No. 33

MALAYSIA

FEASIBILITY STUDY ON SMALL SCALE HYDROELECTRIC POWER DEVELOPMENT PROJECT AT UPPER LIWAGU RIVER BASIN IN SABAH

FINAL REPORT

APPENDIX VOL. I

OCTOBER, 1992

JAPAN INTERNATIONAL COOPERATION AGENCY

M P N
C R (3)
92-176(3)

MALAYSIA FEASIBILITY STUDY ON SMALL SCALE HYDROELECTRIC POWER DEVELOPMENT PROJECT AT UPPER LIWAGU RIVER BASIN IN SABAH FINAL REPORT APPENDIX VOL. I
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FEASIBILITY STUDY
ON
SMALL SCALE HYDROELECTRIC POWER DEVELOPMENT PROJECT
AT UPPER LIWAGU RIVER BASIN
IN SABAH

FINAL REPORT

APPENDIX VOL. I

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OCTOBER, 1992

JAPAN INTERNATIONAL COOPERATION AGENCY

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Appendix 1

TOPOGRAPHIC SURVEY DATA

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SURCOM SERVICES SDN. BHD.
2nd Floor, No. 126 Jalan Gaya, Kota Kinabalu.
Land Surveyors: Land Title, Engineering, Topographic Hydrographic Surveyors

P. O. BOX No. 11125, 88812 KOTA KINABALU.
P. O. BOX No. 276, 91007 Tawau.

TEL: 81802, 217927
FAX: 211933
TELEFAX: 778978

Our Ref: UBS/0[illegible].57

7th January 1992

7/1/92

Pengurus Besar,
Lembaga Letrik Sabah,
Wisma LLS,
Kota Kinabalu.

BTA(B)
Please check claims
17/1

(2) KJ/HA
Kerja-kerja pengukuran ini telah siap 100%. Buat masa ini kami masih menunggu pengesahan dari JICA terhadap quality kerja ini. Surcom sudah telah maraya beberapa kali supaya pembayaran dibuat

Tuan,

RE: SURVEY WORKS AT UPPER LIWAGU RIVER BASIN
TENDER NO. T. 2155

We have the pleasure to inform you that we have completed the survey of the above mentioned. Enclose her with please find the followings for your reference and retention:

1) one set of tracing plans (SUR/UBS/[illegible])
2) 1 Traversing book
3) 2 Levelling books
4) 3 Topographic field books
5) 2 Computation sheets
6) 1 set of List of T.B.M.s
7) Invoice No: UBS/92/1/2

Kami sarankan supaya 70% daripada bayaran sepenuhnya dapat dikeluarkan sementara yang 30% lagi setelah mendapat pengiktirapan daripada JICA pada 7/2/92

17/01/92

Thank you.

(3) UPK Kej.
Sila sediakan baucer.
17/1

Yang Benar,
SURCOM SERVICES SDN. BHD.

P 34,923.70

CHUA THIAM HUAT, A.S.D.K.
B. Surv. (Q'ld), MIS (Aust)
Jurukur Berlesen (Licensed Surveyor)

CTH/cl

Encl:

JURUKUR

CHUA THIAM HUAT ASDK. B. SURV., MIS (AUST.)

(1)

TRAVERSE LINE FOR UPPER LIWAGU RIVER BAS

DIS-CLOSURE= -0.112 0.237 1/ 23558
DISTANCE= 6166.581
MISSING BRG. & DISTANCE: 115 21 39 1.262

AREA= 877367.653

T.NO	ST. NAME	BEARING(DMS)	DISTANCE	LATITUDE	DEPARTURE	LAT.COR	DEP.COR	NORTHING	EASTING
1	TR16							660770.965	766991.164
2	TBM7	52 7 0	1018.117	625.16	803.562	-0.019	0.039	661396.164	767794.687
3	NP1	192 56 0	440.521	-429.34	-98.596	-0.008	0.017	660966.826	767696.074
4	NP2	10 48 10	547.213	537.52	102.564	-0.010	0.021	661504.352	767798.616
5	NP3	331 59 0	402.937	355.71	-189.271	-0.007	0.015	661860.076	767609.330
6	NP4	329 8 30	881.969	757.12	-452.377	-0.016	0.034	662617.206	767156.919
7	NP5	143 53 40	243.235	-196.62	143.219	-0.004	0.009	662420.612	767300.128
8	NP6	69 36 0	296.156	103.22	277.584	-0.005	0.011	662523.850	767577.706
9	NP7	48 50 19	61.050	40.15	45.962	-0.001	0.002	662564.033	767623.660
10	TBM2	328 3 50	49.085	41.65	-25.965	-0.001	0.002	662605.689	767597.693
11	NP8	148 55 30	49.235	-42.16	25.413	-0.001	0.002	662563.520	767623.104
12	NP9	228 48 30	60.646	-39.94	-45.637	-0.001	0.002	662523.581	767577.465
13	NP10	249 53 49	295.758	-101.65	-277.740	-0.005	0.011	662421.933	767299.714
14	NP11	215 16 40	837.895	-684.02	-483.919	-0.015	0.032	661737.923	766815.763
15	TR15	169 42 59	982.762	-966.93	175.439	-0.019	0.038	660770.965	766991.164

(5)

TRAVERSE LINE FOR UPPER LIWAGU RIVER BO

IS-CLOSURE=	0.136	0.152	1/ 28621
ISTANCE=	5839.652		
ISSING BRG. & DISTANCE:	48 7 17	0.204	

AREA= 1753.246

.NO	ST. NAME	BEARING(DMS)	DISTANCE	LATITUDE	DEPARTURE	LAT.COR	DEP.COR	NORTHING	EASTING
	TRI6							660770.965	766991.164
	NP12	334 6 10	872.669	785.035	-381.145	0.020	0.033	661555.977	766609.996
3	NP13	0 47 0	273.550	273.524	3.740	0.006	0.007	661829.496	766613.729
4	NP14	293 49 9	1088.848	439.748	-996.121	0.025	0.028	662269.219	765617.580
5	NP15	357 50 29	365.830	365.370	-12.777	0.009	0.010	662634.583	765603.793
6	NP16	30 56 0	233.504	200.292	120.031	0.005	0.006	662835.866	765723.817
7	NP17	219 11 40	43.111	-37.262	-21.692	0.001	0.001	662797.594	765702.134
8	TBM1	90 31 19	43.750	-0.399	43.748	0.001	0.001	662797.094	765745.881
9	NP18	271 42 9	45.060	1.339	-45.040	0.001	0.001	662798.743	765700.842
10	NP19	32 12 0	41.797	35.368	22.273	0.001	0.001	662834.109	765723.117
11	NP20	219 56 0	232.196	-199.170	-119.358	0.005	0.006	662634.934	765603.747
12	NP21	177 53 9	365.894	-365.645	13.496	0.009	0.010	662269.280	765617.239
13	NP22	113 49 9	1089.116	-439.845	996.348	0.025	0.028	661829.409	766613.564
14	NP23	179 46 29	275.893	-275.893	1.083	0.006	0.007	661553.510	766614.639
15	TRI6	154 18 10	868.412	-782.524	376.557	0.020	0.023	660770.965	766991.164

IS-CLOSURE=	-0.202	0.003	1/ 7529
ISTANCE=	1565.798		
ISSING BRG. & DISTANCE:	179 18 25	0.208	

.NO	ST. NAME	BEARING(DMS)	DISTANCE	LATITUDE	DEPARTURE	LAT.COR	DEP.COR	NORTHING	EASTING
1	NP15							662634.759	765603.793
2	NP24	83 39 50	796.113	86.931	791.017	-0.106	0.001	662724.917	766394.909
3	NP4	98 2 40	769.495	-107.711	762.111	-0.102	0.001	662617.208	767156.919

STATION RECORD SHEET

Station Number:
TBM 1
(LIWAGU RIVER)

Latitude			For Office Use
Longitude			
E.(W)			
N.(S)	Elevation	1051.25	

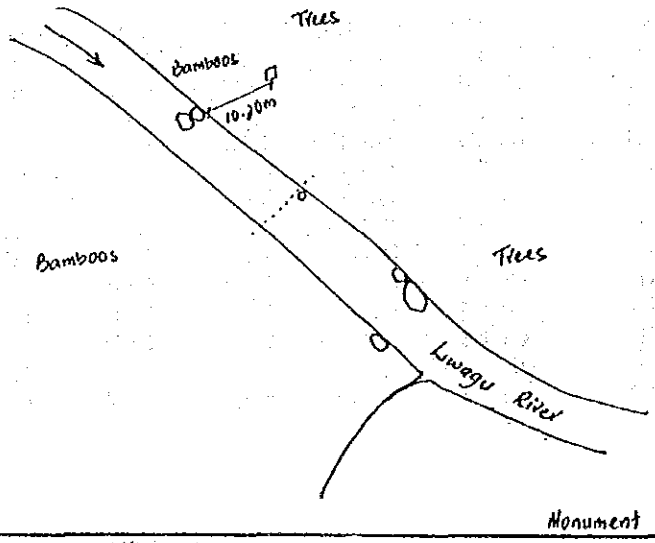
Station established by: Mr. Daniel Y.K. Wong

Date:

General Information :

Coordinates:Rectified Skew Orthomorphic, the Everest Spheroid and mean sea level

Description of Mark



Diagrams

Snap-photos of Mark

STATION RECORD SHEET

				Station Number: TBM 2 (MESILAU RIVER)
Latitude	—			For Office Use
Longitude	—			
E.(W)				
N.(S)		Elevation	7045.09	

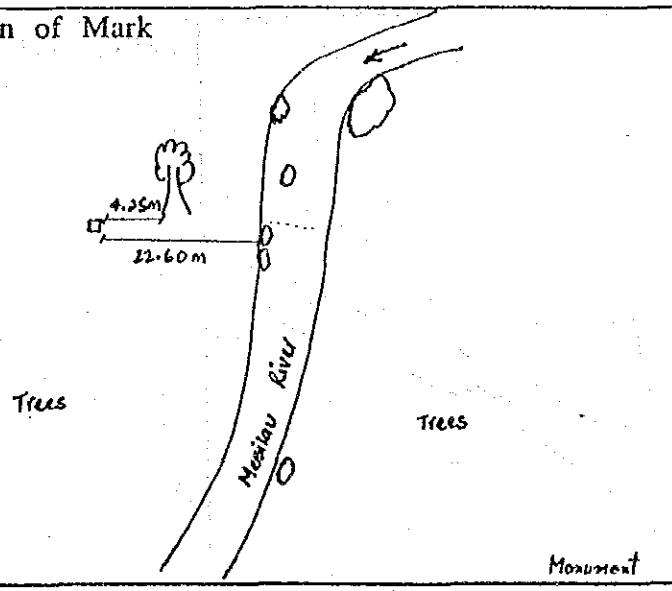
Station established by: Mr. Daniel Y. K. Wong

Date: [illegible]

General Information :

Coordinates:Rectified Skew Orthomorphic, the Everest Spheroid and mean sea level

Description of Mark



Diagrams

Snap-photos of Mark

STATION RECORD SHEET

Station Number: TBM 3

Latitude	—		For Office Use
Longitude	—		
E.(W)			
N.(S)		Elevation	1868.01

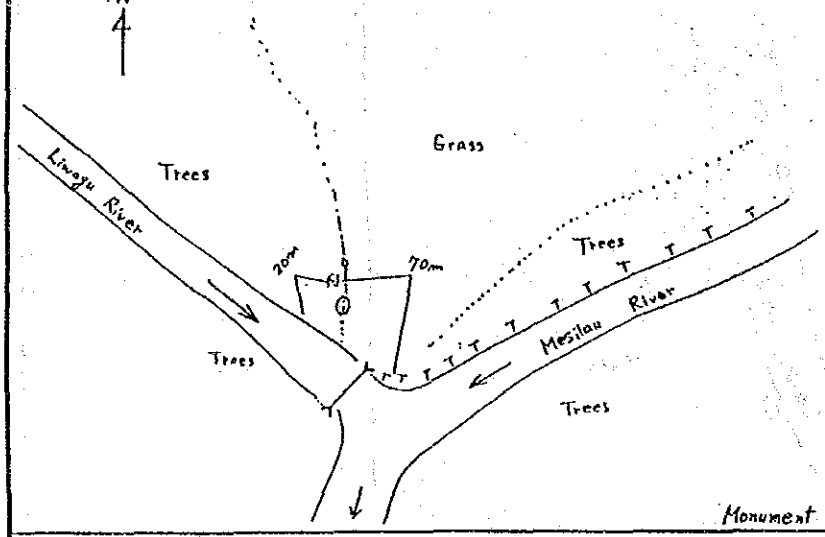
Station established by: TONKIN AND TAYLOR

Date:

General Information :

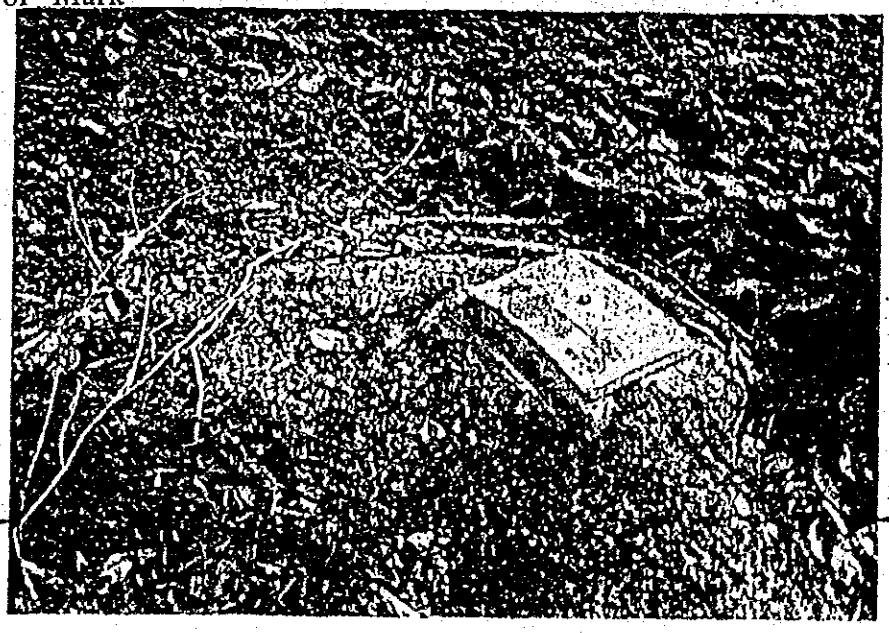
Coordinates : Rectified Skew Orthomorphic, the Everest Spheroid and mean sea level

Description of Mark



Diagrams

Snap-photos of Mark



STATION RECORD SHEET

Station Number:
TBM 5
(LIWAGU RIVER)

Latitude	—		For Office Use
Longitude	—		
E.(W)	—		
N.(S)	—	Elevation (1041.20)	

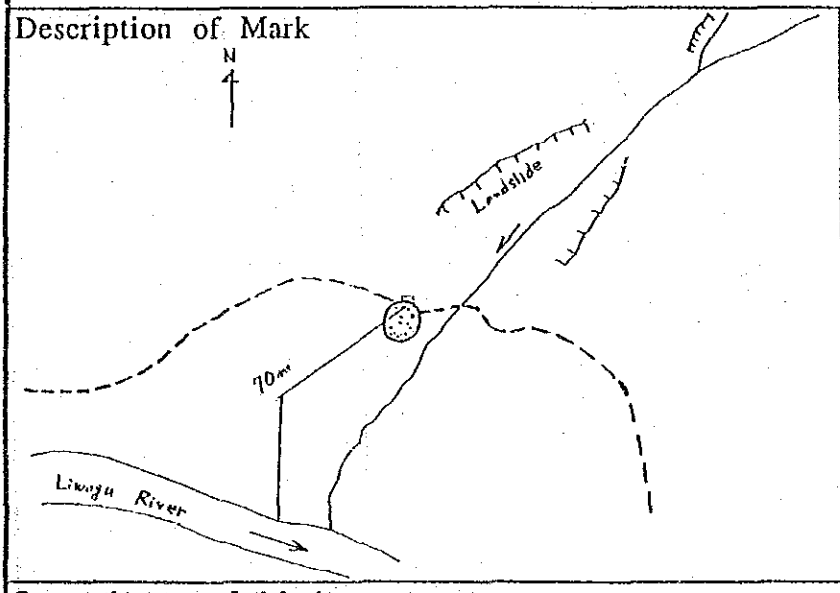
Station established by:

Date:

General Information :

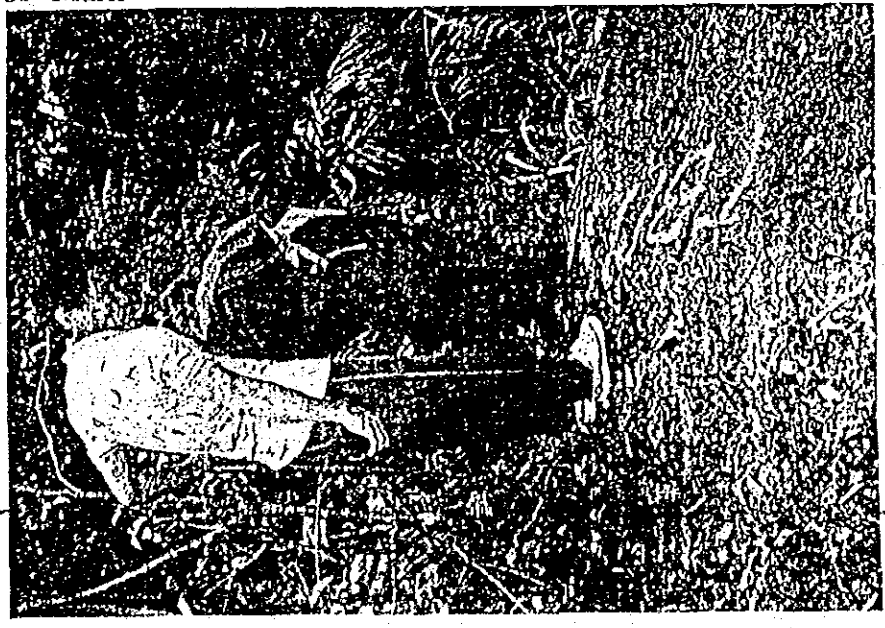
Coordinates:Rectified Skew Orthomorphic, the Everest Spheroid and mean sea level
The station is painted on the stone

