APPENDIX – B

HEHO
SMALL HYDRO

Table B-1-1 Estimated Unit Consumption Demand (1/2)

Object	Accessibility ratio, %	Step		Watt	Simul-taneous use, %	Watt		Watt	Simul-taneous use, %	Watt
1. Household		1-1	a. 3 Lights	90	100		a. 3 Lights	90	15	
Shan South	87		b. Radio	10	30		b. Radio	10	15	
Shan North	84		c. TV (60w)	30	85		c. TV (60w)	30	15	
Kachin	93		Ownership ratio				Ownership ratio			
Total (Un-Ele	87		50%				50%			
ctrified)			Total	130	90%	118	Total	130	15%	20
Total (Electri-	92	1-2	1-1	130	90		1-1	130	15	
fied)			d. Rice Cooker	90	50		d. Rice Cooker	90	30	
Total	88		Ownership ratio				Ownership ratio			
			15%				15%			
			Total	220	70%	163	Total	220	20%	44
2. Public										
2.1 Street Light	100	1. 40w Tube 10/Place		50	100	2,000				0
2.2 Temple	100	1. Light 20wTubex30		600	67		1. Light 20wTubex30	600	0	
		2. TV 1x60w		60	50		2. TV 1x60w	60	0	
		3. Fan 4 x 60w		240	20		3. Fan 4 x 60w	240	50	
		4. Refrigerator(100w)		100	50		4. Refrigerator(100w)	100	100	
		5. A/C:1x1KW		1,000	0		5. A/C:1x1KW	1,000	50	
			Total	2,000	30%	528	Total	2,000	40%	720
2.3 Hospital	100	1. Outer light					1.Outer light			
		20w Tube x 1		20	100		20w Tube x 1	20	0	
		2. Inner light					2. Inner light			
		40w Tube x 5rooms		200	50		Night demand x 50%	200	25	
		3. Refrigerator					3. Refrigerator			
		130w x 1		130	100		130w x 1	130	100	
			Total	350	70%	250	Total	350	50%	180
2.4 Clinic	100	1. Outer light					1.Outer light	20	0	
		20w Tube x 1		20	100					
		2. Inner light					2. Inner light			
		40w Tube x 4rooms		160	50		Night demand x 50%	160	25	
		3. Refrigerator					3. Refrigerator			
		130w x 1		130	100		130w x 1	130	100	
			Total	310	70%	230	Total	310	50%	170
2.5 High	100	1. Outer light		20			1.Outer light	20	0	
School		20w Tube x 1								
		2. Inner light		5,760			2. Inner light	5,760	20	
		Class room (36)					For cloudy, rainy day			
		40w Tube x 4 x 36					use: 5,760x20% use			
		3. Head Master room					(50days/250days/year)			
		40w Tube x 1		40			3. Head Master room	40	20	
		4.Copy machine					4. Copy machine			
		300w x 10%		300			300w x 10%	300	10	
		5. Computer room					5. Computer room	80	100	
		40w x 2		80			40w x 2			
			Total	6,200	0%	0	Total	6,200	20%	1,270
2.6 Middle	100	1. Outer light		20			1.Outer light	20	0	
School		20w Tube x 1								
		2. Inner light		1,280			2. Inner light	1,280	20	
		Class room (8)					For cloudy, rainy day			
		40w Tube x 4 x 8					1.280x20%			
		3 Head Master room					(50days/250days/year)			
		40w Tube x 1		40			3. Head Master room	40	20	
		4 Copy machine		300			4. Copy machine	300	10	
		300w x 10%					300w x 10%			
			Total	1,640	0%	0	Total	1,640	20%	290

Source: The Study Team

Table B-1-2 Estimated Unit Consumption Demand (2/2)

Object	Accessibility ratio, %	Step	Watt	Simul-taneous use, %	Watt		Watt	Simul-taneous use, %	Watt
2.7 Primary School	100	1. Outer light 20w Tube x 1	20			1.Outer light	20	0	
		2. Inner light Class room (8) 40w Tube x 8	320			2. Inner light For cloudy, rainy day use: (50days/250days/year)	320	20	
		3 Head master room 40w Tube x 1	40			3. Head Master room	40	0	
		Total	380	0%	0	Total	380	20%	65
3. Business									
3.1 Restaurant		1. Inner light 40w Tube x 4	160	100		1. Inner light	160	0	
		2. 21" CTV (95w)	95	100		2. 21" CTV (95w)	95	100	
		3. Refrigerator 130w x 1	130	100		3. Refrigerator 130w x 1	130	100	
		4. Rice Cooker 600w x 2	1,200	30		4. Rice Cooker 600w x 2	1,200	30	
		5. Hot plate 800w x 2	1,600	20		5. Hot plate 800w x 2	1,600	20	
		Total	3,185	30%	1,070	Total	3,185	30%	905
3.2 Guest House	100	1 Tube 20w x 22 room	4,400	50		1 Tube 20w x 22 room	4,400	20	
		2. 20w x 2 Toilet	40	20		2. 20w x 2 Toilet	40	20	
		3. Refrigerator 130 w x1	130	100		3. Refrigerator 130 w x1	130	100	
		4 Fan 60w x 4	240	50		4 Fan 60w x 4	240	50	
		5 21"TV 95w x 1	95	100		5 21"TV 95w x 1	95	100	
		Total	4,905	50%	2,550	Total	4,905	30%	1,230
3.3 Hotel	100	All facilities for 22 rooms/Hotel	7,000	80%	5,600	All facilities for 22 rooms/Hotel	7,000	70%	4,900
4. Cottage or Household Industry									
4.1 Rice Mill			5,000	0%	0	1. Motor	5,000	80%	5,000
4.2 Oil Mill			7,000	0%	0	1. Motor	7,000	80%	7,000
4.3 Powder Mill			5,000	0%	0	1. Motor	5,000	80%	5,000
4.4 Sugarcane Processing			5,000	0%	0	1. Motor	5,000	80%	5,000
4.5 Saw Mill			5,000	0%	0	1. Motor	5,000	80%	5,000
4.6 Paper Mill			5,000	0%	0	1. Motor	5,000	80%	5,000
4.7 Tofu Manufacturing			4,000	0%	0	1. Motor	4,000	80%	4,000
4.8 Noodle Mill			7,000	0%	0	1. Motor	7,000	80%	7,000
4.9 Furniture Manufacturing			5,000	0%	0	1. Motor	5,000	80%	5,000
4.10 Iron Work (including car, Trawlergyi, boa etc.repair shop)			4,000	0%	0	1. Motor	4,000	80%	4,000
4.11 Battery Charge Station (BCS)			1,500	0%	0	1. Motor	1,500	80%	1,500
4.12 Weaving			5,000	0%	0	1. Motor	5,000	80%	5,000
4.13 Water Pump			200	0%	0	1. Motor	200	80%	200

Note: It is assumed 15% of household will have 600 W Rice Cooker certain years after electrification.
For Namlan Village, 2 Saw Mills have total 4 machines at 20kW

Source: The Study Team

Table B-1-3 Power Demand Forecast in Nyang Shwe Township

Object	Number of Object	Step	Nighttime						Daytime					
			Unit Consumption Watt	Simultaneous %	Unit Consumption Watt	Accessibility %	Estimated Power Demand kW	Sub-total kW	Unit Consumption Watt	Simultaneous %	Unit Consumption Watt	Accessibility %	Estimated Power Demand kW	Sub-total kW
1.Household	23,552	1-1	130	90%	120	87	2,458.8	2,458.8	130	15%	20	87	409.8	409.8
		1-2	220	70%	160	87	3,278.4	3,278.4	220	20%	50	87	1024.5	1024.5
2. Public														
2.1 Street Light	416		400	50%	200	100	83.2		0	0%	0	100	0.0	
2.2.1 Temple	220		2,000	30%	600	100	132.0		2,000	40%	800	100	176.0	
2.2.2Pagoda	236		2,000	30%	600	100	141.6		2,000	40%	800	100	188.8	
2.3 Hospital	3		350	70%	250	100	0.8		350	50%	180	100	0.5	
2.4 Clinic	6		310	70%	220	100	1.3		310	50%	160	100	1.0	
2.5.1H. School	6		6,200	0%	0	100	0.0		6,200	20%	1,240	100	7.4	
2.5.2 M.School	12		1,640	0%	0	100	0.0		1640	20%	330	100	4.0	
2.5.3 P.School	205		380	0%	0	100	0.0		380	20%	80	100	16.4	
Sub-total								358.9						394.1
3. Business														
3.1 Restaurant	5		3,185	30%	960	100	4.8		3,185	30%	960	100	4.8	
3.2 Hotel	36		7,000	80%	5,600	100	201.6		7,000	70%	4,900	100	176.4	
Sub-total								206.4						181.2
4. Industry														
4.1 Rice Mill	39		5,000	0%	0	100	0.0		5,000	80%	4,000	100	156.0	
4.2 Oil Mill	4		7,000	0%	0	100	0.0		7,000	80%	5,600	100	22.4	
4.3 Powder Mill	3		5,000	0%	0	100	0.0		5,000	80%	4,000	100	12.0	
4.4 Sugarcane Processing	58		5,000	0%	0	100	0.0		5,000	80%	4,000	100	232.0	
4.5 Saw Mill	6		5,000	0%	0	100	0.0		5,000	80%	4,000	100	24.0	
4.6 Paper Mill	0		5,000	0%	0	100	0.0		5,000	80%	4,000	100	0.0	
4.7 Tofu Mf'g	26		4,000	0%	0	100	0.0		4,000	80%	3,200	100	83.2	
4.8 Noodle Mf'g	0		7,000	0%	0	100	0.0		7,000	80%	5,600	100	0.0	
4.9 Furniture	0		5,000	0%	0	100	0.0		5,000	80%	4,000	100	0.0	
4.10 Iron Work	6		4,000	0%	0	100	0.0		4,000	80%	3,200	100	19.2	
4.11 BCS	11		1,500	0%	0	100	0.0		1,500	80%	1,200	100	13.2	
4.12 Weaving	4		5,000	0%	0	100	0.0		5,000	80%	4,000	100	16.0	
4.13 Water Pump	2		200	0%	0	100	0.0		200	80%	160	100	0.3	
Sub-total								0.0						578.3
5. Total														
5.1 1-1+2,3,4								3,024						1,563
5.2 1-2+2,3,4								3,844						2,178
6. Gross Total														
6.1 1-1+2,3,4	Including 5% of transfer loss							3,190	Incl. 5% transfer loss					1,650
6.2 1-2+2,3,4	Including 5% of transfer loss							4,050	Incl. 5% transfer loss					2,300

