642.15	3610.20	3645.25
Chainage (km+m)	0+00.0	0+072.5	0+177.2	0+282.59	0+387.7	0+401.7	0+456.70	0+496.70

LEGEND

- LOOSE TO MEDIUM COMPACT GLACIO-FLUVIAL DEPOSIT
- MEDIUM COMPACT BOULDER MIXED SILTY SAND TO SILTY CLAYEY SAND (CULTIVATED)
- GEOLOGICAL BOUNDARY (INFERRED)

Japan International Co-operation Agency (JICA) and Nepal Electricity Authority (NEA)	Basic Study for the Rural Electrification Through Small Hydropower Development in Rural Hilly Areas in Nepal	GHAMI KHOLA SHP Mustang, WDR, Nepal	Scale 0 20 40 60 80m HORIZONTAL & VERTICAL	ITECO NEPAL (P) LTD. P. O.Box No. 2147, Min Bhawan, Kathmandu Email: iteco@mos.com.np, Tel: 493764, Fax 482298 Web site: www.scaef.com/iteconepal	Butwal Power Company Ltd. P. O.Box No. 11728, Kumaripati, Lalitpur Tel: 535595, Fax 527901 Email: bpc@hydroconsult.com.np	Prepared: Checked: Drawn:	Drawing No. D.2.6 Sheet No. 5/5

GEOLOGICAL PROFILE FROM FOREBAY TO POWERHOUSE