Description of Mark



Diagrams

Snap-photos of Mark



STATION RECORD SHEET

Station Number:
TBM 6
(LIWAGU RIVER)

Latitude	—		For Office Use
Longitude	—		
E.(W)	—		
N.(S)	—	Elevation 918.57	

Station established by:

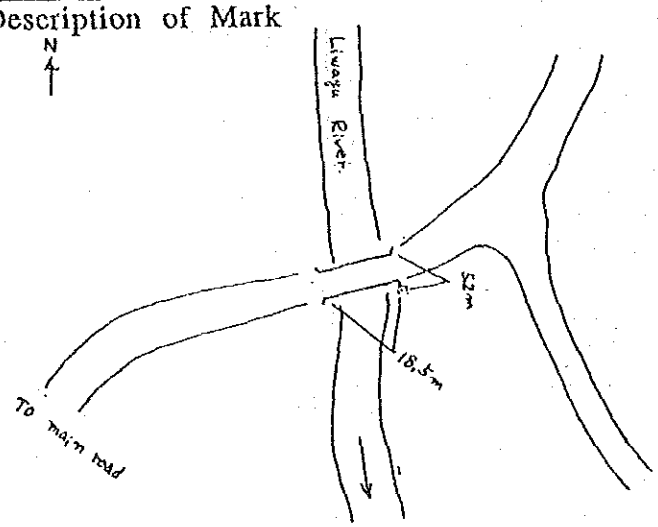
Date:

General Information :

Coordinates: Rectified Skew Orthomorphic, the Everest Spheroid and mean sea level

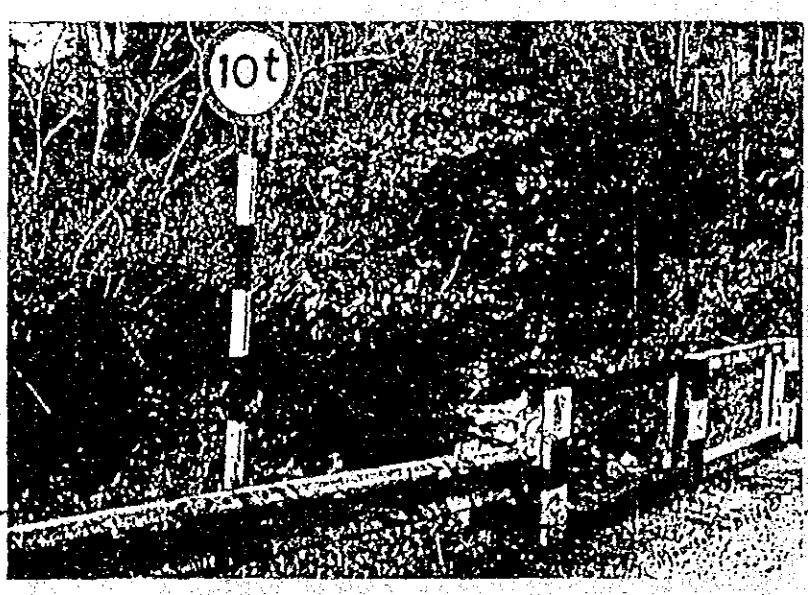
The station is painted on the bridge girder of Piwasak Bridge

Description of Mark



Diagrams

Snap-photos of Mark



STATION RECORD SHEET

Station Number: TBM 7

Latitude	—			For Office Use
Longitude	—			
E.(W)	('			
N.(S)	('	Elevation	969.07	

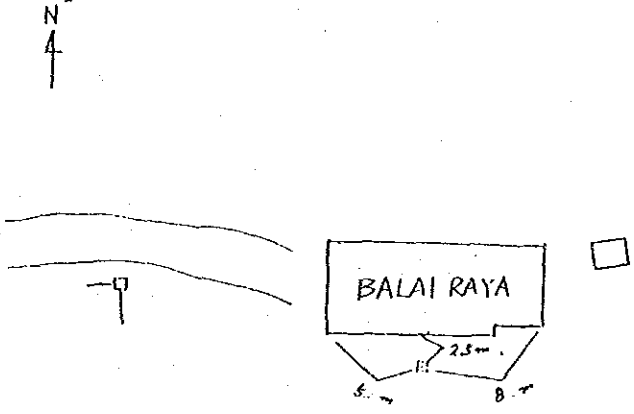
Station established by: SEB

Date:

General Information :

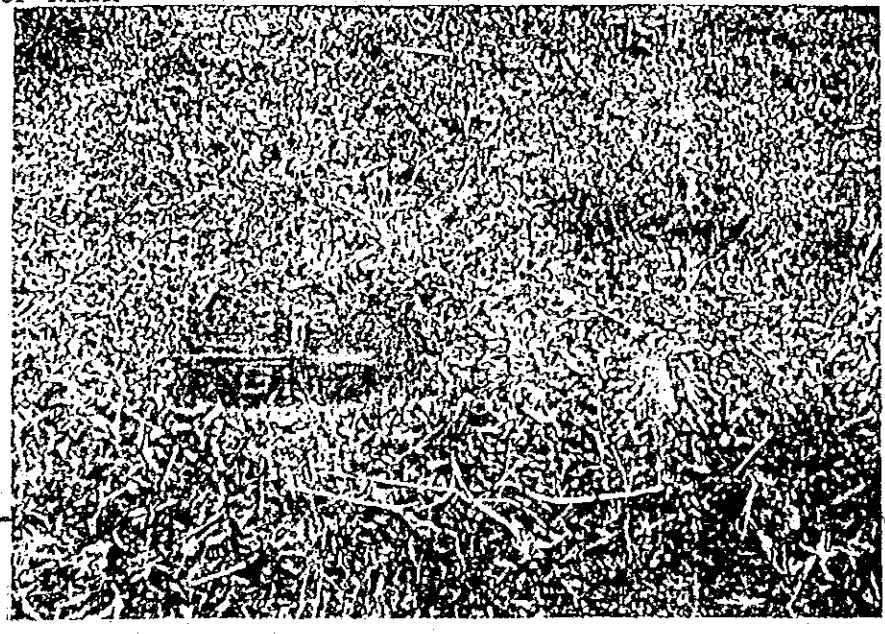
Coordinates:Rectified Skew Orthomorphic, the Everest Spheroid and mean sea level

Description of Mark



Diagrams

Snap-photos of Mark



SURVEY WORKS AT UPPER LIWAGU RIVER BASIN

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TOPOGRAPHIC SURVEY OF PENSTOCK AND POWER HOUSE ..... SUR/UBS/347/6 - 9

SURCOM SERVICES SDN. BHD.

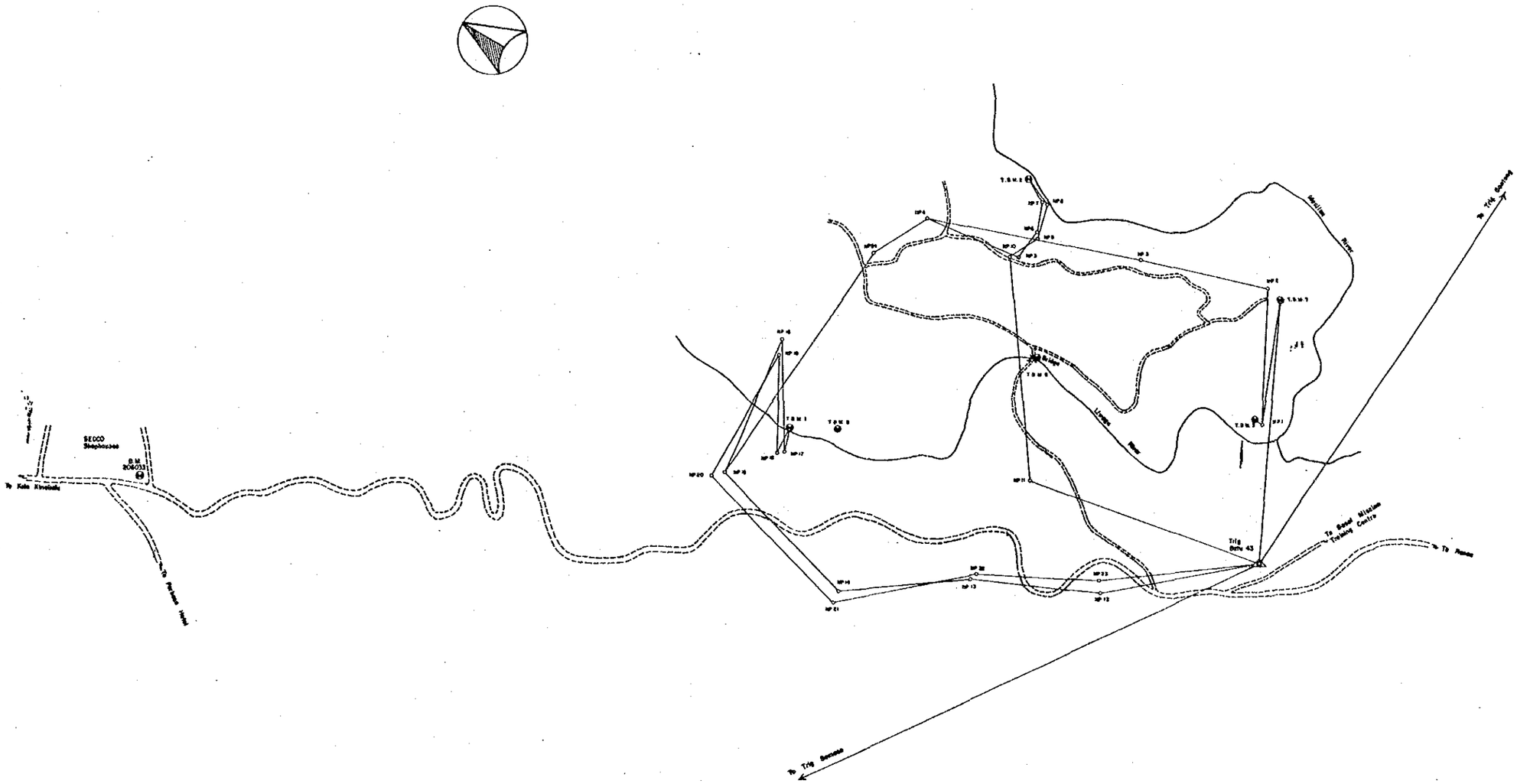
P.O. BOX NO. 11125

88812 KOTA KINABALU

SABAH

TEL. NO. 217927

FAX NO. 211933



PEMILIK : LEMBAGA LETRIK SABAH, MIEWA LLS, 88675 KOTA KINABALU	BIL.	PINDAAN	TARIKH	DI LUKIS	JURUKUR : SURCOM SERVICES SDN. BHD., P.O. BOX NO. 11126, 88812 KOTA KINABALU, TEL. NO. 217827, FAX NO. 211939	DI UKUR / BUKU BIL.	DI LUKIS / TARIKH 6/1/92	JURUTERA PERUNDING : JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)	DI REKA / DI LUKIS; DI SEMAK / TARIKH	UKURAN : Not to scale	PROJEK : SURVEY WORKS AT UPPER LIWAGU RIVER BASIN (INDEX PLAN) LUKISAN : BIL. LUKISAN SUR/UBS/347/1

Appendix 2 GEOLOGICAL INVESTIGATION DATA

Appendix 2

GEOLOGY

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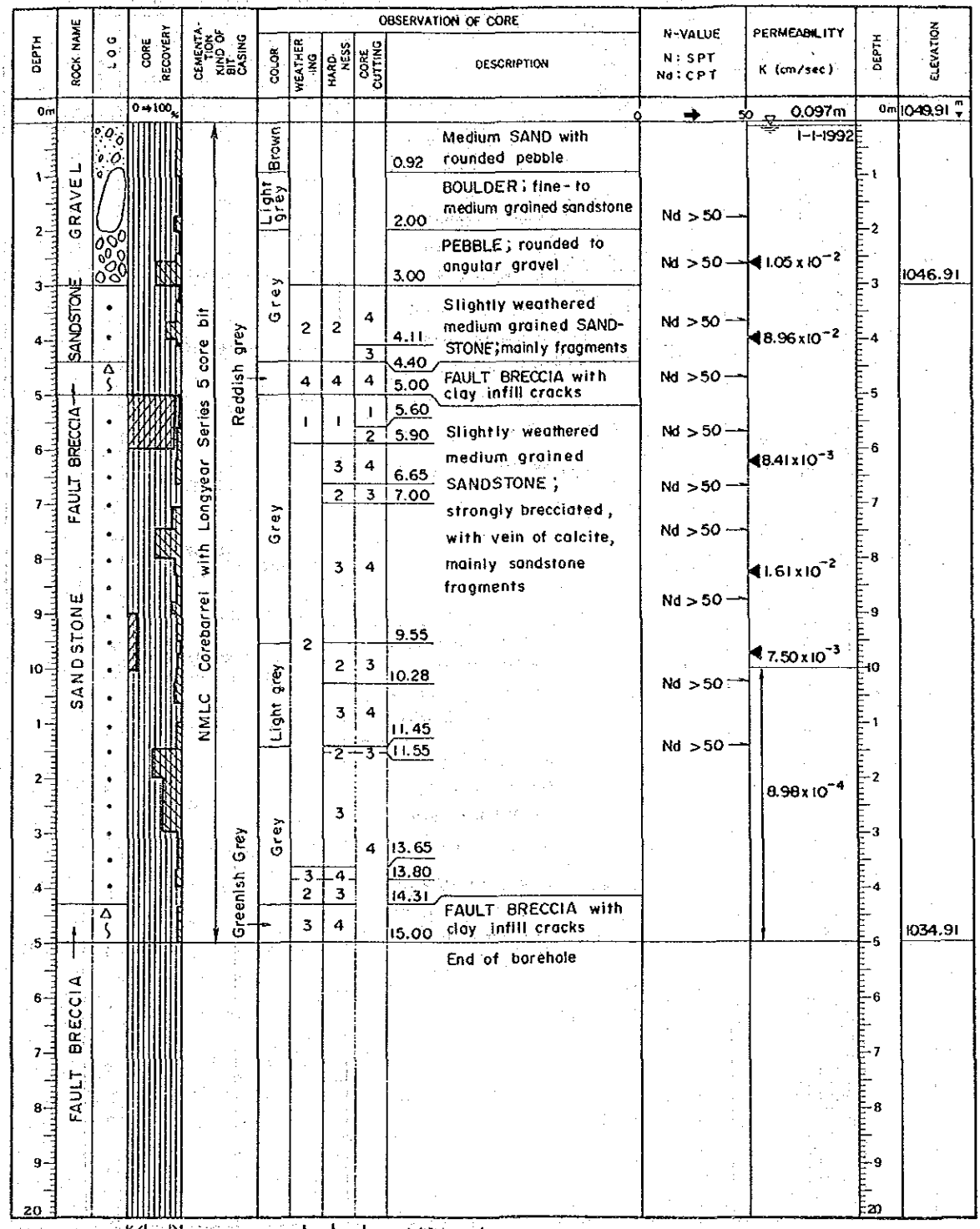
GEOLOGIC LOG OF DRILL HOLE

SMALL SCALE HYDROELECTRIC POWER DEVELOPMENT PROJECT AT UPPER LIWAGU RIVER HOLE No. LI-1 (SHEET 1 OF 1)

LOCATION	Liwagu River Intake	DEPTH OF HOLE	15.00 m	COMMENCED	19 - 12 - 1991
ELEVATION	1049.91 m	DEPTH OF OVERBURDEN	3.00 m	COMPLETED	1 - 1 - 1992
COORDINATE	E765,742.5 N662,788.5	LENGTH OF ROCK DRILLING	12.00 m	DRILLED BY	Wil, M.Liew
ANGLE FROM HOLIZONTAL	90°	TOTAL LENGTH OF CORE	15.00 m	LOGGED BY	T. Hatano
BEARING OF ANGLE HOLE	—	CORE RECOVERY	50~100 %	⧗ : APPLIED GEOTECHNICS	