Appendix B-2-1 Discharge Measurement at Intake Site

Date of Measurement	Gauge Reading (m)	Discharge (m3/s)	Converted Discharge (m3/s) (*)	Remarks
24 May 2001	0.35	3.1	3.1	
25 May 2001	0.50	4.2	4.4	
26 May 2001	0.35	3.0	3.1	
27 May 2001	0.53	4.8	4.6	
28 May 2001	0.78	7.6	7.4	
29 May 2001	0.74	7.3	6.9	
30 May 2001	0.89	8.3	8.8	
31 May 2001	0.79	7.9	7.5	
01 June 2001	0.95	9.0	9.6	
02 June 2001	1.02	10.5	10.6	
03 June 2001	1.06	12.0	11.2	
04 June 2001	0.95	9.1	9.6	
05 June 2001	0.71	6.4	6.5	
06 June 2001	0.45	3.7	3.9	
07 June 2001	0.31	2.8	2.8	
Higest Record	1.60		20.9	flood trace on the gauging staff

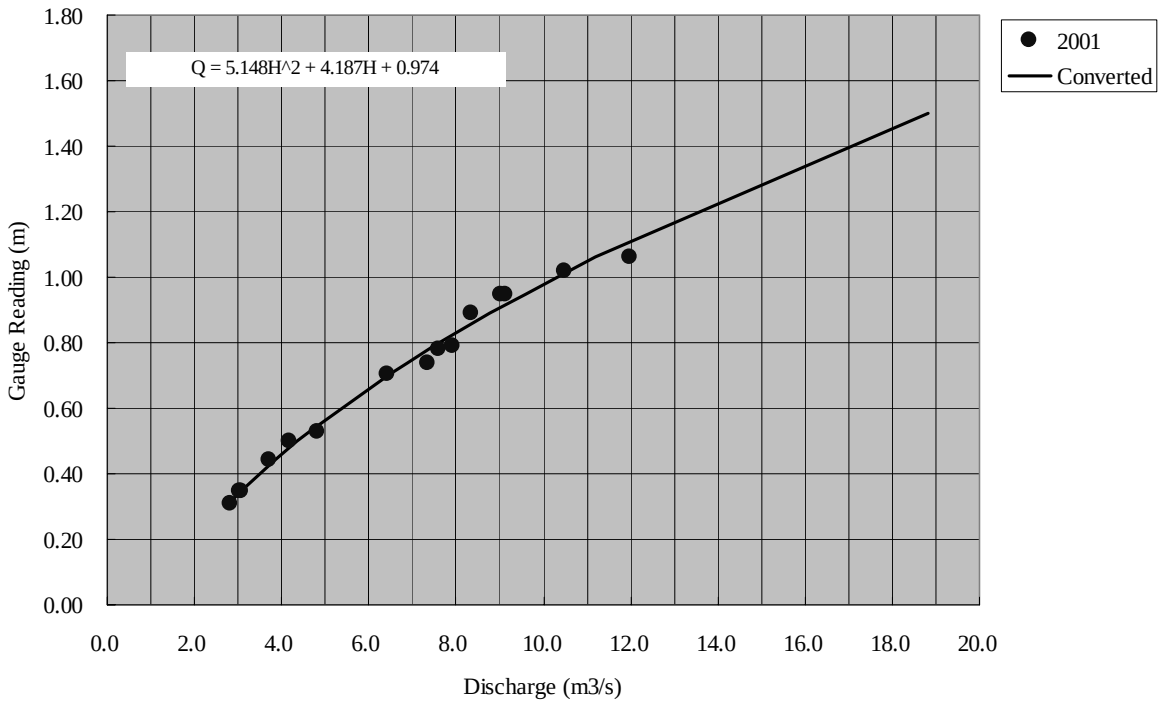
Source : JICA Study Team (*) Converted from Discharge Rating Curve

Appendix B-2-2 Discharge Measurement at Yeype Village

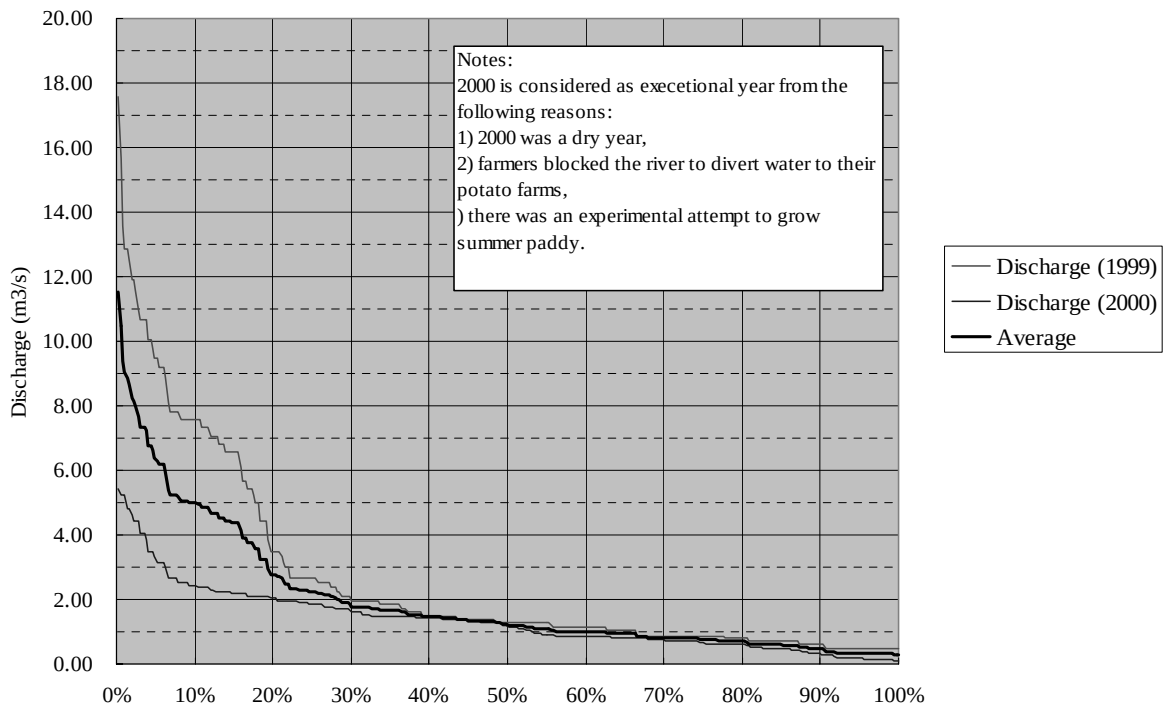
Date of Measurement	Gauge Reading (m)	Discharge (m3/s)	Converted Discharge (m3/s) (*)	Remarks
28 February 2001	0.39	1.5	0.8	
26 May 2001	0.90	3.1	4.4	
30 May 2001	1.20	8.8	7.8	
06 June 2001	1.50	12.0	12.2	
07 June 2001	0.70	3.4	2.7	
23 June 2001	0.55	1.6	1.7	
19 September 2001	0.56	1.2	1.7	
20 September 2001	0.54	1.6	1.6	
Gauge Reading under the bridge	2.00		21.7	highest water level according to the inhabitants

Source : JICA Study Team (*) Converted from Discharge Rating Curve

Appendix B-2-3 Discharge Rating Curve at Intake Site



Appendix B-2-4 Duration Curve at Yeype Bridge



Appendix B-2-5 Calculation of Design Flood

a) Method-1 : Probable rainfall of 100 year return

Probable Rainfall

Since the long-term daily rainfall data of Heho was not obtained, the calculation of the daily probable rainfall was carried out by the data of Taunnggyi station near the Heho project site. (Data source :Yeywa Report, Nippon Koei Co., Ltd.)

Table B-2-5.1 Daily Probable Rainfall

Return Period (year)	Probability	Rainfall (mm)
10	10.0 %	107
20	5.0 %	120
100	1.0 %	150
200	0.5 %	162

Flood Concentration time

The time for the flood to flow on the hill slope is assumed to be considerably short compared with that of the flood flowing down in the river channel judging from the geographical features of the catchment.

The flood concentration time was calculated using Rziha Equation.

$$t = \frac{L}{72(H/L)^{0.6}}$$

t：flood concentration time

L：Length of Stream : 25 km

Difference in elevation : 0.3 km

t = 4.93 hr

Average rainfall intensity

$$r_t = \frac{R_{24}}{100}\left(\frac{34{,}710}{t^{1.35} + 1{,}502}\right) \quad \text{(mm/hr)}$$

R_{24} : Daily Probable Rainfall (100 years' return period)

$r_t \cong 14.2$ mm/hr

Design Flood

Design Flood was calculated by Rational Formula.

$$Q = \frac{1}{3.6} f \cdot r_t \cdot A$$

Q：Design flood

f : Runoff Coefficient
r_t : Rainfall intensity
A : Catchment Area

Many sinkholes area scattered upstream of the Negya Chaung on north part of the catchment. The northern part is not connected with the main river-stream by surface channel. Therefore, in this flood examination the area of the northern part was excluded, the rest, 249 km^2 was treated as the catchment area.
Concerning the runoff coefficient, 0.5 was adopted for the calculation. This value is determined in Design Criteria by Irrigation Department for the land "slightly permeable, partly cultivated or covered with vegetation" .
As a result, the design flood Q was obtained as 491 m^3/s.

b) Mehod-2 : Recorded maximum rainfall
In the daily rainfall observation record at Heho station from 1954 to 1997, maximum rainfall was 131mm. The maximum flood was calculated by the same method as (a).
The design flood Q was 428 m^3/s.

c) Mehod-3 : Flood records commensurate with catchment area
Zauggyi river station is located in the northern part of Heho project site, where discharge has been measured for a long term.
The catchment area of Zauggyi station borders the catchment area of Heho project site, though the Zauggyi river is not in the same rives system as Negya. Therefore, it is expected that the geological and meteorological conditions of Zauggyi are comparatively similar to Heho project site.
The maximum flood of the past of the Zauggyi station is 1,982 m^3/s on September 24, 1949.
The maximum flood at Heho project site becomes 143 m^3/s by converting maximum flood at Zauggyi from the ratio of catchment areas between the two sites.

d) Mehod-4 : Creager's curve
The flood record in Myanmar, the summary of the report concerning the Creager's curve provided by the Irrigation Department and the summary of design flood of MEPE and Irrigation Department facilities of small catchment area were shown in Table B-2-5.2 and B-2-5.3.
The data from vicinities of Heho has been extracted from among these tables. And, 17.4 were obtained as the average value. (Table B-2-5.4, Figure B-2-5.1)

The amount of the maximum flood of Heho project site became 660 m^3/s since this value