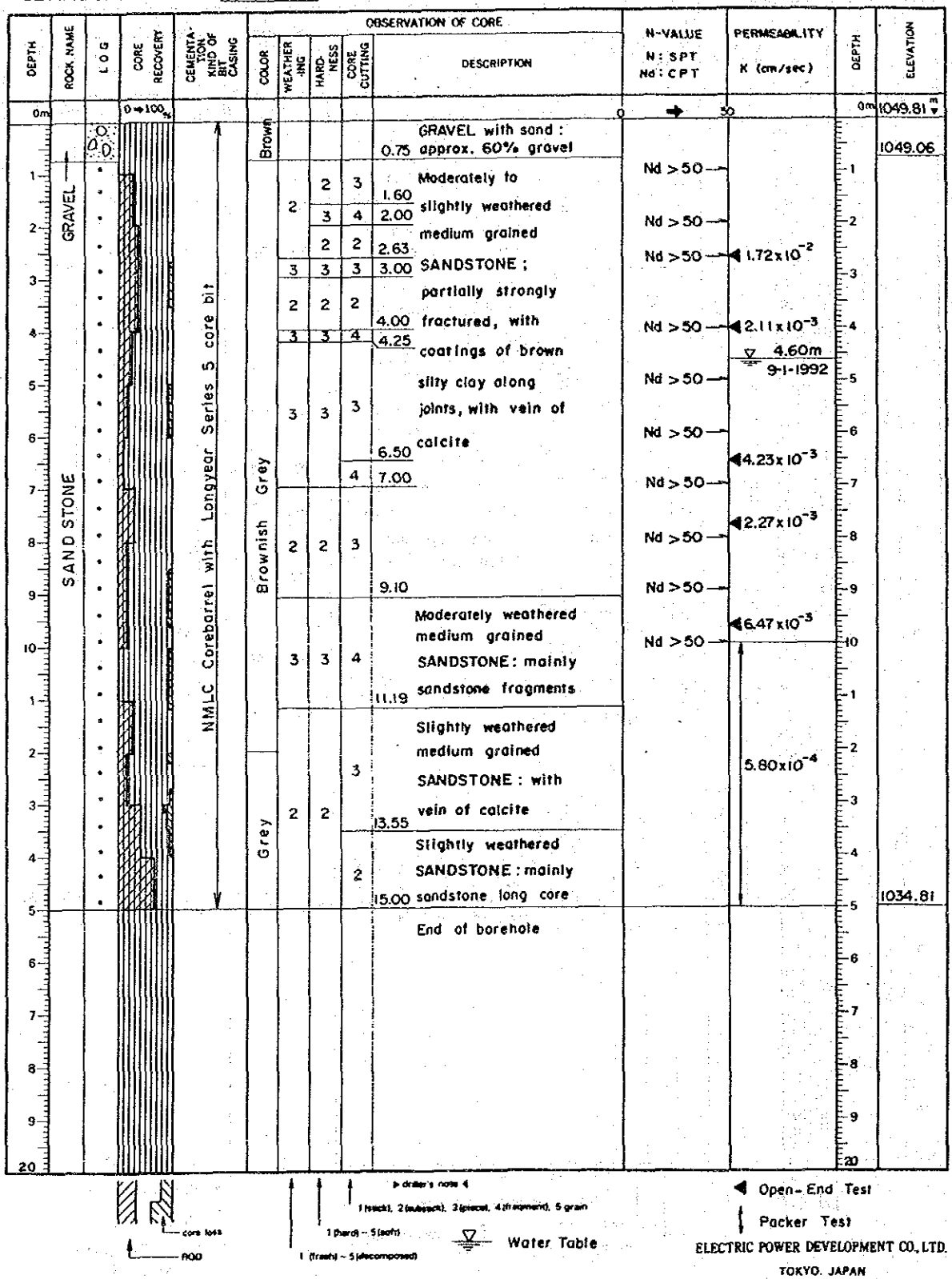


ELECTRIC POWER DEVELOPMENT CO., LTD.
TOKYO, JAPAN

GEOLOGIC LOG OF DRILL HOLE

SMALL SCALE HYDROELECTRIC POWER DEVELOPMENT PROJECT AT UPPER LIWAGU RIVER HOLE No. LI-2 (SHEET 1 OF 1)

LOCATION	Liwagu River Intake	DEPTH OF HOLE	15.00 m	COMMENCED	2 - 1 - 1992
ELEVATION	1049.81 m	DEPTH OF OVERBURDEN	0.75 m	COMPLETED	9 - 1 - 1992
COORDINATE	E765,732.5 N662,777.5	LENGTH OF ROCK DRILLING	14.25 m	DRILLED BY	Wil, M.Liew
ANGLE FROM HOLIZONTAL	90°	TOTAL LENGTH OF CORE	15.00 m	LOGGED BY	T. Hatano
BEARING OF ANGLE HOLE	—	CORE RECOVERY	85 - 100 %	※ : APPLIED	GEOTECHNICS



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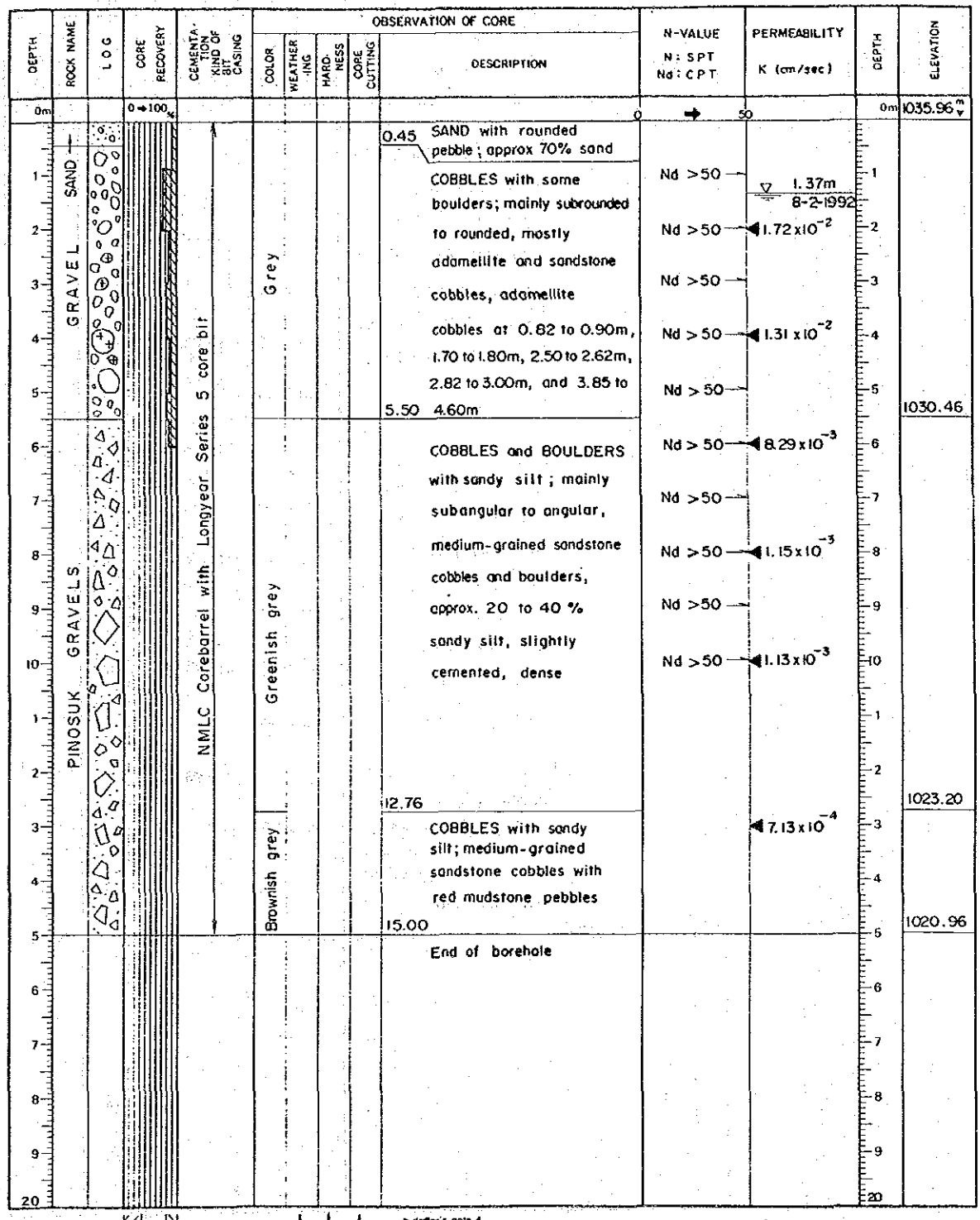
TOKYO, JAPAN

GEOLOGIC LOG OF DRILL HOLE

SMALL SCALE HYDROELECTRIC POWER DEVELOPMENT PROJECT AT UPPER LIWAGU RIVER HOLE No. L I-3 (SHEET 1 OF 1)

LOCATION	Mesilau River Intake	DEPTH OF HOLE	15.00 m	COMMENCED	31 - 1 -1992
ELEVATION	1035.96 m	DEPTH OF OVERBURDEN	5.50 m	COMPLETED	8 - 2 -1992
COORDINATE	E767,644.5 N662,603.5	LENGTH OF ROCK DRILLING	9.50 m	DRILLED BY	Wil, M.Liew
ANGLE FROM HOLIZONTAL	90 °	TOTAL LENGTH OF CORE	15.00 m	LOGGED BY	T. Hatano
BEARING OF ANGLE HOLE	—	CORE RECOVERY	74-100 %	※ : APPLIED GEOTECHNICS	



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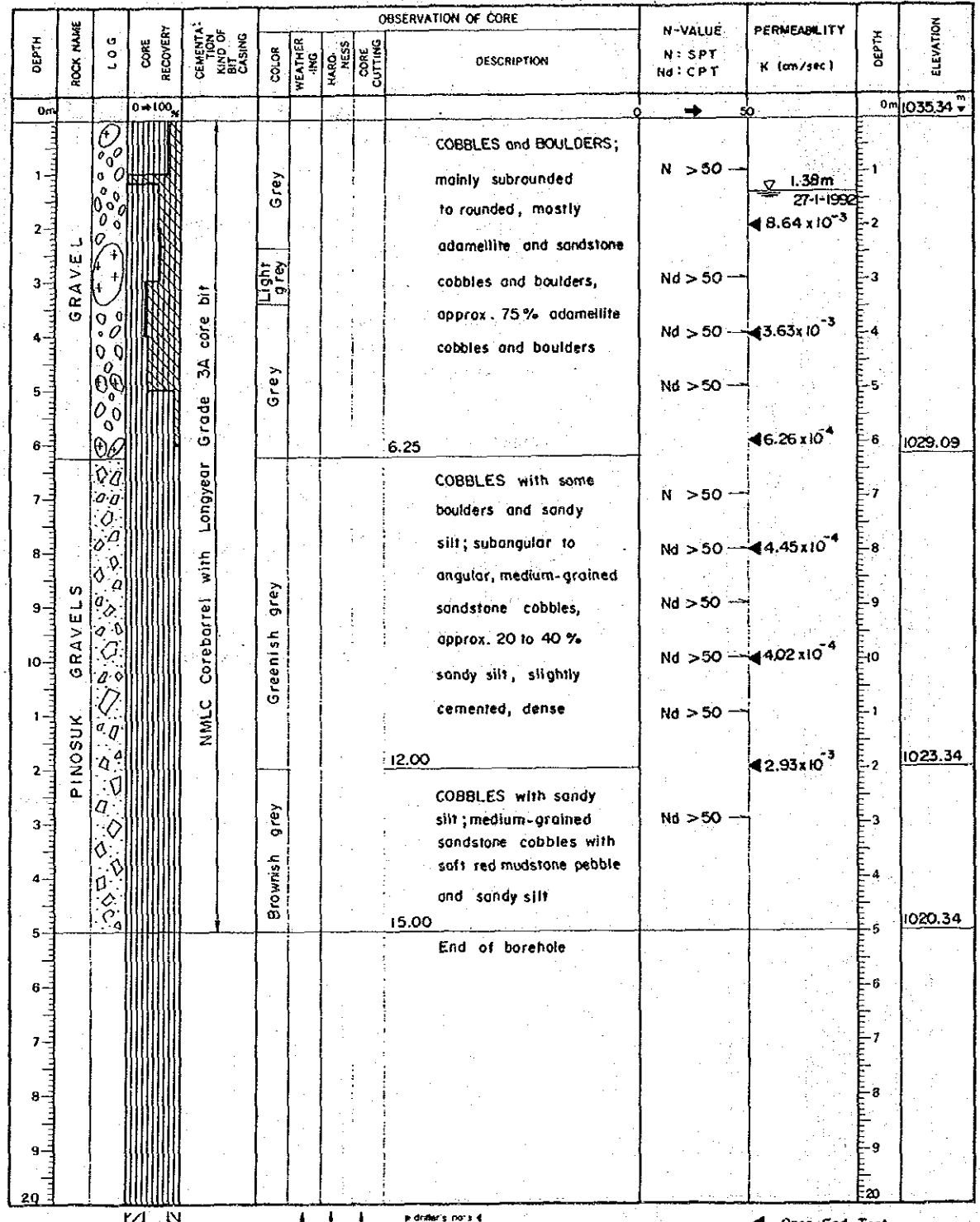
TOKYO, JAPAN

GEOLOGIC LOG OF DRILL HOLE

SMALL SCALE HYDROELECTRIC POWER DEVELOPMENT PROJECT AT UPPER LIWAGU RIVER HOLE No. LI - 4 (SHEET 1 OF 1)

LOCATION	Mesilau River Intake	DEPTH OF HOLE	15.00 m	COMMENCED	21 - 1 - 1992
ELEVATION	1035.34 m	DEPTH OF OVERBURDEN	6.25 m	COMPLETED	27 - 1 - 1992
COORDINATE	E767,623.3 N662,597.5	LENGTH OF ROCK DRILLING	8.75 m	DRILLED BY	Wil, M.Liew
ANGLE FROM HOLIZONTAL	90°	TOTAL LENGTH OF CORE	15.00 m	LOGGED BY	T. Hatano
BEARING OF ANGLE HOLE	—	CORE RECOVERY	35-100 %	※ : APPLIED	GEOTECHNICS



⊕ : Adamellite

core loss

RQD

Water Table

◀ Open-End Test

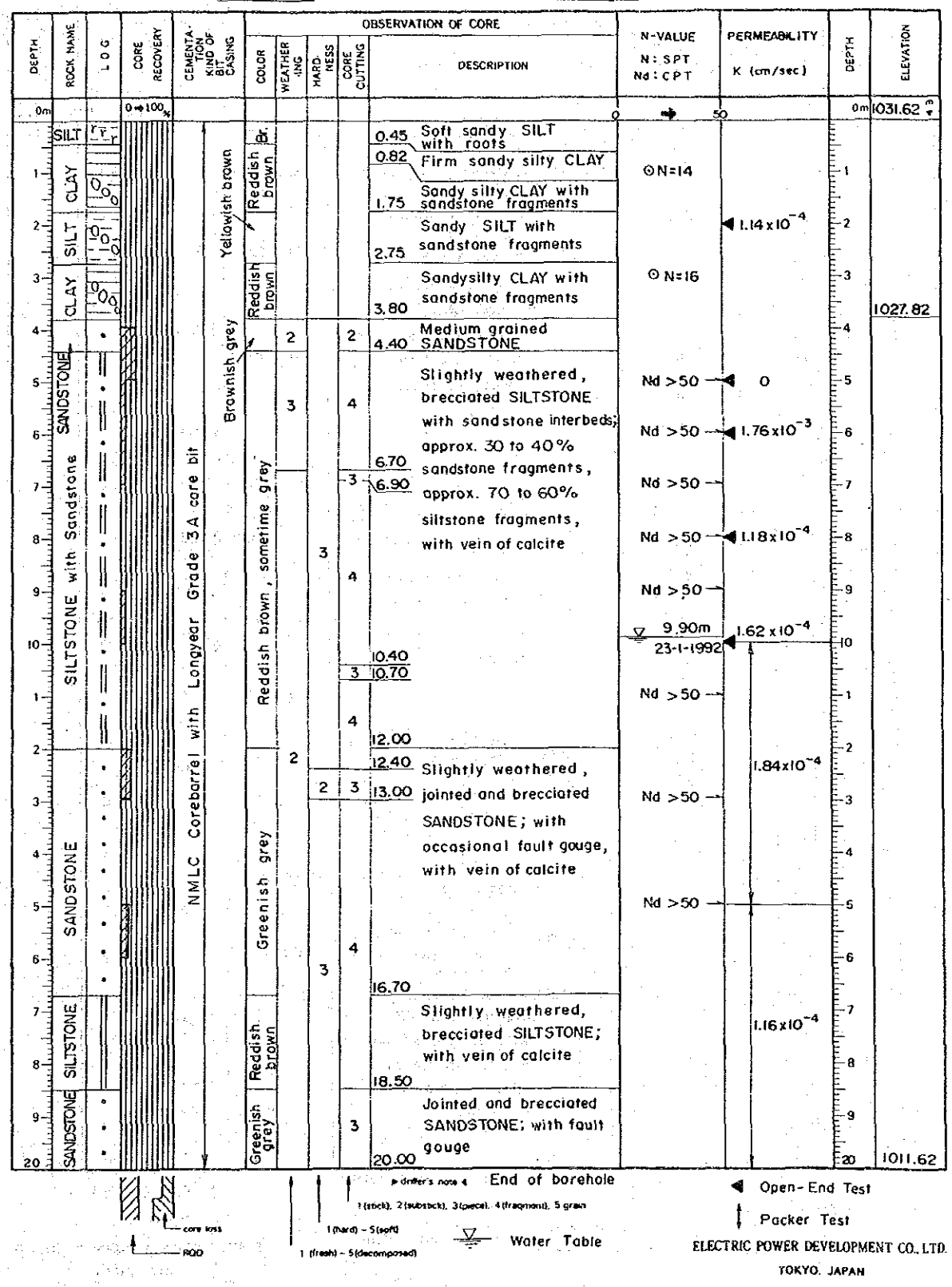
Packer Test

ELECTRIC POWER DEVELOPMENT CO., LTD.
TOKYO, JAPAN

GEOLOGIC LOG OF DRILL HOLE

SMALL SCALE HYDROELECTRIC POWER DEVELOPMENT PROJECT AT UPPER LIWAGU RIVER HOLE No. L.T - 1 (SHEET 1 OF 1)

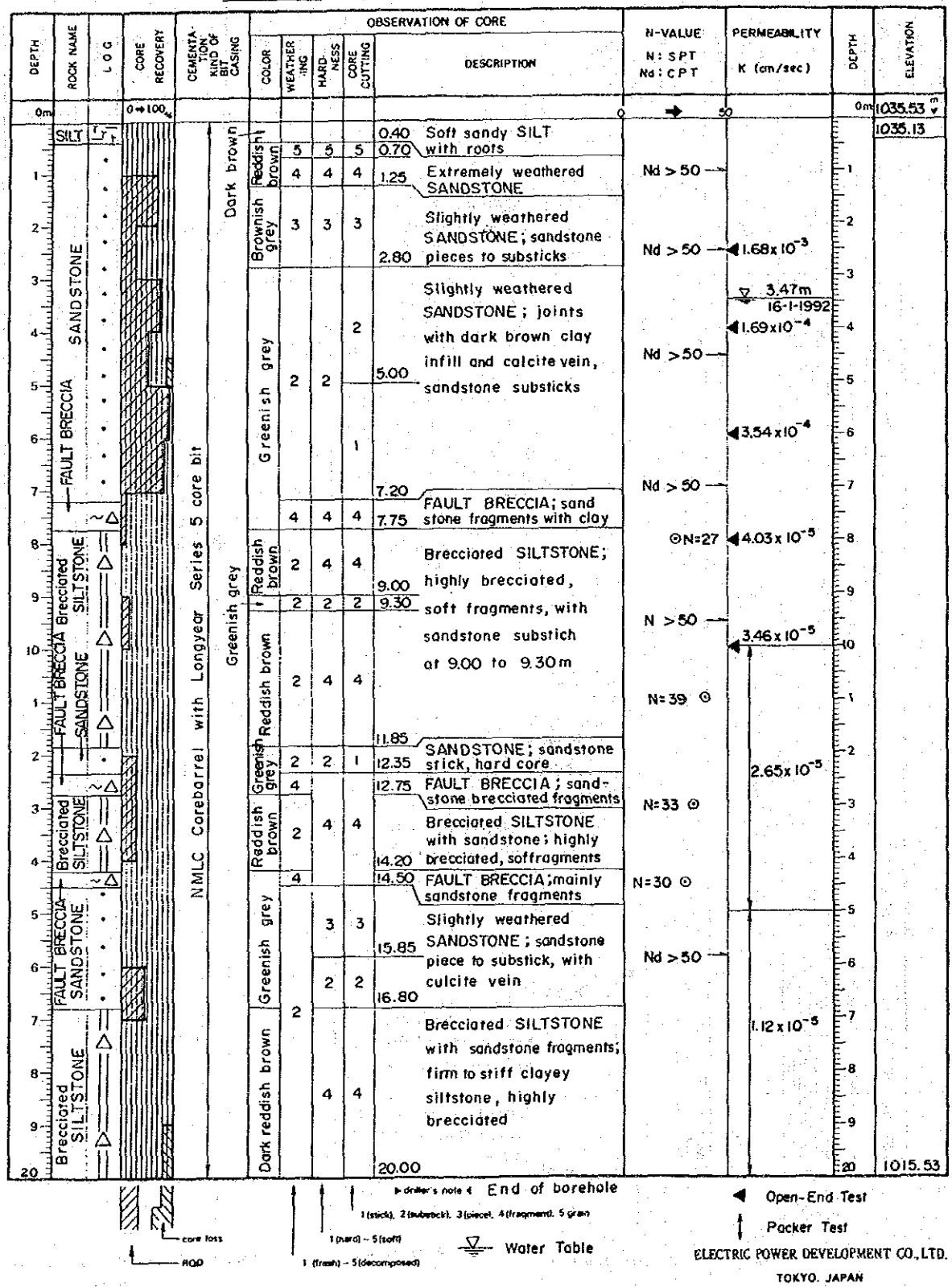
LOCATION	Head Pond	DEPTH OF HOLE	20.00 m	COMMENCED	18 - 1 - 1992
ELEVATION	1031.62 m	DEPTH OF OVERBURDEN	3.80 m	COMPLETED	23 - 1 - 1992
COORDINATE	E767,818.0 N661,692.5	LENGTH OF ROCK DRILLING	16.20 m	DRILLED BY	Litto, M.Liew
ANGLE FROM HOLIZONTAL	90°	TOTAL LENGTH OF CORE	20.00 m	LOGGED BY	T. Hatano
BEARING OF ANGLE HOLE	—	CORE RECOVERY	100 %	X : APPLIED	GEOTECHNICS



GEOLOGIC LOG OF DRILL HOLE

SMALL SCALE HYDROELECTRIC POWER DEVELOPMENT PROJECT AT UPPER LIWAGU RIVER HOLE No. LT-2 (SHEET 1 OF 1)

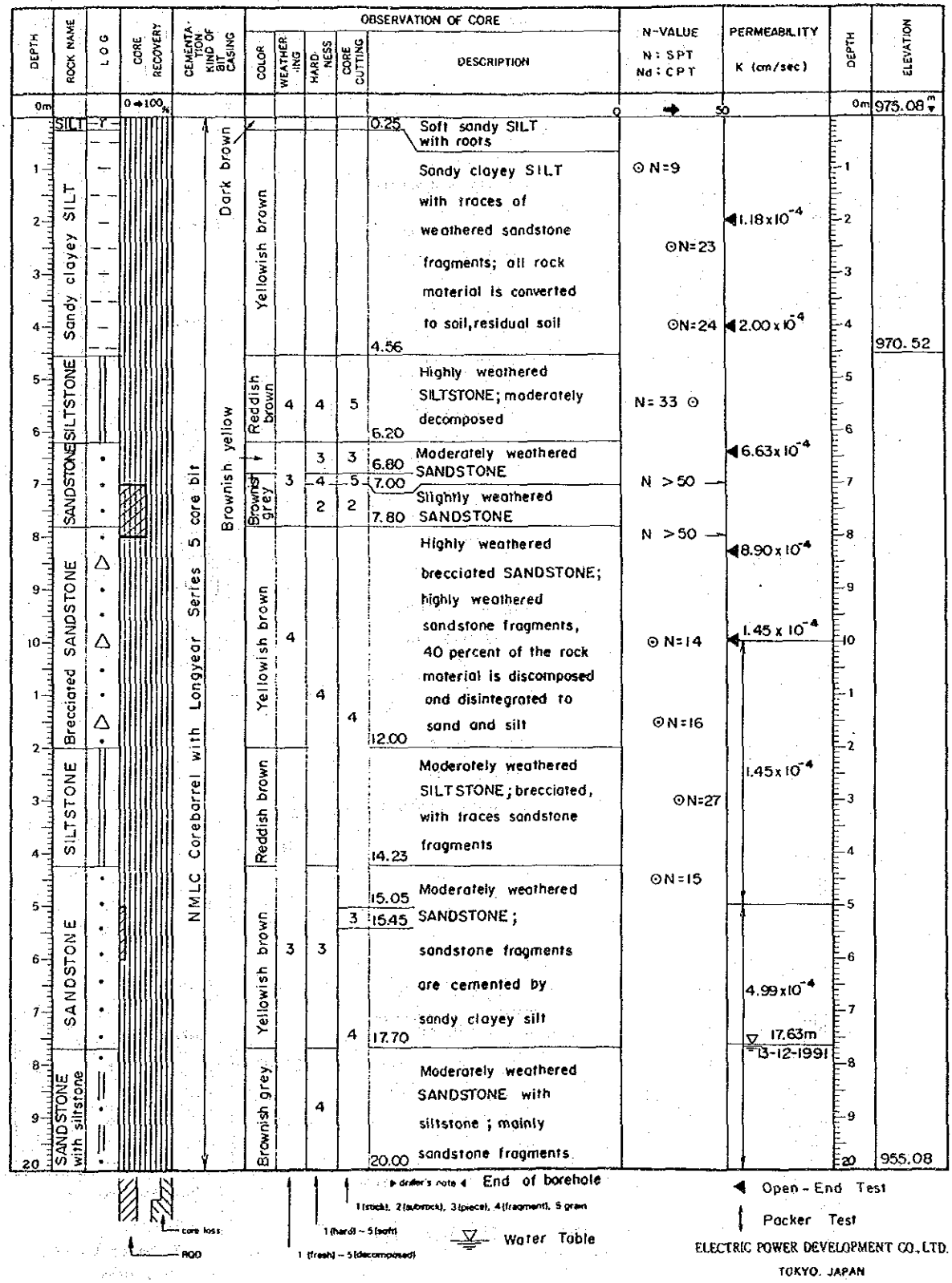
LOCATION	Head Pond	DEPTH OF HOLE	20.00 m	COMMENCED	11 - 1 -1992
ELEVATION	1035.53 m	DEPTH OF OVERBURDEN	0.40 m	COMPLETED	17 - 1 -1992
COORDINATE	E767,725.5 N661,707.5	LENGTH OF ROCK DRILLING	19.60 m	*DRILLED BY	Litio, M. Liew
ANGLE FROM HOLIZONTAL	90°	TOTAL LENGTH OF CORE	20.00 m	LOGGED BY	T. Hatano
BEARING OF ANGLE HOLE	—	CORE RECOVERY	86-100 %	*: APPLIED GEOTECHNICS	



GEOLOGIC LOG OF DRILL HOLE

SMALL SCALE HYDROELECTRIC POWER DEVELOPMENT PROJECT AT UPPER LIWAGU RIVER HOLE No. L.P - 1 (SHEET 1 OF 1)

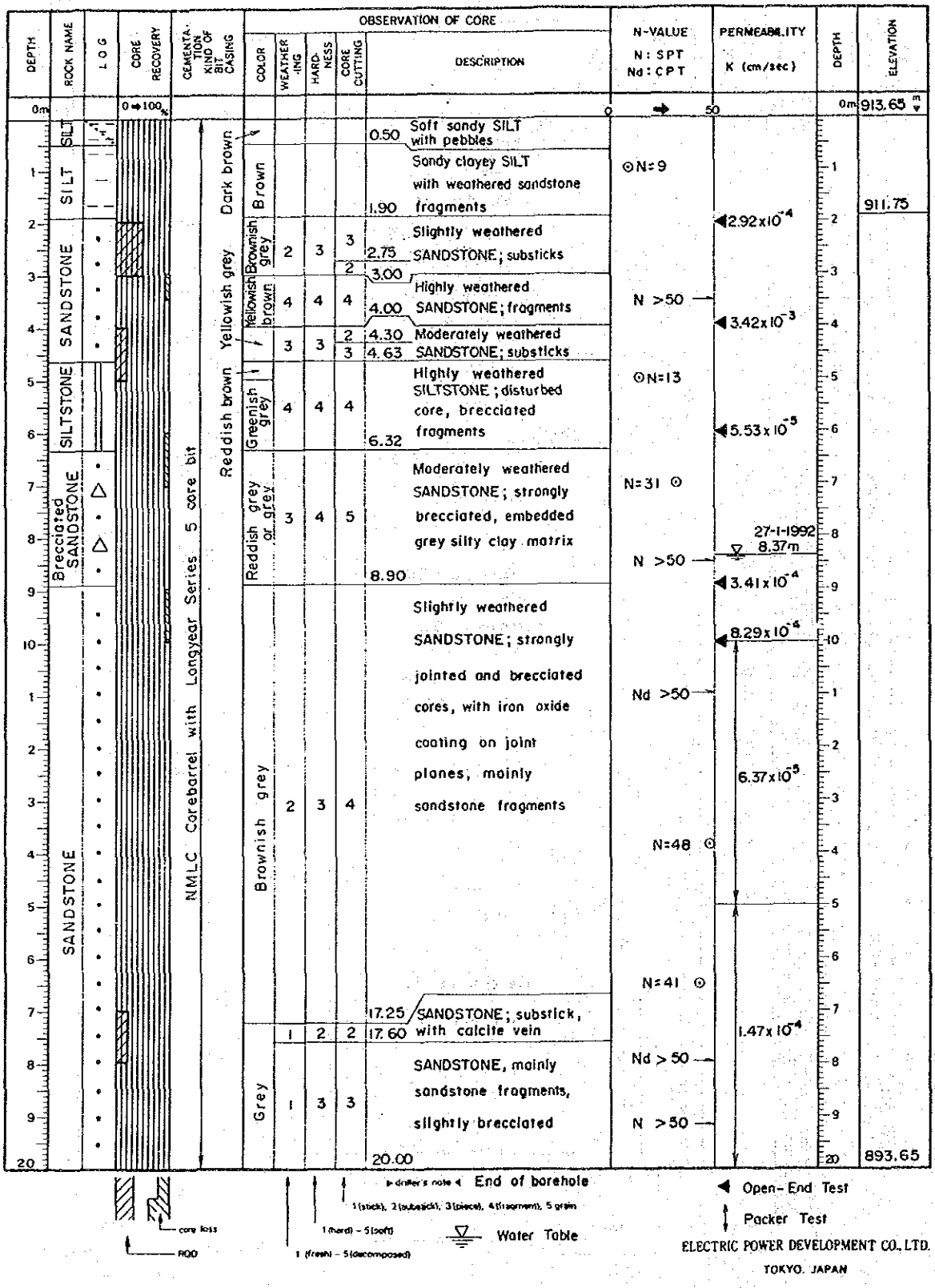
LOCATION	Penstock	DEPTH OF HOLE	20.00 m	COMMENCED	6 - 12 - 1991
ELEVATION	975.08 m	DEPTH OF OVERBURDEN	4.56 m	COMPLETED	12 - 12 - 1991
COORDINATE	E 767,727.0 N661,434.0	LENGTH OF ROCK DRILLING	15.44 m	※ DRILLED BY	Andy, M. Liew
ANGLE FROM HOLIZONTAL	90°	TOTAL LENGTH OF CORE	20.00 m	LOGGED BY	T. Hatano
BEARING OF ANGLE HOLE	—	CORE RECOVERY	100 %	※ : APPLIED GEOTECHNICS	



GEOLOGIC LOG OF DRILL HOLE

SMALL SCALE HYDROELECTRIC POWER DEVELOPMENT PROJECT AT UPPER LIWAGU RIVER HOLE No. LP-2 (SHEET 1 OF 1)

LOCATION	Penstock	DEPTH OF HOLE	20.00 m	COMMENCED	21 - 1 - 1992
ELEVATION	913.65 m	DEPTH OF OVERBURDEN	1.90 m	COMPLETED	27 - 1 - 1992
COORDINATE	E 767,717.0 N661,237.0	LENGTH OF ROCK DRILLING	18.10 m	*DRILLED BY	Andy, M. Liew
ANGLE FROM HOLIZONTAL	90°	TOTAL LENGTH OF CORE	20.00 m	LOGGED BY	T. Hatano
BEARING OF ANGLE HOLE	—	CORE RECOVERY	90-100 %	*: APPLIED	GEOTECHNICS

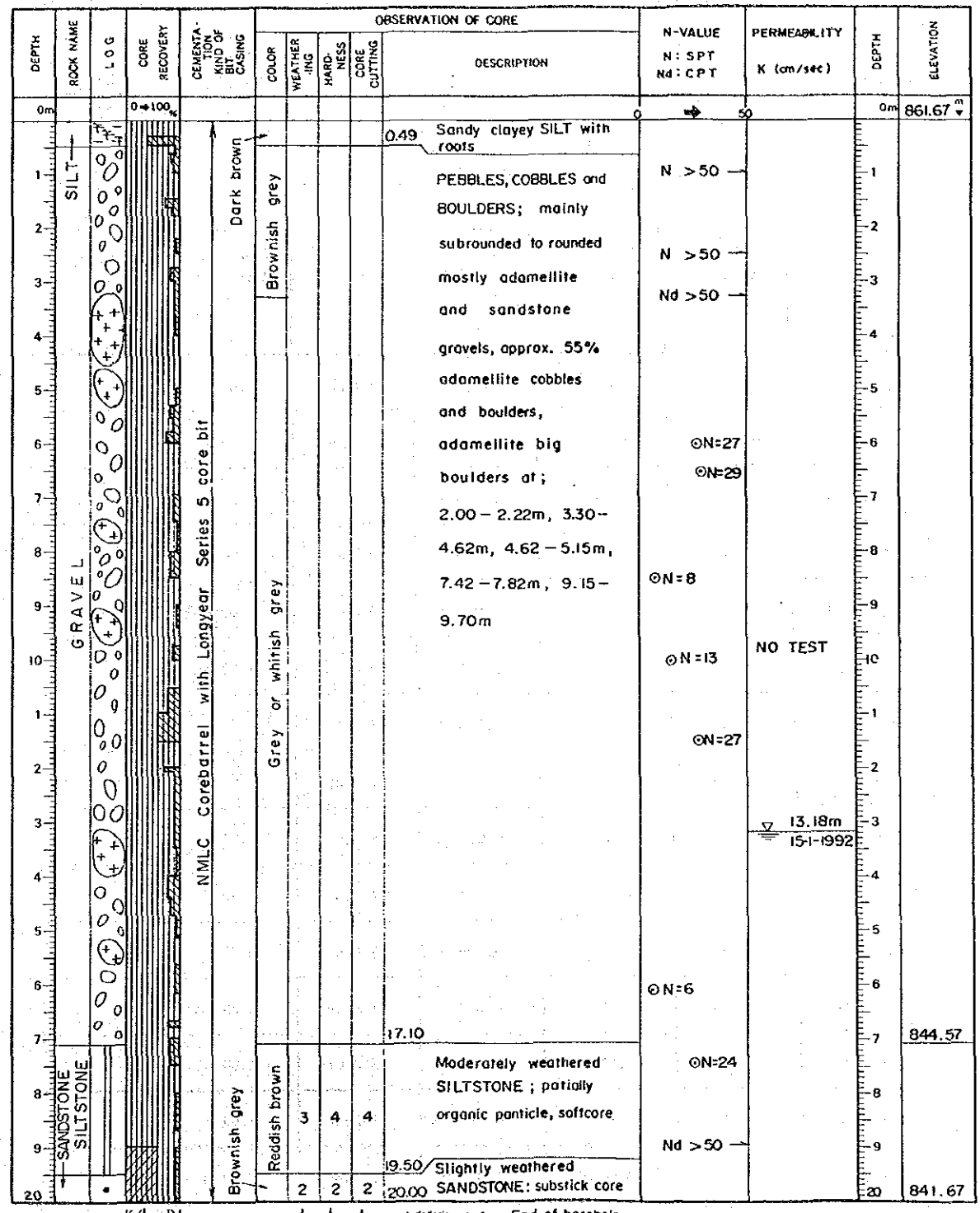


ELECTRIC POWER DEVELOPMENT CO., LTD.
TOKYO, JAPAN

GEOLOGIC LOG OF DRILL HOLE

SMALL SCALE HYDROELECTRIC POWER DEVELOPMENT PROJECT AT UPPER LIWAGU RIVER HOLE No. L.P - 3 (SHEET 1 OF 1)