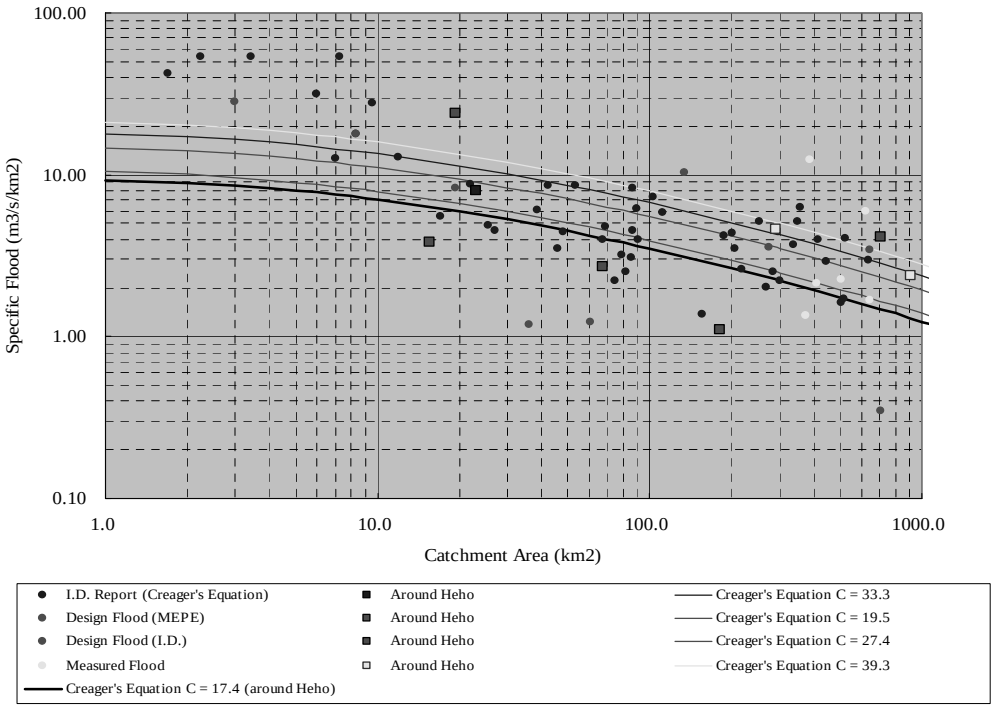
was substituted for the following equation.

（Creager's Equation） $$q = 1.3025C\left(\frac{A}{2.59}\right)^{\left(0.894\left(\frac{A}{2.59}\right)^{-0.048}-1\right)}$$

q : specific discharge（$m^3/s/km^2$）

A : catchment area C : Creager's coefficient

Figure B-2-5.1 Creager's Curve



e) Mehod-5 : Rating Curve at Yeype Bridge to calculate the from highest water level recorded at Yeype Bridge

According to interviews to some villagers, the water level did not rise as high as the wooden bridge near the Yeype gauge station level, which corresponds to a gauge height of 2.0 m of water level.

As discharge corresponding to the gauge level of 2.0 m from the rating curve is 21.5 m^3/s, the maximum flood the villagers ever observed at this site would have been below this figure.

f) Method-6 : Uniform flow at the Intake site

The measured gauge reading between the Yeype bridge and the Intake site have a strong correlation. The correlation coefficient is 0.96.

Taking this into consideration, the maximum gauge reading at the Intake site was estimated at 1.68m corresponding to that of the Yeype bridge.

By using this figure, a discharge of 28.8 m^3/s was obtained by hydraulic analysis assuming the uniform flow.

Table B-2-5.2 Runoff Coefficient in Myanmar (1/3)

Name of River / Project Name	Site	Run-off Coefficient	km2	State/Division	Major township near the site	Source
Mwegwe	Chaung-U	0.18	27	Sagaing	Chaung-U	Chriteria for Selection Techniques of Village Level Embankments (Dams) in Central Dry Zone Area of Burma, Irrigation Department
Mu	Kabo Weir	0.20	12,510	Sagaing	Ye-U	ditto
Kobin	Shwebo	0.17	114	Sagaing	Shwebo	ditto
Paungkadaung	Ye-U	0.15	104	Sagaing	Ye-U	ditto
Indawbauk	Kanbalu	0.19	78	Sagaing		ditto
Sedaw	Indaw	0.20	18	Sagaing	Indaw	ditto
Yezin	Yezin	0.30	93	Sagaing	Myinmu	ditto
Myitha	Kalewa	0.70	25,563	Sagaing	Kalewa	ditto
Thiteon	Thitson	0.19	311	Sagaing	Katha	ditto
Thapangyaung	Pyawbwe	0.18	39	Mandalay	Pyawbwe	ditto
Paunglaung	Pyinmana	0.40	4,400	Mandalay	Pyinmana	ditto
Meiktila Lake	Meiktila	0.14	622	Mandalay	Meiktila	ditto
Kyetmauktaunt	Kyaukpa daung	0.14	360	Mandalay	Kyaukpadaung	ditto
Sinthe	Tatkon	0.18	795	Mandalay	Tatkone	ditto
Sedawgyi	Madaya	0.40	3,424	Mandalay	Mandalay	ditto
Mon	Tatkon	0.30	104	Mandalay	Tatkon	ditto
Kintha	Tatkon	0.30	73	Mandalay	Tatkon	ditto
Bazinyoe	Taungtha	0.13	12	Mandalay	Taungtha	ditto
Pyaungpya	Myingyan	0.14	163	Mandalay	Myingyan	ditto
Letyetma	Myaing	0.18	17	Magway	Pakkoku	ditto
Myaing	Myaing	0.18	46	Magway	Pakkoku	ditto
Boke	Myothit	0.15	14	Magway	Myothit	ditto
Taungkinyan	Gangaw	0.20	75	Magway	Gangaw	ditto
Palaw	Gangaw	0.20	117	Magway	Gangaw	ditto
Mauk	Aingma Weir	0.40	1,476	Magway	Gangaw	ditto
Palaung	Pauk	0.18	27	Magway	Pauk	ditto
Seikchaung	Saw	0.18	28	Magway	Saw	ditto
Kinmundaung	Dam	0.29	80	Magway	Mindon	ditto
Ngalaik	Dam	0.20	316	Magway	Minbu	ditto
Yin	Natmauk	0.14	1,121	Magway	Natmauk	ditto
Panlaung	Kinda Weir	0.49	2,512	Shan	Kalaw	ditto
Yenwe	Myochaung	0.35	790	Bago	Myo Chaung	ditto

Table B-2-5.2 Runoff Coefficient in Myanmar (2/3)

Name of River / Project Name	Site	Run-off Coefficient	km2	State/Division	Major township near the site	Source
Pegu	Pegu	0.40	2,626	Bago	Bago	ditto
Swa	Road Bridge	0.20	1,492	Bago	Thagaya	ditto
Pyu	Road Bridge	0.30	1,106	Bago	Pyu	ditto
Kun	Road Bridge	0.31	1,015	Bago	Pyu	ditto
Okkan	Dam	0.34	225	Bago	Okkan	ditto
Thegaw	Dam	0.35	91	Bago	Let Pa Dan	ditto
Thonze	Dam	0.35	251	Bago	Thaya waddy	ditto
Kadioilin	Dam	0.35	241	Bago	Let Pa Dan	ditto
South Nawin	Dam	0.27	640	Bago	Prome	ditto
North Nawin	Dam	0.27	591	Bago	Prome	ditto
Shwele	Dam	0.27	67	Bago	Bago	ditto
Pyinbongyi	Dam	0.35	23	Bago	Pyin Bone Gyi	ditto
Thaukyegat	Doethaung	0.50	2,455	Bago	Taung Ngu	ditto
Shwegyin	Shwegyin	0.50	1,764	Bago	Shwegyin	ditto
Sittang	Toungoo	0.50	14,400	Bago	Toungoo	ditto
Ngamoyeik	Dam	0.50	414	Yangon	Hlae gu	ditto
Azin	Mudon	0.60	6	Mon	Mudon	ditto
Winpanon	Mudon	0.57	25	Mon	Mudon	ditto
Waba	Thaton	0.60	6	Mon	Thaton	ditto
Mu	Kabo	0.21	12,492	Sagaing	Ye-U	Summary of Stream Flow, Irrigation Department
Zawgyi	Ngapyaung	0.27	4,087	Southern Shan	Kyaukse	diito
Panlaung	Ingon	0.62	2,577	Mandalay	Kyaukse	diito
Meiktila Lake	Meiktila	0.17	622	Mandalay	Meiktila	diito
Chaungmagyi	Sedaw	0.61	3,424	Mandalay	Sedaw	diito
Yezin	Yezin	0.70	93	Mandalay	Yezin, Pyinmana	diito
Paunglaung	Kawmah	0.71	4,509	Mandalay	Pyinmana	diito
Salin	Linzin	0.10	2,124	Magway	Minbu	diito
Mon	Mezali	0.65	5,309	Magway	Minbu	diito
Man	Aingma	0.56	1,476	Magway	Minbu	diito
Pegu	Pegu	0.63	2,556	Bago	Bago	diito
Irrawaddy	Prome	0.55	362,599	Bago	Prome	diito

Table B-2-5.2 Runoff Coefficient in Myanmar (3/3)

Name of River / Project Name	Site	Run-off Coefficient	km2	State/Division	Major township near the site	Source
Saingdin		0.76	917	Rakhine	Maungdaw	diito
Balu Chaung	Loikaw	0.21	6,651	Kayah	Loikaw	diito
Washawng Irrigation Schme		0.65		Kachine	Myitkina	Washawng Irrigation Sheme, Final Design, 1958-1959, Elektroprojekt
Shweli		0.24	12,150	Northen Shan	Namkhan	Feasibility Study on Shweli Hydropower Project in Myanmar, March 2001, JETRO
Zawgyi		0.29	1,715	Southern Shan	Kyaukse	Final Report Zawgyi Hydropower Project, IVO International Ltd., March 1990
Myitnge	Shwesayan GS	0.37		Mandalay	Mandalay	
North Nawin		0.26	592	Bago	Prome	Feasibility Report on South Nawin Irrigation Project
South Nawin		0.41	640	Bago	Prome	ditto
Balu Chaung	Mobye dam	0.22		Kayah	Loikaw	Feasibility Study Report of the Baluchaung No.3 Power Station, EPC, January 1989

Table B-2-5.3 Design Flood of MEPE's Small- Hydro Power Plants and ID's Irrigation Projects

State/Division	Project Name	C.A.		Design Flood			q	Creager's C	Location	Sources
		sq. mile	km2	cusec	m3/s	return period	m3/s/km2			
【MEPE】										
Kachin State	Chinghkrang Hka		61.00	2,645	75	—	1.2	5.1	21 miles from Myitkina	MEPE
Kachin State	Namhkam Hka		36.00	1,500	42	—	1.2	4.1	14 miles east of Magaung	MEPE
Kachin State	Nam Dabak		134.00	49,045	1,389	—	10.4	57.6		MEPE
Mon State	Zingyaik		3.00	3,000	85	—	28.3	57.2	6 miles northeast of Paung, on the way to Mawlamyine	MEPE
Shan State	Kyaington-2 (Nam Lat Chaung)		67.00	6,360	180	—	2.7	11.5	8 miles southeast of Kyaington	MEPE
Shan State	Tatkyi Falls		1293.00		250	—	0.2	3.1	7 miles east of Yat Sauk	MEPE
Shan State	Kyaukme (Nam Saung Ngau Chaung)		181.30		200	—	1.1	6.9	6 miles east of Kyaukme	MEPE
Shant State	Mepin		15.54	2,113	60	—	3.9	10.6	Monghsat Township, Eastern Shan state	MEPE
【Irrigation Dept.】										
Shan State	Konmon Reservoir	7.45	19.30	5,630 6,295	159 178	100 200	8.3 9.2	24.0 26.8	3 miles south of Lashio	Hydrology Report on Konmon Reservoir Project, Hydrology
Mandaly Divisio	Kyauktalon Reservoir	60.00	155.40	23,057	653	1,000	4.2	24.8	Taungha township	Hydrology Report on Kyauktalon Reservoir Project, Hydrology Investigation Circle, May 1992
Chin State	Lai Va Dam	3.24	8.39	5,275 5,885	149 167	100 200	17.8 19.9	42.5 47.4	16 miles to the north-west of Hakha	Lai Va Dam Project, Preliminary Report, Hydrology Section, June 1989
Bago Division	Kabaung Chaung	418.00	1082.62	98,171 115,345	2,780 3,266	100 200	2.6 3.0	37.6 44.2	Shinpinkyetthauk Village, West of	Perspective Overviewing on Hydro-meteorological Information for the "Kabaung Chaung", Hydrology Branch, Irrigation Dept. April 2001
Kachin State	Washawng				300	100			North of Myitkina	Washawng Irrigation Scheme 1958-1959
Bago Division	South Nawin	248.00	642.32	78,337 85,404	2,218 2,418	100 200	3.5 3.8	38.8 42.2	East of Prome	Flood Report of South Nawin Chaung for the year 1980
Shan State	Nanlet Chaung	274.00	709.66	8,774	248	100	0.4	4.1	East of Heho	Nanlet Chaung Irrigation Scheme, Final Design, Elektroprojekt, 1965
Shan State	Nyaunggyat Dam Project	944.00	2444.95		2,200 2,500	100 200	0.9 1.0	20.6 23.4	50 miles to the south-east of Mandalay	Nyaungggyat Dam Project, Stage 1 Report, ECI, Sept. 1975
Yangon	Okkan Dam		275.00		975 865	100 200	3.5 3.1	26.7 23.7	Taikkyi and Hmawbi Township, 50 miles north of Yangon	Feasibility Report on the Okkan Dam Irrigation Project Nov. 1981, JICA

Table B-2-5.4 Design Flood and Measured Date around Heho site

State/ Division	Project Name / Site Name	C.A. (km2)	Design Flood/ Measured (m3/s)	Specific flood (m3/s/km2)	Creager's C	Remarks
Shan	Kyaington-2	67	180	2.69	11.5	
Shan	Kyaukme	181	200	1.10	6.9	
Shan	Nanlet Chaung	710	248	0.35	4.1	Design Flood (100 yrs)
Shan	Nyaunggyat Dam	2445	2200	0.90	20.6	Design Flood (100 yrs)
Shan	Hu-mon	23	183	7.94	24.2	Design Flood (100 yrs)
Shan	Zawgyi	4087	1982	0.48	14.9	Measured Flood (24/09/1949)
Shan	Yenwe	912	2180	2.39	32.0	Measured Flood (1937)
Mandalay	Samon	2580	1526	0.59	13.9	Design Flood (100 yrs)
Mandalay	Thitson	376	510	1.36	11.8	Measured Flood (1917)
Mandalay	Panlaung	2577	1699	0.66	15.5	Measured Flood (10/1926)
Mandalay	Thinbon Chaung	290	1334	4.60	35.5	Measured Flood
				average :	17.4	

Table B-3-1 Head Loss Calculation in Heho Small Hydro Scheme

FSWL at Intake	1,134.00
FSWL at Head Tank	1,132.62
TWL at Tailrace (turbine center)	905.050
Discharge (m3/sec)	4.300
Combined Efficiency of Turbine & Generator	0.850

PENSTOCK

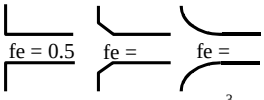
(1) Screen

$$h_{11} = f_r \cdot \frac{v_1^2}{2g} \qquad f_r = \beta(\sin\theta)(\frac{t}{b})^{4/3}$$

B(m)	H(m)	f_r	Velocity (m/s)	Head Loss (m)	Coefficient x 10^{-6} Q^2
6.00	2.63	1.00	0.272	0.0038	204.89

(2) Inlet

$$h_{12} = f_e \cdot \frac{v_2^2}{2g}$$



D (m)	f_e				
1.50	0.20	2.433	0.0604	3,267.60	

(3) Friction

$$h_{13} = \frac{124.5n^2}{D^{4/3}} L \frac{v^2}{2g}$$

$Q(m^3/s)$	n	D (m)	L (m)			
4.30	0.0120	1.50	761.82	2.433	2.4029	129,954.75
2.15	0.0120	0.70	12.00	5.587	0.5512	29,809.94

(4) Bend

$$h_{14} = \{0.131 + 0.1632 \cdot (\frac{D}{R})^{3.5}\} \cdot (\frac{\theta}{90})^{0.5} \cdot \frac{v^2}{2g}$$

$Q(m^3/s)$	R	D(m)	θ (°)			
4.30	5.000	1.50	19.88	2.433	0.0189	1,024.54
4.30	5.000	1.50	9.33	2.433	0.0130	701.62
4.30	5.000	1.50	4.31	2.433	0.0088	477.22
4.30	5.000	1.50	4.06	2.433	0.0086	462.73
4.30	5.000	1.50	33.27	2.433	0.0245	1,325.19
4.30	5.000	1.50	4.31	2.433	0.0088	477.11

(5) Transition

$$h_{15} = f_{gc} \frac{v_2^2}{2g}$$

D_1(m)	D_2(m)	L(m)	$f_{transition}$			
1.50	0.70	4.00	0.002	11.173	0.0127	688.97

(6) Branch

$$h_{16} = f_b \cdot \frac{v_0^2}{2g}$$

D_0(m)	f_b			
1.50	0.500	2.433	0.1510	8,169.00

(7) Inlet valve

$$h_{17} = f_v \cdot \frac{v^2}{2g}$$

$Q(m^3/s)$	D(m)	f_{valve}			
2.15	0.70	0.200	5.587	0.3185	17,224.32

(8) Others	Round-up	0.0069	371.12
Sub-total (1) - (8)		3.5900	194,159.00

TAILRACE

Discharge $Q(m^3/s)$: 4.30

(1) Friction in transition

$$h_{21} = \frac{2.37 \cdot n^2 Q^2 L}{D_2 - D_1} \cdot (\frac{1}{D_1^{13/3}} - \frac{1}{D_2^{13/3}})$$

n	D_1(m)	D_2(m)	L(m)	Velocity (m/s)	Head Loss (m)	Coefficient x 10^{-6} Q^2

(2) Enlargement

$$h_{21} = f_{ge}\{1 - (\frac{A_1}{A_2})\}^2 \cdot \frac{v_1^2}{2g}$$

D_1(m)	D_2(m)	f_{ge}			

(3) Exit

$$h_{23} = f_{exit} \cdot \frac{v^2}{2g}$$

D(m)	f_{exit}			
2.00	1.000	1.369	0.0956	5,169.45

(4) Others	10%	0.0096	516.94
Sub-total		0.1051	5,686.39
Total of Head Loss		3.6951	199,845.40

Gross Head (m)	228.950
Effective Head (m)	223.875
Power Output (kW)	8,000

Table B-3-2 Principle Dimensions of Waterway in Heho Small Hydro Scheme

CTRL + f

General	Discharge (m^3/s)	4.300		
	FSWL (m)	1,134.000		
Intake Weir	FWL.	1,137.000	Crest EL.	1,134.00
	Width (m)	10.000	Overflow capacity (m^3/s)	103.9
Sand Flush	Width (m)	2.000	Sill Level	1,130.800
	Slope	1:10		
Intake	Bottom floor level	1,132.300	Velocity at Intake (m/s)	0.632
	Intake deck level	1,138.000	Freeboard on FWL (m)	1.000
	Width (m)	4.000	Top EL. of Gate	1,134.000
	Gate width (m)	2.000	Velocity at Gate (m/sec)	1.265
De-Silting Basin	Width (m)	6.000	V_{max} (m/sec)	0.422
	Bottom EL. at B.P. (m)	1,132.300	V_{min} (m/sec)	0.212
	Bottom EL. at E.P. (m)	1,130.620	$Depth_{min}$ (m)	1.700
	Length (m)	23.000	$Length_{max}$ (m)	15.300
	Slope	1 : 25	$Length_{min}$ (m)	10.200
Headrace (free flow)	FH. at BP. of Tunnel	1,132.262	FH. at EP. of Tunnel	1,131.043
	Length (m)	1,218.480	Uniform flow depth (m)	1.580
	Slope (1 : ####)	1,000.000	Velocity (m/sec)	1.573
	B or D (m)	2.000	Depth ratio (%)	0.790
	Roughness	0.016		
Head Tank	Transition length (m)	6.500	WL at Head Tank	1,132.623
	FH. at EP. Transition (m)	1,130.579	Tank Volume (m^3)	259.142
	Length of Tank (m)	19.500	Volume / Q (sec)	60.3
	Min. Water Level (m)	1,130.800	Area / Q (sec/m)	33.3
	Width of Tank (m)	6.000	Velocity at EP. Tank	0.35
Penstock	Diameter (m)	1.500	Velocity (m/sec)	2.433
	Dia. after branch (m)	0.700	V after branch(m/sec)	5.587