LOCATION	Power House	DEPTH OF HOLE	20.00 m	COMMENCED	18 - 12 - 1991
ELEVATION	861.67 m	DEPTH OF OVERBURDEN	17.10 m	COMPLETED	15 - 1 - 1992
COORDINATE	E767,712.0 N661,075.0	LENGTH OF ROCK DRILLING	2.90 m	DRILLED BY	Andy, M.Liew
ANGLE FROM HOLIZONTAL	90 °	TOTAL LENGTH OF CORE	20.00 m	LOGGED BY	T. Hatano
BEARING OF ANGLE HOLE	—	CORE RECOVERY	40-100 %	※ : APPLIED GEOTECHNICS	



ELECTRIC POWER DEVELOPMENT CO., LTD.
TOKYO, JAPAN

RECORD OF WATER LEVEL IN DRILL - HOLE DURING DRILLING

PROJECT: G.I. At Upper Liwagu Mini Hydro Project Site HOLE NO. LI-1

LOCATION Sg. Liwagu Intake DEPTH OF HOLE 15.0 m COMMENCED 19-12-91

ELEVATION 1049.91m DIAMETER OF HOLE 80 mm COMPLETED 1-1-92

COORDINATE E76 5742.5 N66 2788.5

ANGLE FROM HORIZONTAL 90 ° MEASURED BY Lu

BEARING OF ANGLE HOLE

EQUIPMENT FOR WATER MEASUREMENT Dip meter

DATE MEASURED	TIME MEASURED	DEPTH OF HOLE AT MEASUREMENT	DEPTH OF * WATER LEVEL	ELASPED ** TIME	CEMENTING CASING	REMARKS
19-12-91	07 00	-	-	-	-	
19-12-91	13 00	1.00 m	none	1 hour	1.00 m	
20-12-91	07 00	1.75 m	1.050 m	13 hours	1.50 m	
20-12-91	13 00	2.60 m	1.030 m	1 hour	1.90 m	
21-12-91	07 00	2.60 m	0.100 m	13 hours	2.60 m	
23-12-91	07 00	3.68 m	0.031 m	38 hours	3.00 m	
23-12-91	12 20	4.00 m	0.0315 m	12 mins	3.10 m	
24-12-91	07 00	4.00 m	0.030 m	13 hours	4.00 m	
24-12-91	12 39	5.63 m	1.021 m	7 mins	4.00 m	
26-12-91	06 50	5.63 m	0.0305 m	38 hours	5.50 m	
26-12-91	13 00	6.00 m	0.0315 m	1 hour	5.90 m	
27-12-91	07 05	6.25 m	0.009 m	13 hours	6.25 m	
27-12-91	13 00	6.65 m	0.017 m	1 hour	6.25 m	
28-12-91	06 52	7.08 m	0.030 m	13 hours	6.60 m	
28-12-91	13 00	7.50 m	0.0305 m	1 hour	7.00 m	
29-12-91	07 00	8.00 m	0.032 m	13 hours	7.50 m	

* Mark "none" when water level exists under the bottom of hole
** Elapsed time from shutting off of drilling water

RECORD OF WATER LEVEL IN DRILL - HOLE DURING DRILLING

PROJECT: G.1. At Upper Liwagu Mini Hydro project Site HOLE NO. LI-1

LOCATION Sg.Liwagu Intake DPETH OF HOLE 15.0 m COMMENCED 19-12-91

ELEVATION 1049.91m DIAMETER OF HOLE 80 mm COMPLETED 1-1-92

COORDINATE E76 5742.5 N66 2788.5

ANGLE FROM HORIZONTAL 90 ° MEASURED BY Lu

BEARING OF ANGLE HOLE

EQUIPMENT FOR WATER MEASUREMENT Dip Meter

DATE MEASURED	TIME MEASURED	DEPTH OF HOLE AT MEASUREMENT	DEPTH OF * WATER LEVEL	ELASPED ** TIME	CEMENTING CASING	REMARKS
29-12-91	11 32	8.78 m	0.0315 m	10 mins	8.19 m	
30-12-91	07 00	9.50 m	0.036 m	13 hours	8.80 m	
30-12-91	06 26	11.45	0.094 m	14 mins	10.00 m	
31-12-91	06 50	11.45 m	0.040 m	12½ hours	10.00 m	
31-12-91	18 15	14.00 m	0.109 m	6 mins	11.20 m	
1-1-92	06 50	14.00 m	0.043 m	13 hours	11.20 m	
1-1-92	09 05	15.00 m	0.097 m	12 mins	11.20 m	

* Mark "none" when water level exists under the bottom of hole
** Elapsed time from shutting off of drilling water

RECORD OF WATER LEVEL IN DRILL - HOLE DURING DRILLING

PROJECT: G.I. At Upper Liwagu Mini Hydro Project Site HOLE NO. LI-2

LOCATION Liwagu River Intake DPETH OF HOLE 15 m COMMENCED 2-1-92

ELEVATION 1049.81m DIAMETER OF HOLE 80 mm COMPLETED 9-1-92

COORDINATE E76 5732.5 N66 2777.5

ANGLE FROM HORIZONTAL 90 ^{o} MEASURED BY Lu

BEARING OF ANGLE HOLE

EQUIPMENT FOR WATER MEASUREMENT Dipmeter

DATE MEASURED	TIME MEASURED	DEPTH OF HOLE AT MEASUREMENT	DEPTH OF * WATER LEVEL	ELASPED ** TIME	CEMENTING CASING	REMARKS
2-1-92	07 00	-	-	-	-	
3-1-92	07 00	2.00 m	0.032 m	13 hours	1.32 m	
3-1-92	13 00	3.00 m	1.70 m	1 hour	2.53 m	
4-1-92	07 00	3.50 m	2.90 m	13 hours	2.53 m	
4-1-92	13 00	4.50 m	3.31 m	1 hour	2.53 m	
5-1-92	07 00	6.00 m	4.50 m	13 hours	4.49 m	
5-1-92	12 32	7.00 m	4.50 m	12 mins	6.52 m	
6-1-92	07 00	8.00 m	4.30 m	13 hours	7.30 m	
6-1-92	09 49	9.00 m	4.54 m	15 mins	9.00 m	
7-1-92	07 00	10.00 m	4.76 m	13 hours	9.64 m	
7-1-92	12 18	12.00 m	5.07 m	7 mins	9.64 m	
8-1-92	07 00	13.00 m	5.15 m	13 hours	9.64 m	
8-1-92	17 46	14.00 m	4.60 m	15 mins	9.64 m	
9-1-92	07 00	14.00 m	5.25 m	13½ hours	9.64 m	
9-1-92	09 50	15.00 m	4.60 m	16 mins	9.64 m	

* Mark "none" when water level exists under the bottom of hole
** Elapsed time from shutting off of drilling water

RECORD OF WATER LEVEL IN DRILL - HOLE DURING DRILLING

PROJECT: G.I. At Upper Liwagu Mini Hydro Project Site HOLE NO. LI-3

LOCATION Mesilau Intake DEPTH OF HOLE 15.0 m COMMENCED 31-1-92

ELEVATION 1035.96 m DIAMETER OF HOLE mm COMPLETED 8-2-92
E76 7594
COORDINATE N66 2603

ANGLE FROM HORIZONTAL 90 ° MEASURED BY Will

BEARING OF ANGLE HOLE

EQUIPMENT FOR WATER MEASUREMENT Dip meter

DATE MEASURED	TIME MEASURED	DEPTH OF HOLE AT MEASUREMENT	DEPTH OF * WATER LEVEL	ELASPED ** TIME	CEMENTING CASING	REMARKS
31-1-92	07 00	-	-	-	-	
31-1-92	18 35	3.00 m	0.45 m	10 mins	2.60 m	
1-2-92	07 00	3.00 m	0.60 m	12½ hours	2.60 m	
1-2-92	18 43	5.50 m	0.50 m	13 mins	4.20 m	
2-2-92	07 00	5.50 m	0.50 m	12½ hours	4.20 m	
2-2-92	20 18	9.00 m	0.72 m	18 mins	8.00 m	
3-2-92	06 30	9.00 m	1.03 m	10½ hours	8.00 m	
3-2-92	12 23	10.00 m	1.18 m	20 mins	10.00 m	
7-2-92	09 43	10.00 m	0.62 m	4 day	10.00 m	
7-2-92	18 22	12.00 m	0.41 m	5 mins	12.00 m	
8-2-92	06 30	12.00 m	0.63 m	12 hours	12.00 m	
8-2-92	17 44	15.00 m	1.37 m	22 mins	13.00 m	

* Mark "none" when water level exists under the bottom of hole
** Elapsed time from shutting off of drilling water

RECORD OF WATER LEVEL IN DRILL - HOLE DURING DRILLING

PROJECT: G.I. At Upper Liwagu Mini Hydro Project Site HOLE NO. LI-4

LOCATION Sg.Mesilau Intake DPETH OF HOLE 15 m COMMENCED 21-1-92

ELEVATION 1035.34m DIAMETER OF HOLE 80 mm COMPLETED 27-1-92

COORDINATE E76 7571 N66 2597

ANGLE FROM HORIZONTAL 90 ^{o} MEASURED BY Ampahon

BEARING OF ANGLE HOLE _____

EQUIPMENT FOR WATER MEASUREMENT Dipmeter

DATE MEASURED	TIME MEASURED	DEPTH OF HOLE AT MEASUREMENT	DEPTH OF * WATER LEVEL	ELASPED ** TIME	CEMENTING CASING	REMARKS
21-1-92	06 00	-	-	-	-	
21-1-92	18 28	2.00 m	0.21 m	10 mins	1.50 m	
22-1-92	06 30	2.00 m	0.15 m	12 hours	2.00 m	
22-1-92	18 35	4.00 m	0.22 m	10 mins	4.00 m	
23-1-92	07 00	4.00 m	0.21 m	12½ hours	4.00 m	
23-1-92	18 32	6.00 m	0.26 m	12 mins	4.90 m	
24-1-92	07 00	6.00 m	0.30 m	12½ hours	4.90 m	
24-1-92	18 00	8.00 m	0.12 m	13 mins	7.20 m	
25-1-92	06 50	8.00 m	0.20 m	12½ hours	7.20 m	
25-1-92	18 00	10.00 m	0.08 m	7 mins	10.0 m	
26-1-92	06 55	10.00 m	0.06 m	12½ hours	10.0 m	
26-1-92	18 10	12.00 m	0.12 m	7 mins	12.0 m	
27-1-92	07 00	12.00 m	0.16 m	12½ hours	12.0 m	
27-1-92	17 10	15.00 m	1.38 m	12 mins	12.0 m	

* Mark "none" when water level exists under the bottom of hole
** Elapsed time from shutting off of drilling water

RECORD OF WATER LEVEL IN DRILL - HOLE DURING DRILLING

PROJECT: G.I. At Upper Liwagu Mini Hydro Project Site HOLE NO. LT-1

LOCATION Head Pond DPETH OF HOLE 20 m COMMENCED 18-1-92

ELEVATION 1031.62m DIAMETER OF HOLE 80 mm COMPLETED 23-1-92

COORDINATE E76 7818 N66 1692.5

ANGLE FROM HORIZONTAL 90 ° MEASURED BY Lu

BEARING OF ANGLE HOLE

EQUIPMENT FOR WATER MEASUREMENT Dipmeter

DATE MEASURED	TIME MEASURED	DEPTH OF HOLE AT MEASUREMENT	DEPTH OF * WATER LEVEL	ELASPED ** TIME	CEMENTING CASING	REMARKS
18-1-92	07 00	-	-	-	-	
18-1-92	16 51	5.00 m	2.80 m	10 mins	3.00 m	
19-1-92	07 00	5.00 m	3.20 m	13 hours	4.50 m	
19-1-92	16 04	8.00 m	2.35 m	18 mins	7.50 m	
20-1-92	07 00	8.00 m	5.50 m	13 hours	8.00 m	
20-1-92	07 40	11.0 m	1.25 m	16 mins	10.0 m	
20-1-92	18 30	11.00 m	1.83 m	12 mins	11.00 m	
21-1-92	07 00	11.00 m	7.50 m	13 hours	11.00 m	
21-1-92	18 10	13.00 m	8.80 m	10 mins	13.00 m	
22-1-92	07 00	13.00 m	12.73 m	13 hours	13.00 m	
22-1-92	18 20	16.00 m	9.70 m	10 mins	16.00 m	
23-1-92	07 00	16.00 m	10.20 m	13 hours	16.00 m	
23-1-92	20 00	20.00 m	9.90 m	10 mins	18.00 m	

* Mark "none" when water level exists under the bottom of hole
** Elapsed time from shutting off of drilling water

RECORD OF WATER LEVEL IN DRILL - HOLE DURING DRILLING

PROJECT: G.I. At Upper Liwagu Mini Hydro Project Site HOLE NO. LT-2

LOCATION Head Pond DPETH OF HOLE 20 m COMMENCED 11-1-92

ELEVATION 1035.53m DIAMETER OF HOLE 80 mm COMPLETED 17-1-92

COORDINATE E76 7725.5
N66 1707.5

ANGLE FROM HORIZONTAL 90 ° MEASURED BY Lu

BEARING OF ANGLE HOLE _____

EQUIPMENT FOR WATER MEASUREMENT Dipmeter

DATE MEASURED	TIME MEASURED	DEPTH OF HOLE AT MEASUREMENT	DEPTH OF * WATER LEVEL	ELASPED ** TIME	CEMENTING CASING	REMARKS
11-1-92	13 00	-	-	-	-	
12-1-92	13 00	3.00 m	1.50 m	18½ hours	3.00 m	
13-1-92	07 00	4.00 m	2.15 m	13 hours	3.00 m	
13-1-92	16 20	8.00 m	2.75 m	17 mins	8.00 m	
14-1-92	07 00	8.00 m	4.20 m	12 hours	8.00 m	
14-1-92	13 00	10.00 m	4.15 m	1 hour	10.00 m	
15-1-92	07 00	12.00 m	3.70 m	13 hours	12.00 m	
15-1-92	-	15.00 m	2.20 m	15 mins	12.00 m	
16-1-92	07 00	15.00 m	7.30 m	12½ hours	15.00 m	
16-1-92	14 39	20.00 m	3.47 m	12 mins	15.00 m	

* Mark "none" when water level exists under the bottom of hole
** Elapsed time from shutting off of drilling water

RECORD OF WATER LEVEL IN DRILL - HOLE DURING DRILLING

PROJECT: G.I. At Upper Liwagu Mini Hydro Project Site HOLE NO. LP-1

LOCATION Kundasang DPETH OF HOLE 20 m COMMENCED 6-12-91

ELEVATION 975.08m DIAMETER OF HOLE 80 mm COMPLETED 12-12-91

COORDINATE E76 7727 N66 1434

ANGLE FROM HORIZONTAL 90 ° MEASURED BY Lu

BEARING OF ANGLE HOLE

EQUIPMENT FOR WATER MEASUREMENT Dipmeter

DATE MEASURED	TIME MEASURED	DEPTH OF HOLE AT MEASUREMENT	DEPTH OF * WATER LEVEL	ELASPED ** TIME	CEMENTING CASING	REMARKS
6-12-91	07 00	-	-	-	-	
7-12-91	07 00	2.50 m	2.12 m	13 hours	2.00 m	
7-12-91	13 00	4.00 m	2.03 m	1 hour	3.00 m	
8-12-91	07 30	5.00 m	2.37 m	13½ hours	5.00 m	
9-12-91	07 00	8.00 m	3.59 m	13 hours	7.00 m	
9-12-91	13 00	9.00 m	6.53 m	1 hour	8.50 m	
10-12-91	07 00	11.50 m	9.50 m	13 hours	11.00 m	
10-12-91	13 00	12.50 m	4.03 m	1 hour	12.00 m	
11-12-91	07 00	15.00 m	6.60 m	13 hours	13.00 m	
11-12-91	13 00	15.50 m	11.55 m	1 hour	14.35 m	
12-12-91	07 00	18.00 m	17.65 m	13 hours	14.35 m	
12-12-91	13 00	18.80 m	7.97 m	1 hour	17.35 m	
13-12-91	07 00	20.00 m	13.35 m	13 hours	17.35 m	
13-12-91	08 20	20.00 m	17.63 m	½ hour	18.78 m	

* Mark "none" when water level exists under the bottom of hole
** Elapsed time from shutting off of drilling water

RECORD OF WATER LEVEL IN DRILL - HOLE DURING DRILLING

PROJECT: G.I. At Upper Liwagu Mini Hydro Project Site HOLE NO. LP-2

LOCATION Penstock DPETH OF HOLE 20 m COMMENCED 21-1-92

ELEVATION 913.65m DIAMETER OF HOLE 80 mm COMPLETED 27-1-92

COORDINATE E76 7717.5 N66 1236

ANGLE FROM HORIZONTAL 90 ° MEASURED BY Andy

BEARING OF ANGLE HOLE

EQUIPMENT FOR WATER MEASUREMENT Dipmeter

DATE MEASURED	TIME MEASURED	DEPTH OF HOLE AT MEASUREMENT	DEPTH OF* WATER LEVEL	ELASPED** TIME	CEMENTING CASING	REMARKS
21-1-92	07 00	-	-	-	-	
21-1-92	14 25	3.95 m	2.42 m	15 mins	3.95 m	
21-1-92	18 30	6.00 m	4.10 m	15 mins	6.00 m	
22-1-92	07 00	6.00 m	5.80 m	9½ hours	6.00 m	
22-1-92	12 00	7.50 m	5.70 m	10 mins	6.00 m	
23-1-92	07 00	7.50 m	6.09 m	18 hours	6.00 m	
23-1-92	18 25	10.00 m	5.89 m	10 mins	10.00 m	
24-1-92	07 00	10.00 m	9.65 m	12½ hours	10.00 m	
24-1-92	12 30	11.00 m	9.82 m	21 mins	10.45 m	
24-1-92	18 00	12.00 m	9.45 m	25 mins	10.45 m	
25-1-92	07 00	12.00 m	10.00 m	13 hours	10.45 m	
25-1-92	13 15	13.85 m	11.27 m	19 mins	10.45 m	
26-1-92	07 00	15.00 m	10.8 m	13 hours	13.06 m	
26-1-92	12 00	16.00 m	9.45 m	20 mins	13.06 m	
26-1-92	18 30	16.95 m	9.92 m	31 mins	13.06 m	