Reference	Crest Level of Intake Weir	EL. 1	= Full Supply Water Level
	F.H. of Sand Flush Gate	EL. 2	= Original River Bed + (0.5m ~ 1.0m)
	F.H. of Intake	EL. 3	= EL.2 + (1.0m ~ 1.5m)
	Velocity at Intake		0.5 m/sec ~ 1.0 m/sec approx.
	Top of Intake Deck	EL. 4	= Flood Water Level + freeboard (> 1.0m)
	Top of Intake Gate		= FSWL
	Velocity at Intake Gate		1.0 m/sec ~ 1.5 m/sec approx.
	Crest of Side Spillway	EL. 5	= FSWL - (0cm ~ 10cm)
	Slope of De-silting Basin	n_1	1 : 10 ~ 1 : 30
	Velicity in De-silting Basin		< 0.3 m/sec
	Length of De-silting Basin		> (2 ~ 3) x depth x velocity / sedimentation rate
			= (2 ~ 3) x depth x 0.3 / 0.1 = (6 ~ 9) x depth
	EL. of Sand Drain	EL. 6	> (original river bed)
	F.H. of Intake Conduit	EL. 7	= EL. 1
	Slope of Headrace Tunnel		1 : 1,000 ~ 1 : 1,500
	Velocity in Headrace Tunnel		2 ~ 3m/s

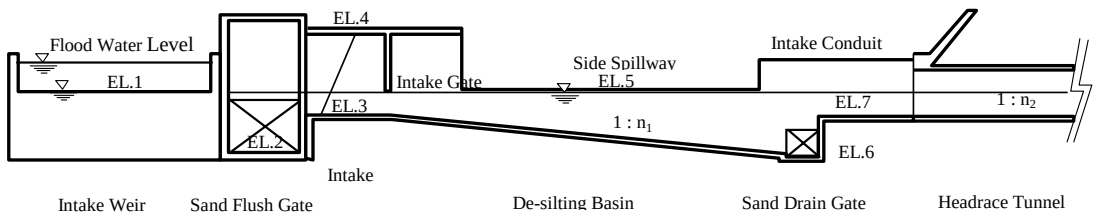


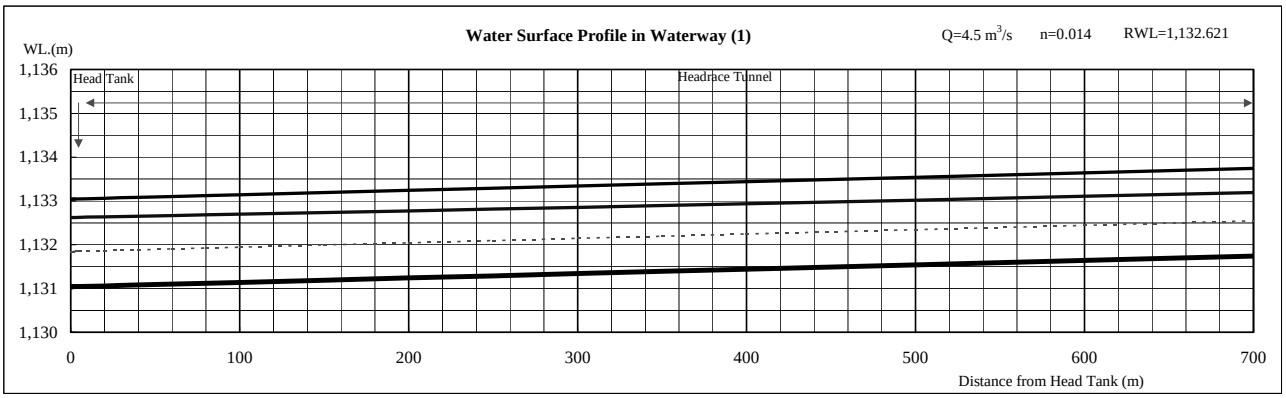
Table B-3-3 Waterway Surface Profile in Intake and Headrace Tunnel (1/2)

Title Water Surface Profile from Head Tank to Intake

	Shape
Rectangle	1
Trapezoid	2
Circle	3
C & R	4
(x, y)	5

No.	Q (m3/s)	EL. (m)	Distance (m)	n	Width (m)	Dia. (m)	Depth (m)	WL. (m)	F.B. (m)	V (m/s)	C.D. (m)	Shape	C.W.L. (m)
1	4.300	1,131.041	0.000	0.0140	2.000	2.000	1.580	1,132.621	0.420	1.391	0.804	4	1,131.845
2	4.300	1,131.042	1.000	0.0140	2.000	2.000	1.580	1,132.622	0.420	1.391	0.804	4	1,131.846
3	4.300	1,131.043	2.000	0.0140	2.000	2.000	1.579	1,132.622	0.421	1.391	0.804	4	1,131.847
4	4.300	1,131.044	3.000	0.0140	2.000	2.000	1.579	1,132.623	0.421	1.392	0.804	4	1,131.848
5	4.300	1,131.046	5.000	0.0140	2.000	2.000	1.579	1,132.625	0.421	1.392	0.804	4	1,131.850
6	4.300	1,131.051	10.000	0.0140	2.000	2.000	1.577	1,132.628	0.423	1.393	0.804	4	1,131.855
7	4.300	1,131.061	20.000	0.0140	2.000	2.000	1.575	1,132.636	0.425	1.395	0.804	4	1,131.865
8	4.300	1,131.071	30.000	0.0140	2.000	2.000	1.572	1,132.643	0.428	1.397	0.804	4	1,131.875
9	4.300	1,131.081	40.000	0.0140	2.000	2.000	1.570	1,132.651	0.430	1.399	0.804	4	1,131.885
10	4.300	1,131.101	60.000	0.0140	2.000	2.000	1.565	1,132.666	0.435	1.402	0.804	4	1,131.905
11	4.300	1,131.121	80.000	0.0140	2.000	2.000	1.560	1,132.681	0.440	1.406	0.804	4	1,131.925
12	4.300	1,131.141	100.000	0.0140	2.000	2.000	1.555	1,132.696	0.445	1.410	0.804	4	1,131.945
13	4.300	1,131.191	150.000	0.0140	2.000	2.000	1.543	1,132.734	0.457	1.419	0.804	4	1,131.995
14	4.300	1,131.241	200.000	0.0140	2.000	2.000	1.532	1,132.773	0.468	1.428	0.804	4	1,132.045
15	4.300	1,131.291	250.000	0.0140	2.000	2.000	1.522	1,132.813	0.478	1.436	0.804	4	1,132.095
16	4.300	1,131.341	300.000	0.0140	2.000	2.000	1.512	1,132.853	0.488	1.445	0.804	4	1,132.145
17	4.300	1,131.391	350.000	0.0140	2.000	2.000	1.502	1,132.893	0.498	1.452	0.804	4	1,132.195
18	4.300	1,131.441	400.000	0.0140	2.000	2.000	1.493	1,132.934	0.507	1.460	0.804	4	1,132.245
19	4.300	1,131.541	500.000	0.0140	2.000	2.000	1.477	1,133.018	0.523	1.474	0.804	4	1,132.345
20	4.300	1,131.641	600.000	0.0140	2.000	2.000	1.464	1,133.105	0.536	1.487	0.804	4	1,132.445
21	4.300	1,131.741	700.000	0.0140	2.000	2.000	1.451	1,133.192	0.549	1.498	0.804	4	1,132.545
22	4.300	1,131.841	800.000	0.0140	2.000	2.000	1.441	1,133.282	0.559	1.507	0.804	4	1,132.645
23	4.300	1,131.941	900.000	0.0140	2.000	2.000	1.432	1,133.373	0.568	1.516	0.804	4	1,132.745
24	4.300	1,132.041	1,000.000	0.0140	2.000	2.000	1.425	1,133.466	0.575	1.523	0.804	4	1,132.845
25	4.300	1,132.115	1,074.000	0.0140	2.000	2.000	1.420	1,133.535	0.580	1.528	0.804	4	1,132.919
26	4.300	1,132.165	1,124.000	0.0140	2.000	2.000	1.417	1,133.582	0.583	1.531	0.804	4	1,132.969
27	4.300	1,132.205	1,164.000	0.0140	2.000	2.000	1.415	1,133.620	0.585	1.533	0.804	4	1,133.009
28	4.300	1,132.235	1,194.000	0.0140	2.000	2.000	1.413	1,133.648	0.587	1.534	0.804	4	1,133.039
29	4.300	1,132.255	1,214.000	0.0140	2.000	2.000	1.412	1,133.667	0.588	1.535	0.804	4	1,133.059
30	4.300	1,132.256	1,215.000	0.0140	2.000	2.000	1.412	1,133.668	0.588	1.535	0.804	4	1,133.060
31	4.300	1,132.257	1,216.000	0.0140	2.000	2.000	1.412	1,133.669	0.588	1.535	0.804	4	1,133.061
32	4.300	1,132.258	1,217.000	0.0140	2.000	2.000	1.412	1,133.670	0.588	1.535	0.804	4	1,133.062
33	4.300	1,132.259	1,218.000	0.0140	2.000	2.000	1.412	1,133.671	0.588	1.535	0.804	4	1,133.063
34	4.300	1,132.259	1,218.483	0.0140	2.000		1.416	1,133.675	0.584	1.519	0.804	1	1,133.063
35	4.300	1,132.259	1,219.483	0.0140	2.000		1.417	1,133.676	0.583	1.517	0.804	1	1,133.063
36	4.300	1,132.259	1,224.483	0.0140	2.000		1.422	1,133.681	0.578	1.512	0.804	1	1,133.063
37	4.300	1,132.259	1,229.483	0.0140	2.000		1.428	1,133.687	0.572	1.506	0.804	1	1,133.063
38	4.300	1,132.259	1,239.483	0.0140	2.000		1.439	1,133.698	0.561	1.494	0.804	1	1,133.063
39	4.300	1,132.259	1,250.183	0.0140	2.000		1.450	1,133.709	0.550	1.483	0.804	1	1,133.063
40	4.300	1,132.259	1,255.183	0.0140	2.000		1.455	1,133.714	0.545	1.477	0.804	1	1,133.063
41	4.300	1,130.620	1,258.263	0.0140	6.000		3.237	1,133.857		0.221	0.386	1	1,131.006
42	4.300	1,130.620	1,259.263	0.0140	6.000		3.237	1,133.857		0.221	0.386	1	1,131.006
43	4.300	1,130.620	1,260.263	0.0140	6.000		3.237	1,133.857		0.221	0.386	1	1,131.006
44	4.300	1,130.620	1,261.263	0.0140	6.000		3.237	1,133.857		0.221	0.386	1	1,131.006
45	4.300	1,130.620	1,261.763	0.0140			3.237	1,133.857	0.043	0.247	0.644	5	1,131.264
46	4.300	1,130.660	1,264.349	0.0140			3.197	1,133.857	0.043	0.250	0.644	5	1,131.304
47	4.300	1,130.700	1,265.349	0.0140			3.156	1,133.856	0.044	0.254	0.644	5	1,131.344
48	4.300	1,130.740	1,266.349	0.0140			3.116	1,133.856	0.044	0.258	0.644	5	1,131.384
49	4.300	1,130.780	1,267.349	0.0140			3.076	1,133.856	0.044	0.261	0.644	5	1,131.424
50	4.300	1,130.820	1,268.349	0.0140			3.036	1,133.856	0.044	0.265	0.644	5	1,131.464
51	4.300	1,130.860	1,269.349	0.0140			2.996	1,133.856	0.044	0.269	0.644	5	1,131.504
52	4.300	1,130.900	1,270.349	0.0140			2.956	1,133.856	0.044	0.273	0.644	5	1,131.544
53	4.300	1,130.940	1,271.349	0.0140			2.916	1,133.856	0.044	0.278	0.644	5	1,131.584
54	4.300	1,130.980	1,272.349	0.0140			2.876	1,133.856	0.044	0.282	0.644	5	1,131.624
55	4.300	1,131.020	1,273.349	0.0140			2.836	1,133.856	0.044	0.286	0.644	5	1,131.664
56	4.300	1,131.060	1,274.349	0.0140			2.795	1,133.855	0.045	0.291	0.644	5	1,131.704
57	4.300	1,131.097	1,275.349	0.0140			2.754	1,133.851	0.049	0.409	0.631	5	1,131.728
58	4.300	1,131.137	1,276.263	0.0140			2.714	1,133.851	4.149	0.415	0.631	5	1,131.768
59	4.300	1,131.177	1,277.263	0.0140			2.674	1,133.850	4.150	0.422	0.631	5	1,131.808
60	4.300	1,131.217	1,278.263	0.0140			2.633	1,133.850	4.150	0.429	0.631	5	1,131.848
61	4.300	1,131.257	1,279.263	0.0140			2.593	1,133.850	4.150	0.436	0.631	5	1,131.888
62	4.300	1,131.297	1,280.263	0.0140			2.553	1,133.849	4.151	0.443	0.631	5	1,131.928
63	4.300	1,131.497	1,281.263	0.0140	5.200		2.357	1,133.854	4.146	0.351	0.425	1	1,131.922