* Mark "none" when water level exists under the bottom of hole
** Elapsed time from shutting off of drilling water

RECORD OF WATER LEVEL IN DRILL - HOLE DURING DRILLING

PROJECT: G.I.'At Upper Liwagu Mini Hydro Project Site HOLE NO. LP-2

LOCATION: Penstock DEPTH OF HOLE: 20 m COMMENCED: 21-1-92

ELEVATION: 913.65m DIAMETER OF HOLE: 80 mm COMPLETED: 27-1-92

COORDINATE: E76 7717.5 N66 1236

ANGLE FROM HORIZONTAL: 90 ° MEASURED BY: Andy

BEARING OF ANGLE HOLE: _____

EQUIPMENT FOR WATER MEASUREMENT: Dipmeter

DATE MEASURED	TIME MEASURED	DEPTH OF HOLE AT MEASUREMENT	DEPTH OF * WATER LEVEL	ELASPED ** TIME	CEMENTING CASING	REMARKS
27-1-92	07 00	16.95 m	10.82 m	13 hours	13.06 m	
27-1-92	15 44	20.00 m	8.37 m	23 mins	13.06 m	

* Mark "none" when water level exists under the bottom of hole
** Elapsed time from shutting off of drilling water

RECORD OF WATER LEVEL IN DRILL - HOLE DURING DRILLING

PROJECT: G.I. At Upper Liwagu Mini Hydro Project Site HOLE NO. LP-3

LOCATION Power House DPETH OF HOLE 20.0 m COMMENCED 18-12-91

ELEVATION 861.67m DIAMETER OF HOLE 80 mm COMPLETED 15-1-92

COORDINATE E76 7662.5 N66 1075

ANGLE FROM HORIZONTAL 90 ^{o} MEASURED BY Ampahon

BEARING OF ANGLE HOLE

EQUIPMENT FOR WATER MEASUREMENT Dipmeter

DATE MEASURED	TIME MEASURED	DEPTH OF HOLE AT MEASUREMENT	DEPTH OF* WATER LEVEL	ELASPED** TIME	CEMENTING CASING	REMARKS
17-12-91	13 00	-	-	-	-	
18-12-91	07 05	65 cm	0.08 m	14 hours	-	
18-12-91	18 35	2.50 m	0.31 m	8 mins	1.50 m	
19-12-91	06 50	2.50 m	0.45 m	12½ hours	2.50 m	
19-12-91	12 17	3.00 m	1.43 m	8 mins	2.50 m	
20-12-91	07 00	3.29 m	1.66 m	13 hours	2.50 m	
20-12-91	06 07	4.62 m	0.93 m	12 mins	2.50 m	
21-12-91	06 52	4.62 m	1.92 m	13 hours	2.50 m	
21-12-91	17 54	6.00 m	1.07 m	10 mins	2.50 m	
22-12-91	07 00	6.00 m	1.19 m	13 hours	2.50 m	
22-12-91	08 15	6.50 m	None	13 mins	2.50 m	
23-12-91	07 00	8.00 m	None	12 hours	2.50 m	BH caving cement grouting
24-12-91	-	-	-	-	-	No work at site
25-12-91	-	-	-	-	-	No work at site
26-12-91	07 00	7.10 m	1.97 m	2½ day	2.50 m	BH caving cement grouting
27-12-91	07 00	6.00 m	2.01 m	13 hours	2.50 m	

* Mark "none" when water level exists under the bottom of hole
** Elapsed time from shutting off of drilling water

RECORD OF WATER LEVEL IN DRILL - HOLE DURING DRILLING

PROJECT: G.I. At Upper Liwagu Mini Hydro Project Site HOLE NO. LP-3

LOCATION Power House DPETH OF HOLE 20.0 m COMMENCED 18-12-91

ELEVATION 861.67m DIAMETER OF HOLE 80 mm COMPLETED 15-1-92

COORDINATE E76 7662.5 N66 1075

ANGLE FROM HORIZONTAL 90 ° MEASURED BY Ampahon

BEARING OF ANGLE HOLE

EQUIPMENT FOR WATER MEASUREMENT Dipmeter

DATE MEASURED	TIME MEASURED	DEPTH OF HOLE AT MEASUREMENT	DEPTH OF * WATER LEVEL	ELASPED ** TIME	CEMENTING CASING	REMARKS
27-12-91	13 00	7.35 m	2.06 m	1 hour	3.25 m	
28-12-91	07 00	7.35 m	1.81 m	13 hours	3.25 m	
28-12-91	13 00	7.35 m	2.16 m	1 hour	4.78 m	
29-12-91	07 00	8.00.m	2.13 m	13 hours	4.78 m	
29-12-91	13 00	9.00 m	2.19 m	1 hour	4.78 m	BH caving cement grouting
30-12-91	07 00	8.00 m	2.70 m	15 hours	4.78 m	
30-12-91	13 15	9.75 m	2.41 m	18 mins	4.78 m	BH caving cement grouting
31-12-91	07 00	8.00 m	2.14 m	14 hours	4.78 m	Hardened cement 8.0 m - 10.0 m
1-1-92	07 00	10.0 m	2.20 m	13 hours	4.78 m	
1-1-92	12 31	10.50 m	2.48 m	15 mins	4.78 m	
2-1-92	07 00	9.50 m	2.91 m	13 hours	4.78 m	Hardened cement 11.0 m - 9.5 m
2-1-92	16 35	12.00 m	2.53 m	10 mins	4.78 m	
3-1-92	07 00	10.50 m	2.44 m	13 hours	4.78 m	Hardened cement 10.5 m - 12.0 m
3-1-92	13 00	12.06 m	2.39 m	1 hour	4.78 m	
4-1-92	07 00	12.06 m	1.30 m	13 hours	4.78 m	
4-1-92	13 00	12.06 m	1.15 m	1 hour	4.78 m	

* Mark "none" when water level exists under the bottom of hole
** Elapsed time from shutting off of drilling water

RECORD OF WATER LEVEL IN DRILL - HOLE DURING DRILLING

PROJECT: G.I. At Upper Liwagu Mini Hydro Project Site HOLE NO. LP-3

LOCATION Power House DPETH OF HOLE 20.0 m COMMENCED 18-12-91

ELEVATION 861.67m DIAMETER OF HOLE 80 mm COMPLETED 15-1-92

COORDINATE E76 7662.5 N66 1075

ANGLE FROM HORIZONTAL 90 ^{o} MEASURED BY Ampahon

BEARING OF ANGLE HOLE

EQUIPMENT FOR WATER MEASUREMENT Dipmeter

DATE MEASURED	TIME MEASURED	DEPTH OF HOLE AT MEASUREMENT	DEPTH OF * WATER LEVEL	ELASPED ** TIME	CEMENTING CASING	REMARKS
5-1-92	07 00	12.06 m	1.20 m	13 hours	4.78 m	
6-1-92	13 00	12.06 m	1.39 m	1 hour	4.78 m	
7-1-92	07 00	12.06 m	1.08 m	13 hours	4.78 m	
7-1-92	13 00	12.06 m	2.48 m	1 hour	4.78 m	
8-1-92	07 00	12.06 m	3.92 m	13 hours	4.78 m	
8-1-92	18 15	13.46 m	2.09 m	10 mins	4.78 m	
9-1-92	07 00	13.46 m	3.49 m	13 hours	4.78 m	
9-1-92	14 05	14.00 m	13.22 m	25 mins	4.78 m	
10-1-92	19 00	12.32 m	4.13 m	15 hours	4.78 m	Cement Grout 12.32 m - 14.0 m
10-1-92	14 16	15.00 m	13.06 m	35 mins	4.78 m	
11-1-92	07 00	12.90 m	3.71 m	15 hours	4.78 m	
11-1-92	14 45	16.09 m	12.94 m	25 mins	4.78 m	
14-1-92	14 15	16.13 m	4.59 m	70 hours	4.78 m	Cement Grout 16.13 m - 14 m
15-1-92	07 00	16.72 m	5.73 m	13 hours	4.78 m	
	16 30	20.00 m	13.18 m	20 mins	4.78 m	

* Mark "none" when water level exists under the bottom of hole
** Elapsed time from shutting off of drilling water

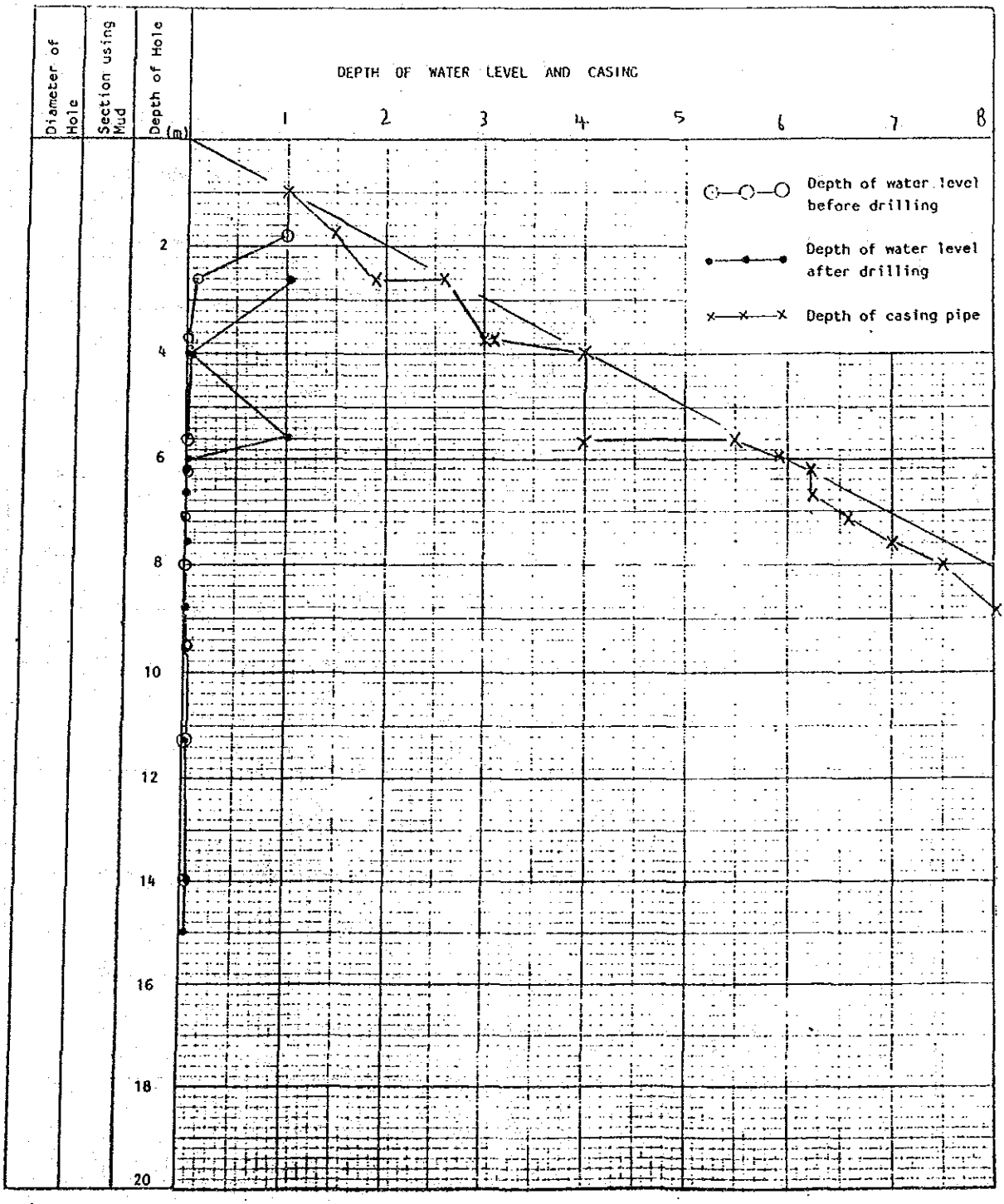
RECORD OF WATER LEVEL IN DRILL HOLE DURING DRILLING

PROJECT: G.I. At Upper Liwagu Mini Hydro Project Site HOLE NO. LI-1 (Sheet 1 of 1

LOCATION: Sg. Liwagu Intake DEPTH OF HOLE: 15 m COMMENCED: 19-12-91

ELEVATION: 1049.91m DIAMETER OF HOLE: 80 mm COMPLETED: 1-1-92

COORDINATE: E76 5742.5 N66 2788.5 ANGLE FROM HORIZONTAL: 90° MEASURED BY: Lu



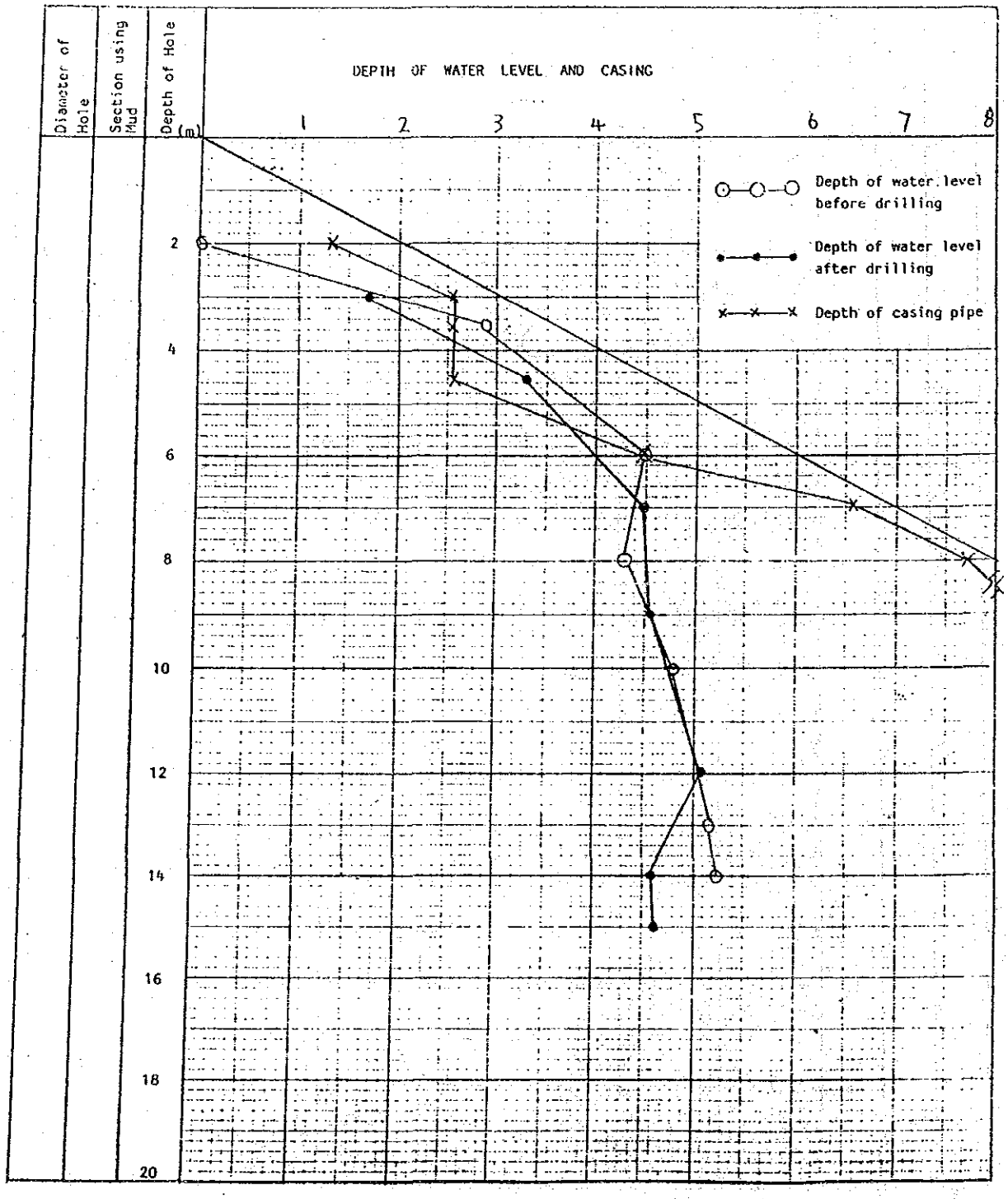
RECORD OF WATER LEVEL IN DRILL HOLE DURING DRILLING

PROJECT: C.I. At Upper Liwagu Mini Hydro Project Site HOLE NO. LI-2 (Sheet 1 of 1)

LOCATION: Liwagu River Intake DEPTH OF HOLE: 15 m COMMENCED: 2-1-92

ELEVATION: 1049.81m DIAMETER OF HOLE: 80 mm COMPLETED: 9-1-92

COORDINATE: E76 5732.5 N66 2777.5 ANGLE FROM HORIZONTAL: 90° MEASURED BY: Lu



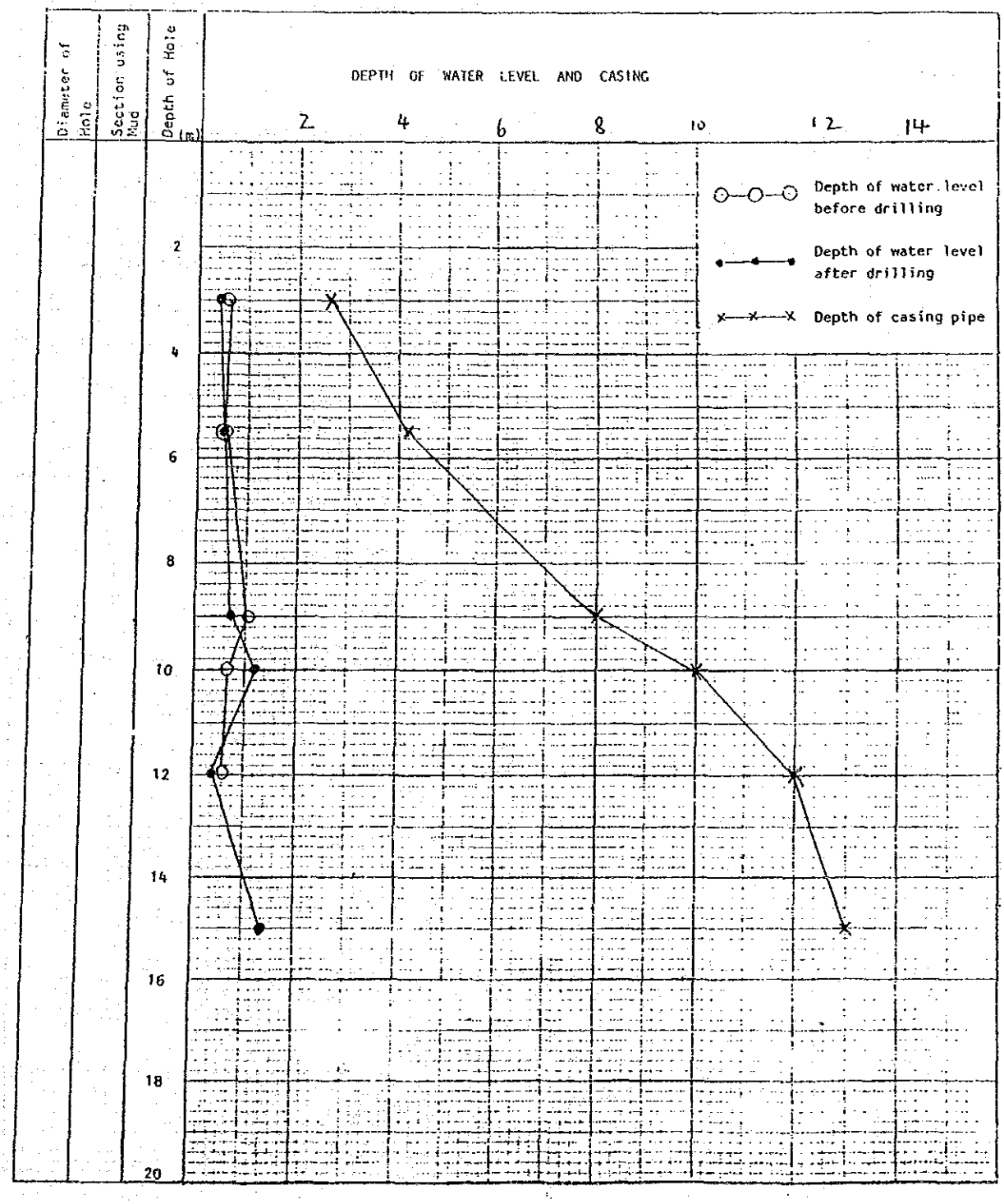
RECORD OF WATER LEVEL IN DRILL HOLE DURING DRILLING

PROJECT: Geological Investigation At Upper Liwagu Mini Hydro Project Site HOLE NO. L1-3 (Sheet 1 of 1)

LOCATION: Mesilau Intake DEPTH OF HOLE: 15 m COMMENCED: 31-1-92

ELEVATION: 1035,96 m DIAMETER OF HOLE: 80 mm COMPLETED: 8-2-92

COORDINATE: E76 7594 N66 2603 ANGLE FROM HORIZONTAL: 90° MEASURED BY: Wil



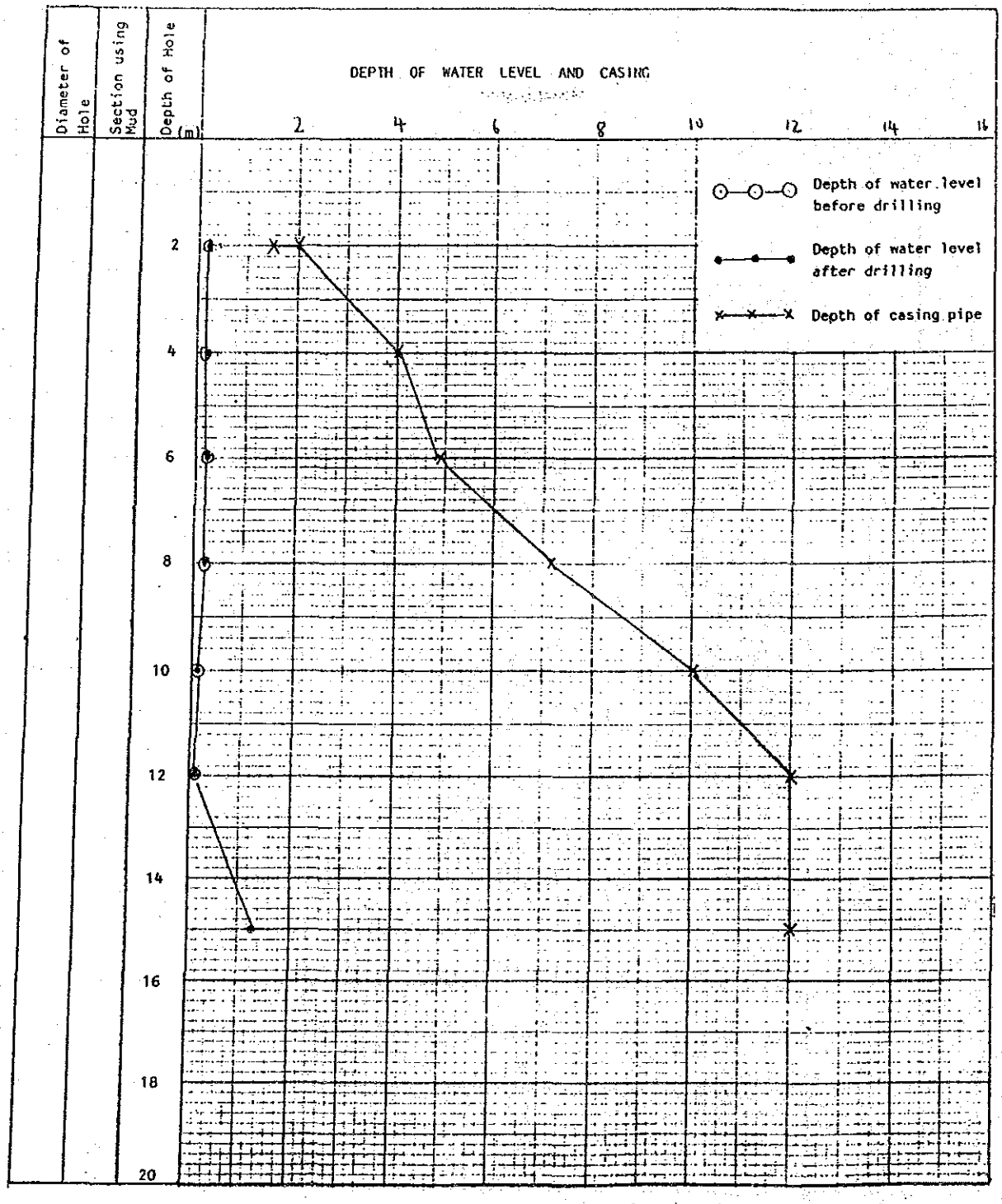
RECORD OF WATER LEVEL IN DRILL HOLE DURING DRILLING

PROJECT: G.I. At Upper Liwagu Mini Hydro Project Site HOLE NO. LI-4 (Sheet 1 of 1)

LOCATION: Sg. Mesilau Intake DEPTH OF HOLE: 15 m COMMENCED: 21-1-92

ELEVATION: 1035.34m DIAMETER OF HOLE: 80 mm COMPLETED: 27-1-92

COORDINATE: E76 7571 N66 2597 ANGLE FROM HORIZONTAL: 90° MEASURED BY: Ampahon



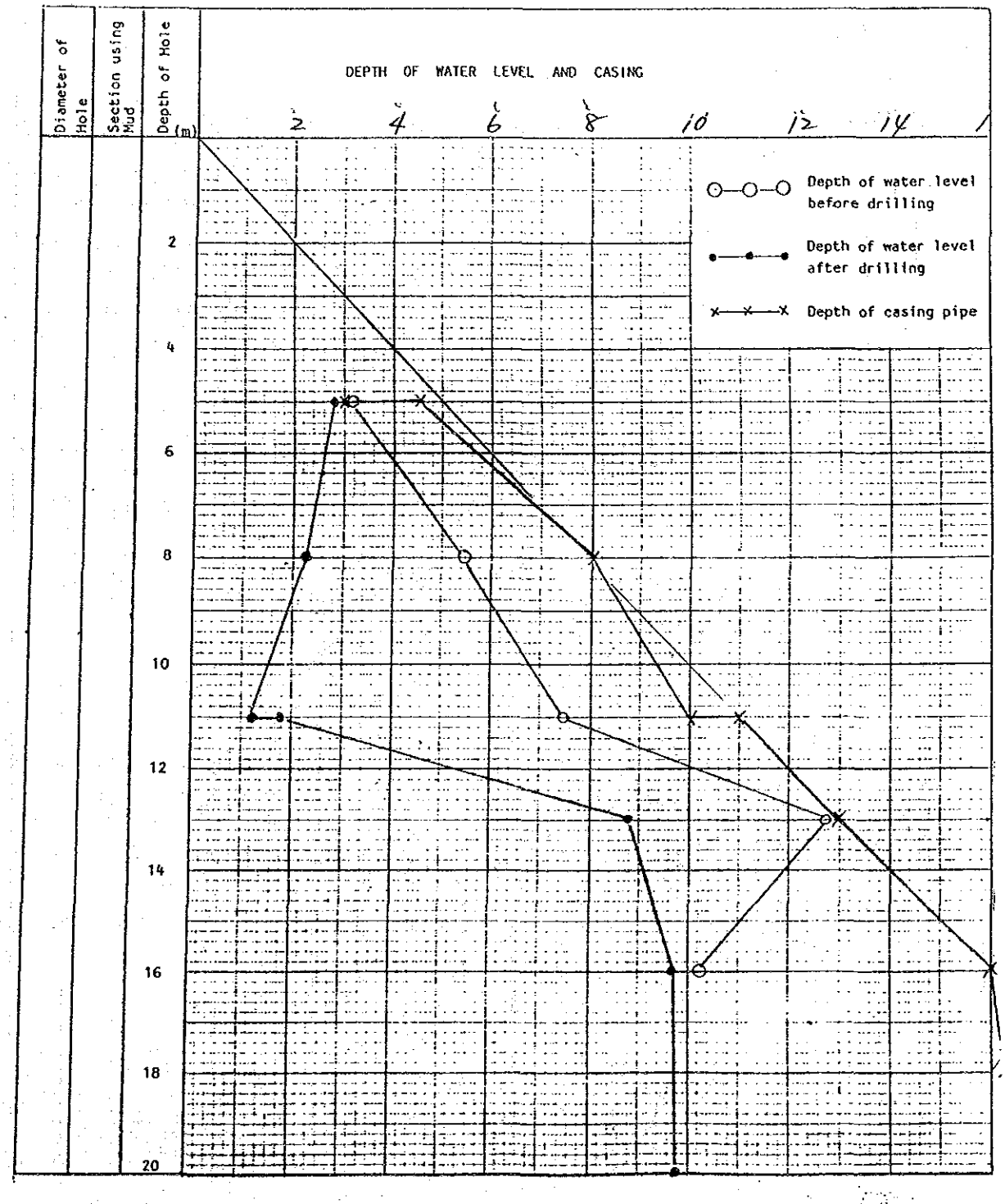
RECORD OF WATER LEVEL IN DRILL HOLE DURING DRILLING

PROJECT: G.I. At Upper Liwagu Mini Hydro Project Site HOLE NO. LT-1 (Sheet 1 of 1)

LOCATION: Head Pond DEPTH OF HOLE: 20 m COMMENCED: 18-1-92

ELEVATION: 1031.62m DIAMETER OF HOLE: 80 mm COMPLETED: 23-1-92

COORDINATE: E76 7818 N66 1692.5 ANGLE FROM HORIZONTAL: 90° MEASURED BY: Lu



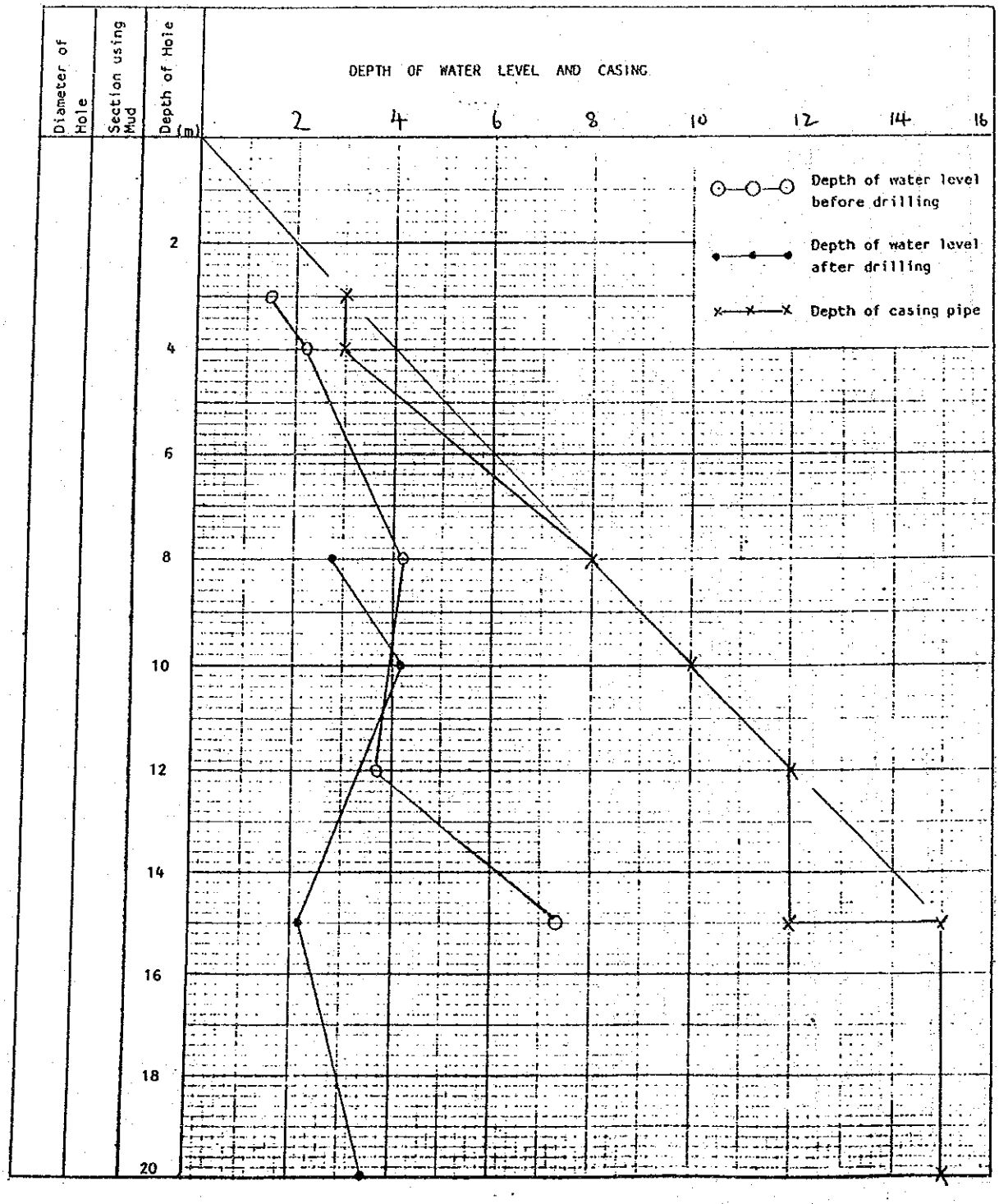
RECORD OF WATER LEVEL IN DRILL HOLE DURING DRILLING

PROJECT: G.I. At Upper Liwagu Mini Hydro Project Site HOLE NO. LT-2 (Sheet 1 of 1)