Table B-3-4 Waterway Surface Profile in Intake and Headrace Tunnel (2/2)



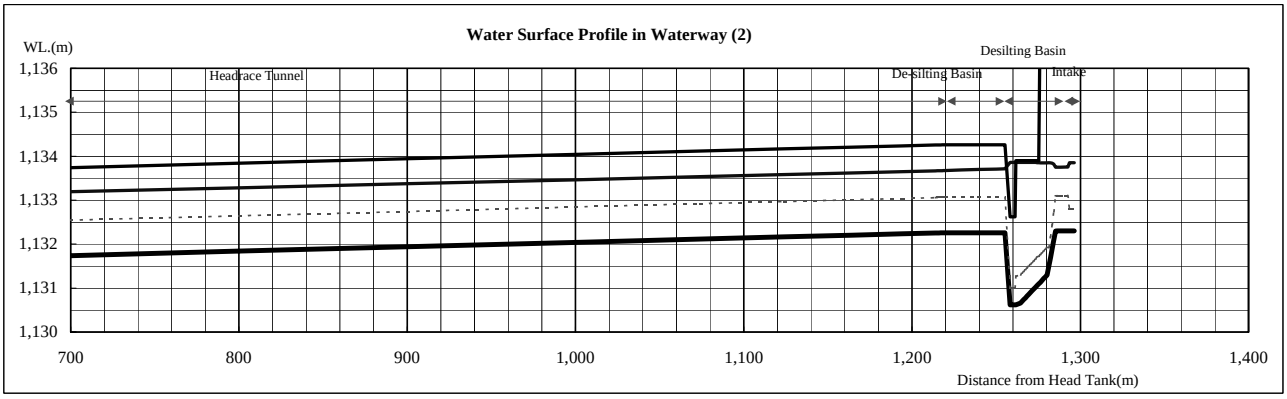


Table B-4-1 Calculation of Power Generation for Run-of-River Operation using Inflow into Heho Dam from 1966 to 1971 and from 1996 to 2001

Conditions

Max. Discharge (m^3/sec)	4.300
FSWL. at Intake	1,134.00
FSWL. at Head Tank	1,132.62
TWL at Tailrace	905.05
Gross Head (m)	228.950
Effective Head (m)	223.875
Installed Capacity (kW)	8,000
Nos. of Turbine (units)	2
Min. Discharge (m^3/s)	0.645

Results

Average Output (kW)	5,712
Average Energy (kWh/day)	4,178,908
Annual Energy (GWh/year)	47.64
Plant Factor (%)	67.8%

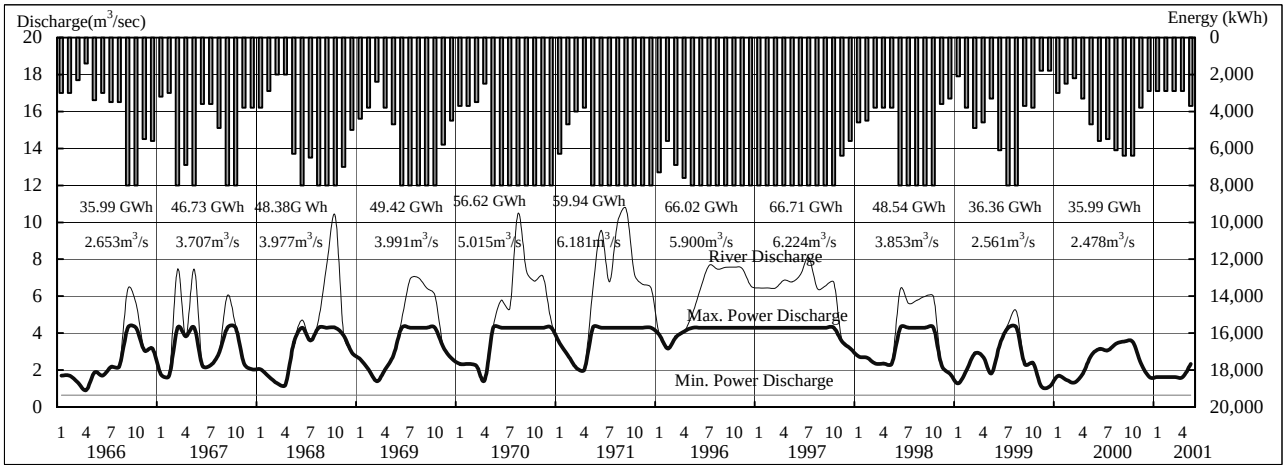


Table B-4-2 Calculation of Power Generation for Run-of-River Operation using Discharge at Yeype Bridge from 1998 to 2001

Conditions

Max. Discharge (m^3/sec)	**4.300**
FSWL. at Intake	**1,134.00**
FSWL. at Head Tank	**1,132.62**
TWL at Tailrace	**905.05**
Gross Head (m)	**228.950**
Effective Head (m)	**223.875**
Installed Capacity (kW)	**8,000**
Nos. of Turbine (units)	**2**
Min. Discharge (m^3/s)	**0.645**

Results

Average Output (kW)	**3,137**
Average Energy (kWh/day)	**2,306,147**
Annual Energy (GWh/year)	**26.29**
Plant Factor (%)	**37.3%**

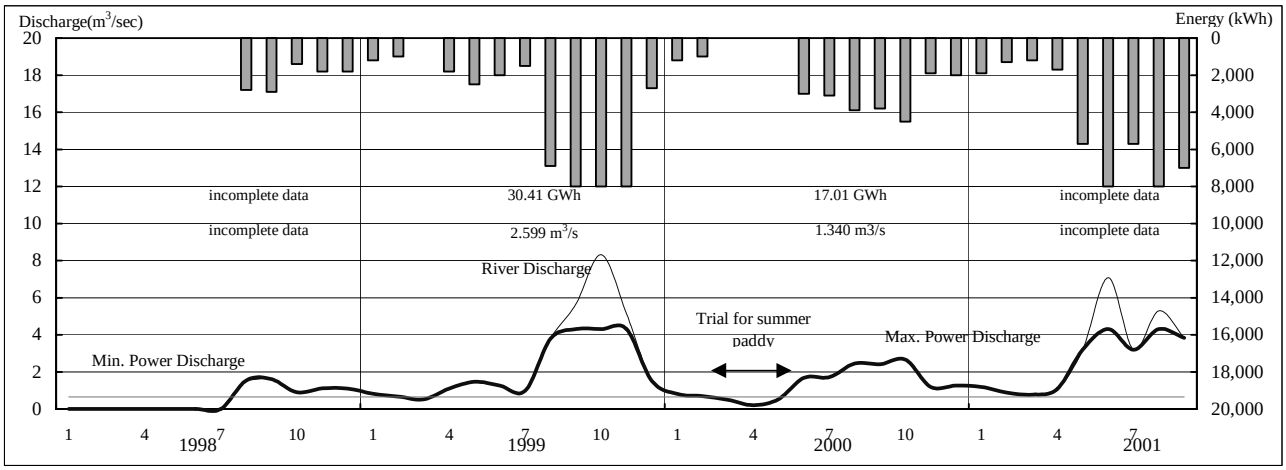
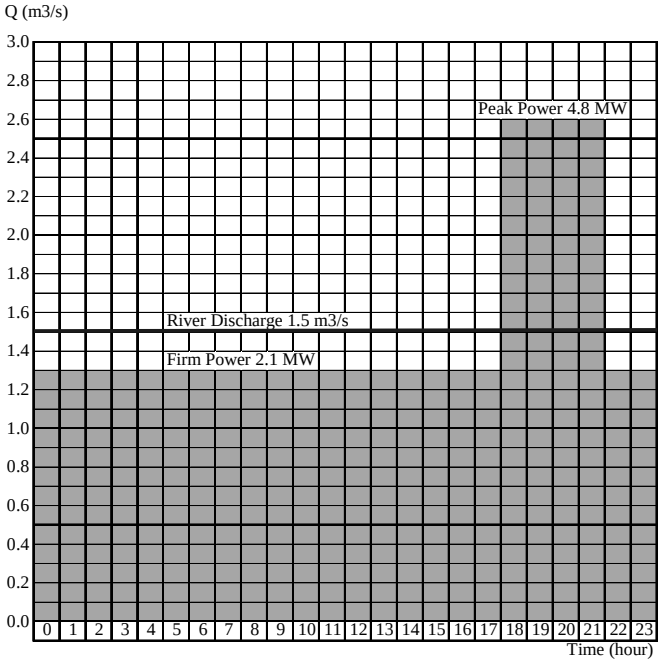


Table B-4-3 Calculation of Power Generation for River Channel Storage Operation During Dry Season

Inflow (m3/s)	Qpower (m3/s)	Storage (m3)	η
1.50	1.28	18,800	0.765
			0.850

River slope 1/500
Gate height 2.5 m
Storage length 2.5 x 500 = 1,250m
River width 12 m

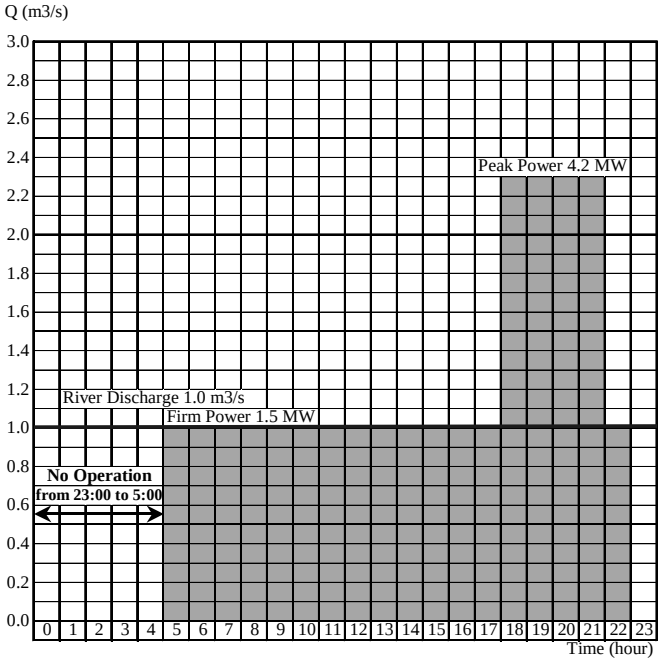
Hour	Inflow (m3/s)	Qfirm (m3/s)	Qpeak (m3/s)	Qtotal (m3/s)	Power (kW)
1	1.50	1.28		1.28	2,144
2	1.50	1.28		1.28	2,144
3	1.50	1.28		1.28	2,144
4	1.50	1.28		1.28	2,144
5	1.50	1.28		1.28	2,144
6	1.50	1.28		1.28	2,144
7	1.50	1.28		1.28	2,144
8	1.50	1.28		1.28	2,144
9	1.50	1.28		1.28	2,144
10	1.50	1.28		1.28	2,144
11	1.50	1.28		1.28	2,144
12	1.50	1.28		1.28	2,144
13	1.50	1.28		1.28	2,144
14	1.50	1.28		1.28	2,144
15	1.50	1.28		1.28	2,144
16	1.50	1.28		1.28	2,144
17	1.50	1.28		1.28	2,144
18	1.50	1.28	1.31	2.59	4,807
19	1.50	1.28	1.31	2.59	4,807
20	1.50	1.28	1.31	2.59	4,807
21	1.50	1.28	1.31	2.59	4,807
22	1.50	1.28		1.28	2,144
23	1.50	1.28		1.28	2,144
24	1.50	1.28		1.28	2,144
		110,800	18,800		
	129,600	129,600		129,600	



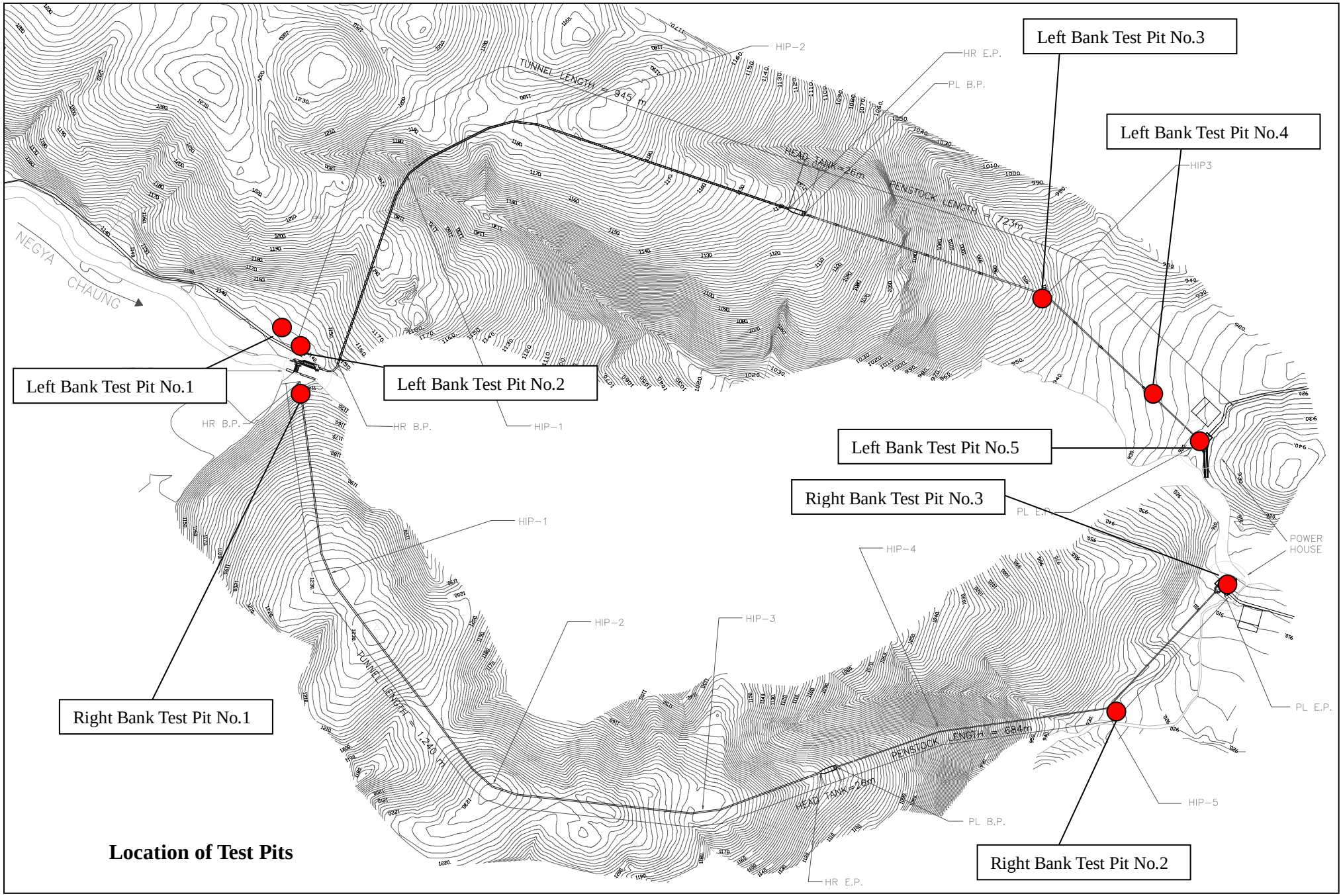
Inflow (m3/s)	Qpower (m3/s)	Storage (m3)	η
1.00	1.00	18,800	0.723
			0.850

River slope 1/500
Gate height 2.5 m
Storage length 2.5 x 500 = 1,250m
River width 12 m

Hour	Inflow (m3/s)	Qfirm (m3/s)	Qpeak (m3/s)	Qtotal (m3/s)	Power (kW)
1	1.00	0.00		0.00	0
2	1.00	0.00		0.00	0
3	1.00	0.00		0.00	0
4	1.00	0.00		0.00	0
5	1.00	0.00		0.00	0
6	1.00	1.00		1.00	1,579
7	1.00	1.00		1.00	1,579
8	1.00	1.00		1.00	1,579
9	1.00	1.00		1.00	1,579
10	1.00	1.00		1.00	1,579
11	1.00	1.00		1.00	1,579
12	1.00	1.00		1.00	1,579
13	1.00	1.00		1.00	1,579
14	1.00	1.00		1.00	1,579
15	1.00	1.00		1.00	1,579
16	1.00	1.00		1.00	1,579
17	1.00	1.00		1.00	1,579
18	1.00	1.00	1.31	2.31	4,283
19	1.00	1.00	1.31	2.31	4,283
20	1.00	1.00	1.31	2.31	4,283
21	1.00	1.00	1.31	2.31	4,283
22	1.00	1.00		1.00	1,579
23	1.00	1.00		1.00	1,579
24	1.00	0.00		0.00	0
		64,800	18,800		
	86,400	83,600		83,600	



River Storage Patterns of Heho Small Hydro Scheme (Right Bank)



Location of Test Pits

GEODYNAMICS CO.,LTD.

Geotechnical Engineering.

LOG OF TEST PIT OR AUGER HOLE

FOR BORROW AND FOUNDATION INVESTIGATIONS

Feature INTAKE PORTAL Project HEHO HYDROPOWER PROJECT Hole No. TP-1

Area Designation---------- Coordinates---------- Ground Elevation---------- Depth to Ground Water Level NIL

Method of Excavation Manual Approx;Dimension of Hole 4'x6'x15' Dates of Excavation 25/26-May-01 Hole Logged By S.Lwin

CLASSIFICATION SYMBOL LETTER	CLASSIFICATION SYMBOL GRAPHIC	DEPTH (FEET)	SIZE AND TYPE OF SAMPLE TAKEN	CLASSIFICATION AND DESCRIPTION OF MATERIAL (SEE CHART UNIFIED SOIL CLASSIFICATION GIVE GEOLOGIC AND IN-PLACE DESCRIPTIONFOR FOUNDATION INVESTIGATION)	PERCENTAGE OF COBBLES AND BOULDERS** VOLUME OF HOLES SAMPLED (CUIC FEET)	WEIGHT OF 3 TO 5 INCH SAMPLED(LBS)	PERCENTAGE BY VOLUME OF 3 TO 5 INCH	WEIGHT OF PLUS 5 INCH SAMPLED (LBS)	PERCENTAGE BY VOLUME OF PLUS TO 5 INCH
				0-2.5ft. Top soil. Dark brown silty clay with organic matter					
CH		5		2.5 -7.0ft .Slope wash Yellowish brown stiff clay .At 6-7ft highly weathered rock pieces are found mixing with clay (CH)					
CH		10		7.0-15ft stiff clay. Reddish yellow, hard in excavation,slightly moist,with scattered highly weathered limestone pieces scattered all over the layer (CH)					
		15		Note-Phacoidal Limestone outcrop is found at 50 ft from the pit on the higher slope level.Bedding strike N20°E and dip west.					

REMARKS

NOTES Record water test and density test data, if applicable, under remarks
*Record after water has reached its natural level, give date of reading adjacent to graphic symbol or in remarks
**Applicable ely to borrow pits and to foundations which are potential sources of construction materials

*** (lbs of rock sampled)(100)
(bulk specific gravity of rock)(624 (Cubic feet hole sampled)
Record bulk specific gravity in remarks, stating how obtained (measured or estimated)

Figure B-5-1 Log of Left Bank Test Pit No.1

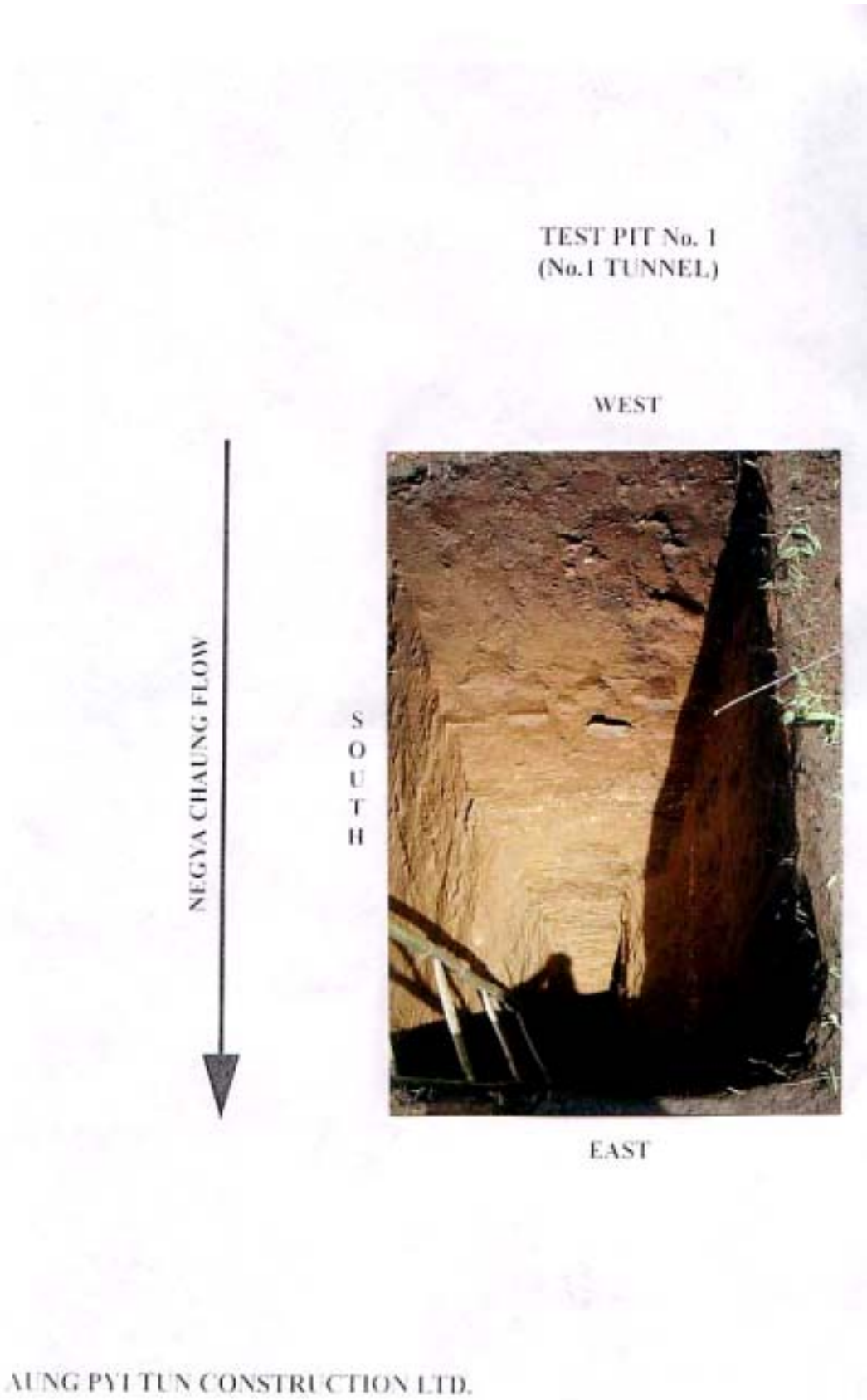


Figure B-5-2 Photograph of Left Bank Test Pit No.1 (1/2)

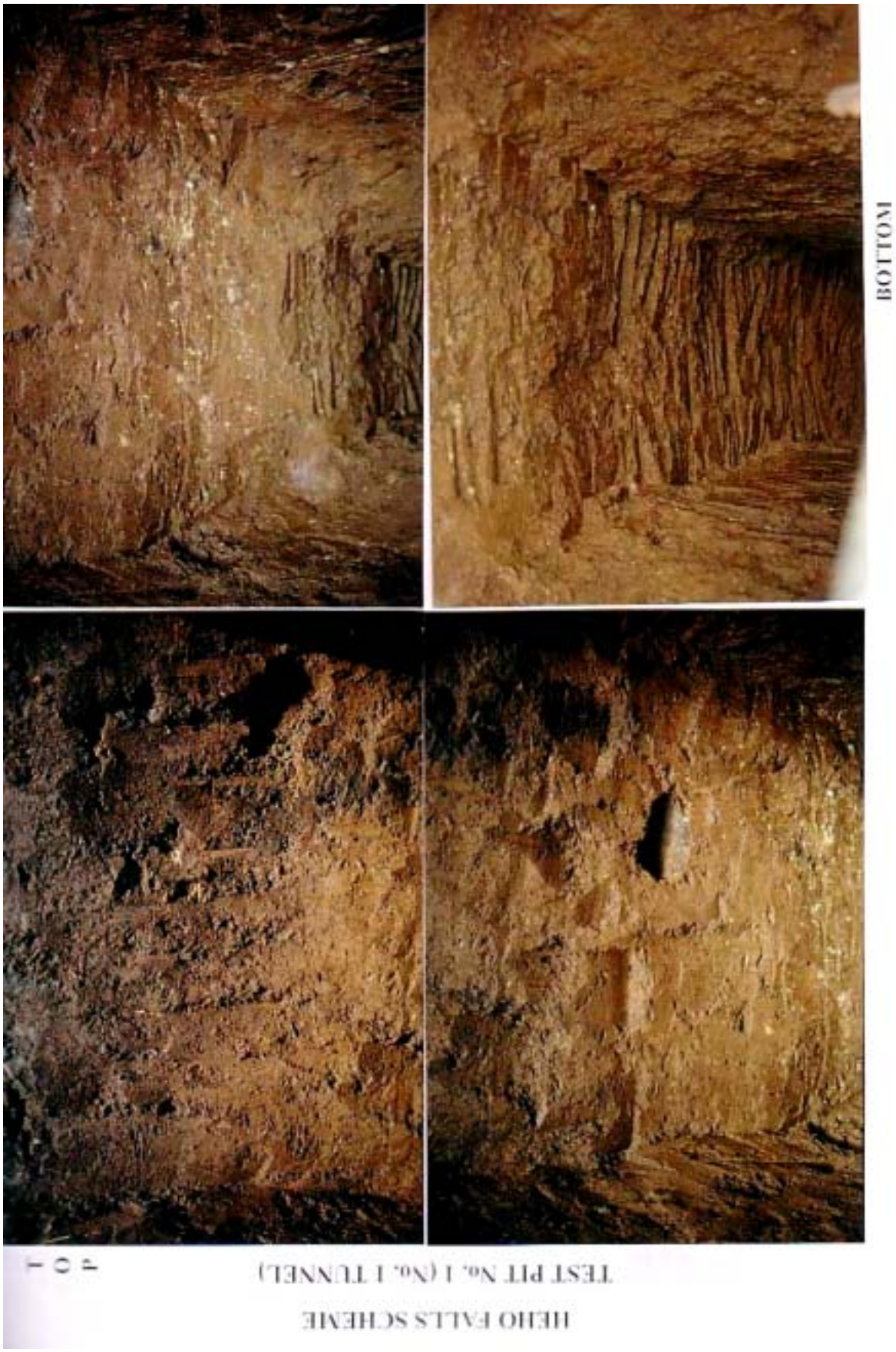


Figure B-5-3 Photograph of Left Bank Test Pit No.1 (2/2)

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Geotechnical Engineering.

LOG OF TEST PIT OR AUGER HOLE

FOR BORROW AND FOUNDATION INVESTIGATIONS

Feature ALTERNATIVE PORTAL SITE Project HEHO HYDROPOWER PROJECT

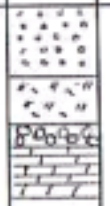
Hole No. TP-2

Area Designation---------- Coordinates----------Ground Elevation----------

Depth to Ground Water Level NIL

Method of Excavation Manual Approx;Dimension of Hole 4'x6'x5.5' Dates of Excavation 25-May-01

Hole Logged By S.Lwin

CLASSIFICATION SYMBOL LETTER	CLASSIFICATION SYMBOL GRAPHIC	DEPTH (FEET)	SIZE AND TYPE OF SAMPLE TAKEN	CLASSIFICATION AND DESCRIPTION OF MATERIAL (SEE CHART UNIFIED SOIL CLASSIFICATION GIVE GEOLOGIC AND IN-PLACE DESCRIPTIONFOR FOUNDATION INVESTIGATION)	PERCENTAGE OF COBBLES AND BOULDERS** VOLUME OF HOLES SAMPLED (CUBIC FEET)	WEIGHT OF 3 TO 3 INCH SAMPLED(LBS)	PERCENTAGE BY VOLUME OF 3 TO 5 INCH	WEIGHT OF PLUS 5 INCH SAMPLED (LBS)	PERCENTAGE BY VOLUME OF PLUS TO 5 INCH
CL		5' 10 15'		0-2.5ft. Top soil. Dark brown silty clay with organic matter 2.5 -3.4 ft .Reddish brown silty clay (CL) with small pieces of weathered limestone 3.4-4.0 Rock boulders.Loose pieces of limestone in clay.Largest size 1-1.5ft^3 4.0-5.5 Bed rock.Moderately weathered phacoidal limestone light yellow colour Very hard to excavat manually. Joint N-S with 80°-85° dip towards west. One joint set strike 118° and dip east at high angle.					

REMARKS

NOTES:Record water test and density test data, if applicable, under remarks

*Record after water has reached its natural level, give date of reading adjacent to graphic symbol or in remarks

**Applicable ally to borrow pits and to foundations which are potential sources of construction materials

*** (lbs of rock sampled)/100

(bulk specific gravity of rock)(24 (Cubic feet hole sampled)

(Record bulk specific gravity in remarks stating how obtained (in control or estimated)

Figure B-5-4 Log of Left Bank Test Pit No.2