LOCATION: Head Pond DEPTH OF HOLE: 20 m COMMENCED: 11-1-92

ELEVATION: 1035.53m DIAMETER OF HOLE: 80 mm COMPLETED: 17-1-92

COORDINATE: E76 7725.5 N66 1797.5 ANGLE FROM HORIZONTAL: 90° MEASURED BY: Lu



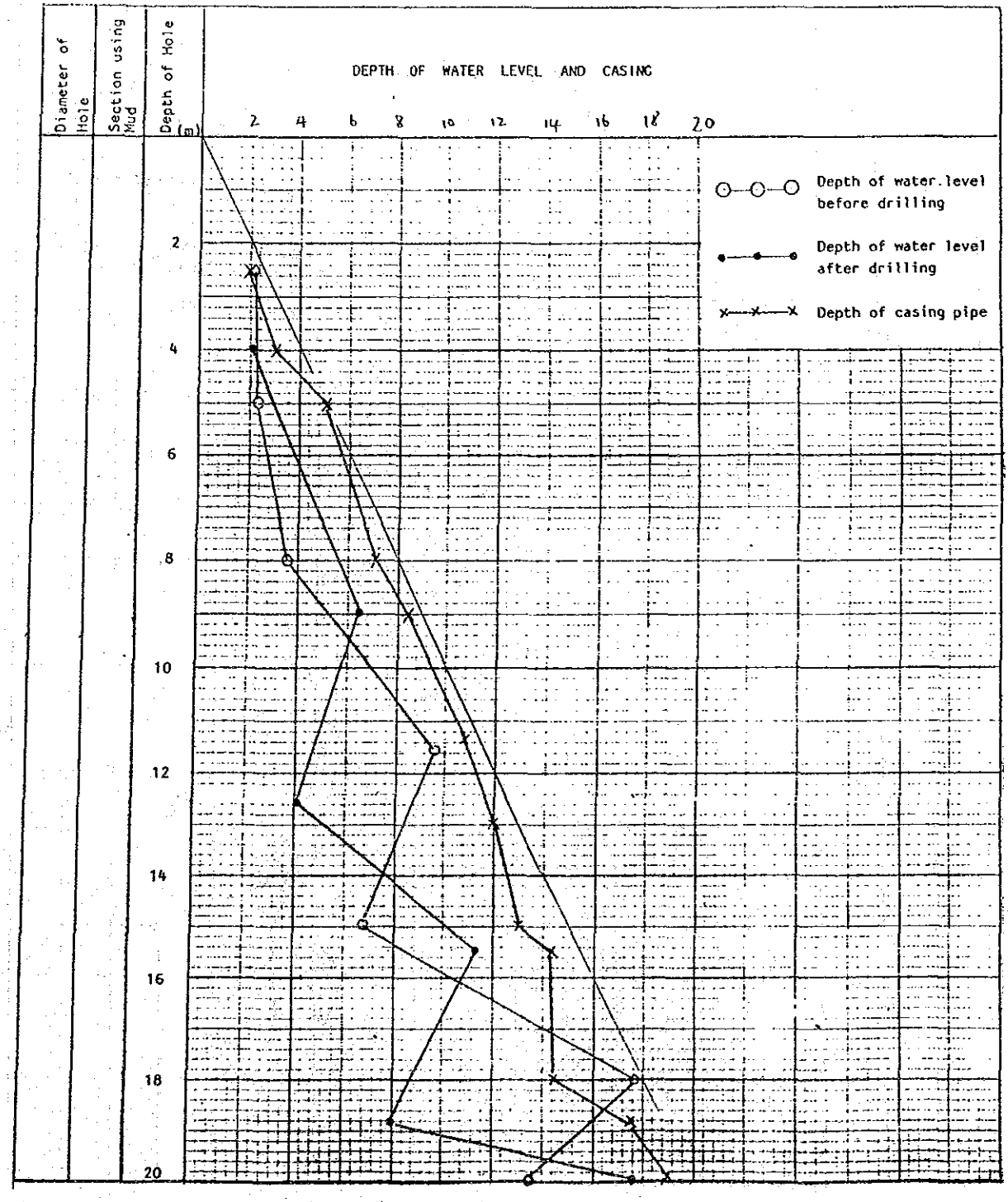
RECORD OF WATER LEVEL IN DRILL HOLE DURING DRILLING

PROJECT: G.I. At Upper Liwagu Mini Hydro Project Site HOLE NO. LP-1 (Sheet 1 of 1)

LOCATION: Kundasang DEPTH OF HOLE: 20 m COMMENCED: 6-12-91

ELEVATION: 975.08m DIAMETER OF HOLE: 80 mm COMPLETED: 12-12-91

COORDINATE: E76 7727 N66 1434 ANGLE FROM HORIZONTAL: 90° MEASURED BY: Lu



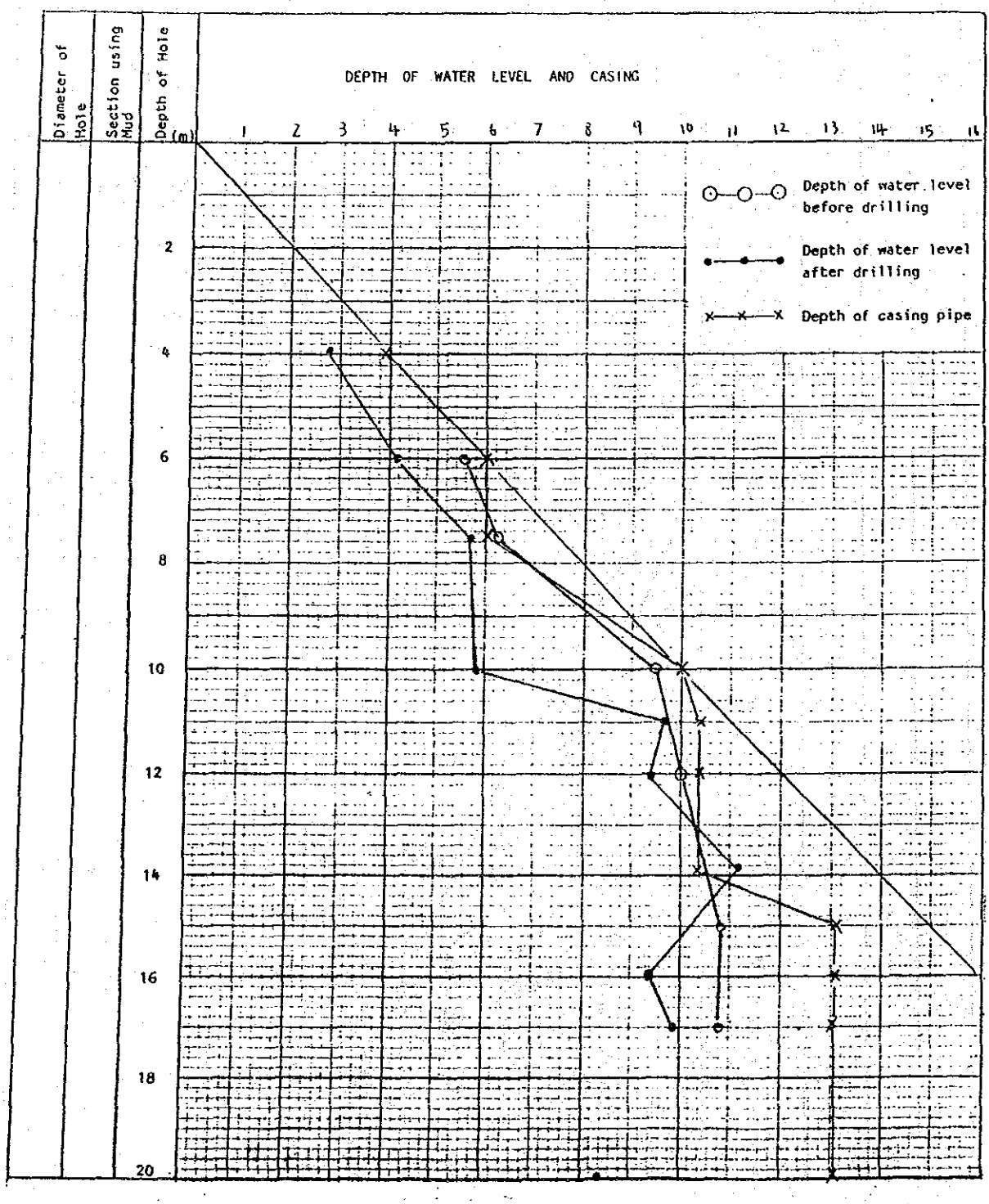
RECORD OF WATER LEVEL IN DRILL HOLE DURING DRILLING

PROJECT: G.I. At Upper Liwagu Mini Hydro Project Site HOLE NO. LP-2 (Sheet 1 of 1)

LOCATION: Penstock DEPTH OF HOLE: 20 m COMMENCED: 21-1-92

ELEVATION: 913.65m DIAMETER OF HOLE: 80 mm COMPLETED: 27-1-92

COORDINATE: E76 7717.5 N66 1236 ANGLE FROM HORIZONTAL: 90° MEASURED BY: Andy



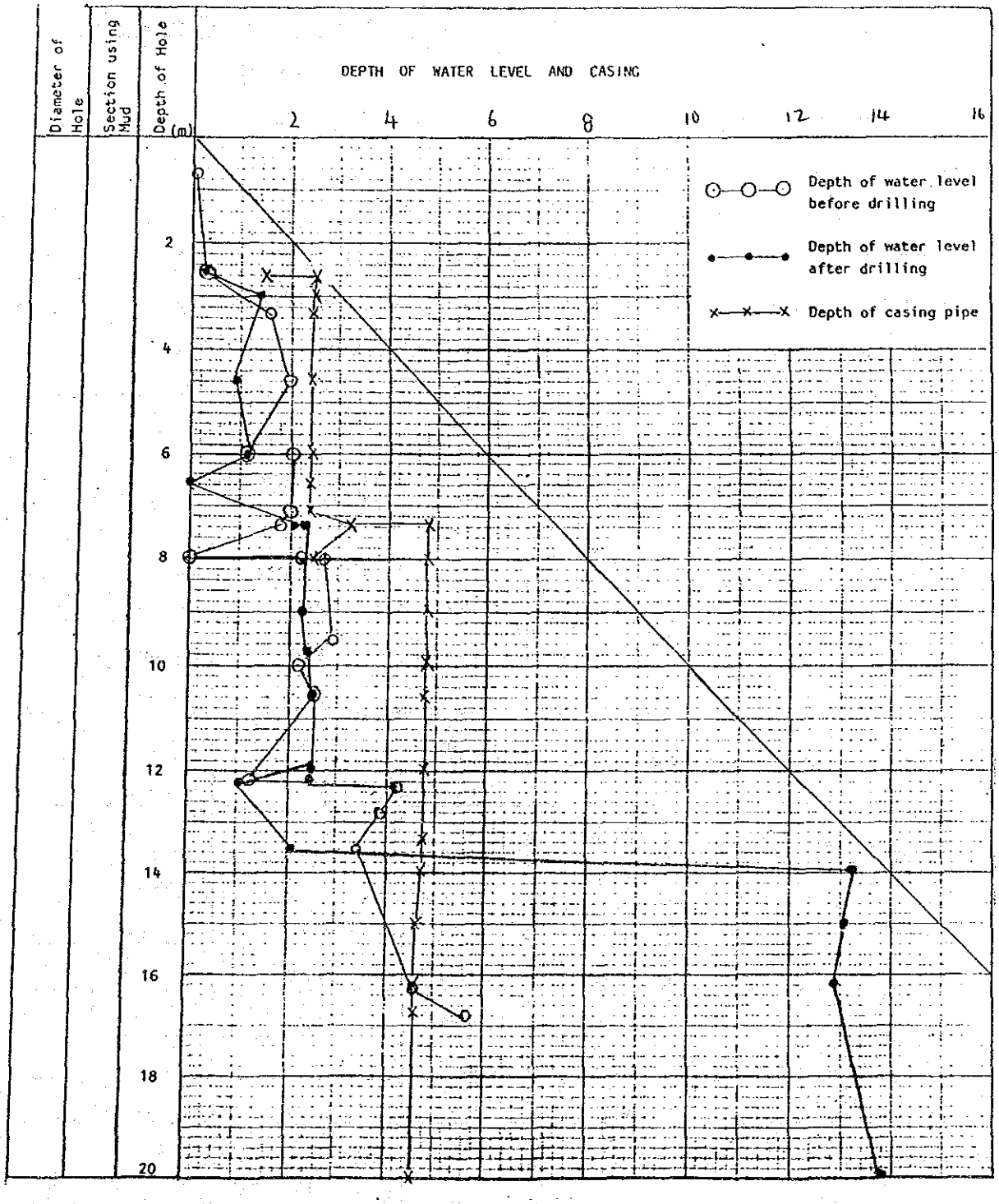
RECORD OF WATER LEVEL IN DRILL HOLE DURING DRILLING

PROJECT: G. I. At Upper Liwagu Mini Hydro Project Site HOLE NO. LP-3 (Sheet 1 of 1)

LOCATION: Power House DEPTH OF HOLE: 20 m COMMENCED: 18-12-91

ELEVATION: 861.67m DIAMETER OF HOLE: 80 mm COMPLETED: 15-1-92

COORDINATE: E76 7662.5 N66 1075 ANGLE FROM HORIZONTAL: 90° MEASURED BY: Ampahon



OPEN - END PERMEABILITY TEST

(Sheet 1 Of 5)

PROJECT : G.I. At Upper Liwagu Mini Hydro Project Site HOLE No. LI-1

LOCATION Liwagu Intake DATE OF TEST 20-12-91 TESTED BY Ampahon

GROUND ELEVATION 1049.91 m SIZE OF CASING NW CHECKED BY M.Liew

GEOLOGICAL CONDITION OF THE BOTTOM OF DRILL HOLE Yellowish grey weathered fine-grained SANDSTONE

DEPTH FROM GROUND SURFACE TO THE BOTTOM OF CASING 260 cm

HEIGHT FROM GROUND SURFACE TO THE TOP OF CASING 46 cm

INTERNAL RADIUS OF CASING : r = 3.90 cm

GROUND TEMPERATURE 25 ^{o}C WATER TEMPERATURE 20 ^{o}C

DEPTH FROM GROUND SURFACE TO WATER SURFACE IN THE DRILL HOLE BEFORE TEST 31 cm

DEPTH FROM GROUND SURFACE TO WATER SURFACE IN THE DRILL HOLE AFTER TEST 31.5 cm

Time		Differential Head Of Water H (cm)	Water Volume			Coefficient Of Permeability K (cm/sec)
Clock Hr min	min		Accum. Flow (lt)	Diff. Flow (lt/min)	Constant Rate Of Flow Q (cm^3/sec)	
16 21	0		0			
16 26	5		5.50	1.10	18.33	0.0111
16 31	10		11.00	1.10	18.33	0.0111
16 36	15		17.00	1.20	20.00	0.0122
16 41	20		23.50	1.30	21.67	0.0121
16 46	25		29.50	1.20	20.00	0.0122
16 51	30	77	33.50	0.80	13.33	$8.07X10^{-3}$
16 56	35		38.00	0.90	15.00	$9.08X10^{-3}$
17 01	40		44.00	1.20	20.00	0.0122
17 06	45		49.00	1.00	16.67	0.0101
17 11	50		53.50	0.90	15.00	$9.08X10^{-3}$
17 16	55		58.25	0.95	15.83	$9.58X10^{-3}$
17 21	60		62.50	0.85	14.17	$8.58X10^{-3}$

Constant Rate Of Flow For Steady State Condition : Q = 17.36 cm^3/sec

Coefficient Of Permeability For Steady State Condition : K = 1.05×10^{-2} cm/sec

OPEN - END PERMEABILITY TEST

PROJECT : G.I. At Upper Liwagu Mini Hydro Project Site HOLE No. LI-1

LOCATION Liwagu Intake DATE OF TEST 23-12-91 TESTED BY Ampahon

GROUND ELEVATION 1049.91 m SIZE OF CASING NW CHECKED BY M.Liew

GEOLOGICAL CONDITION OF THE BOTTOM OF DRILL HOLE Yellowish grey weathered SANDSTONE

DEPTH FROM GROUND SURFACE TO THE BOTTOM OF CASING 400 cm

HEIGHT FROM GROUND SURFACE TO THE TOP OF CASING 36 cm

INTERNAL RADIUS OF CASING : r = 3.90 cm

GROUND TEMPERATURE 25 ^{o}C WATER TEMPERATURE 20 ^{o}C

DEPTH FROM GROUND SURFACE TO WATER SURFACE IN THE DRILL HOLE BEFORE TEST 30.50 cm

DEPTH FROM GROUND SURFACE TO WATER SURFACE IN THE DRILL HOLE AFTER TEST 11.50 cm

Time		Differential Head Of Water H (cm)	Water Volume			Coefficient Of Permeability K (cm/sec)
Clock Hr min	min		Accum. Flow (lt)	Diff. Flow (lt/min)	Constant Rate Of Flow Q (cm^3/sec)	
15 45	0		0			
15 50	5		3.70	0.74	12.33	$8.64X10^{-3}$
15 55	10		7.70	0.80	13.33	$9.35X10^{-3}$
16 00	15		12.20	0.90	15.00	0.0105
16 05	20		16.40	0.84	14.00	$9.81X10^{-3}$
16 10	25		19.90	0.70	11.67	$8.18X10^{-3}$
16 15	30	66.5	23.80	0.78	13.00	$9.11X10^{-3}$
16 20	35		27.60	0.76	12.67	$8.88X10^{-3}$
16 25	40		31.80	0.84	14.00	$9.81X10^{-3}$
16 30	45		36.10	0.86	14.33	0.01005
16 35	50		39.30	0.64	10.67	$7.48X10^{-3}$
16 40	55		42.20	0.58	9.67	$6.78X10^{-3}$
16 45	60		46.00	0.76	12.67	$8.88X10^{-3}$

Constant Rate Of Flow For Steady State Condition : Q = 12.78 cm^3/sec

Coefficient Of Permeability For Steady State Condition : K = $8.96X10^{-3}$ cm/sec

OPEN - END PERMEABILITY TEST

(Sheet 3 Of 5)

PROJECT : G.I. At Upper Liwagu Mini Hydro Project Site HOLE No.LI-1

LOCATION Liwagu Intake DATE OF TEST 26-12-91 TESTED BY LU

GROUND ELEVATION 1049.91 m SIZE OF CASING NW CHECKED BY M.Liew

GEOLOGICAL CONDITION OF THE BOTTOM OF DRILL HOLE Grey fine-grained SANDSTONE

DEPTH FROM GROUND SURFACE TO THE BOTTOM OF CASING 625 cm

HEIGHT FROM GROUND SURFACE TO THE TOP OF CASING 37 cm

INTERNAL RADIUS OF CASING : r = 3.9 cm

GROUND TEMPERATURE 25 ^{o}C WATER TEMPERATURE 20 ^{o}C

DEPTH FROM GROUND SURFACE TO WATER SURFACE IN THE DRILL HOLE BEFORE TEST 21 cm

DEPTH FROM GROUND SURFACE TO WATER SURFACE IN THE DRILL HOLE AFTER TEST 7 cm

Time		Differential Head Of Water H (cm)	Water Volume			Coefficient Of Permeability K (cm/sec)
Clock Hr min	min		Accum. Flow (lt)	Diff. Flow (lt/min)	Constant Rate Of Flow Q (cm^3/sec)	
15 22	0		0			
15 27	5		3.0	0.60	10.00	$8.04X10^{-3}$
15 32	10		5.90	0.58	9.67	$7.77X10^{-3}$
15 37	15		8.65	0.55	9.17	$7.37X10^{-3}$
15 42	20		11.95	0.66	11.00	$8.84X10^{-3}$
15 47	25		14.45	0.50	8.33	$6.70X10^{-3}$
15 52	30	58	17.90	0.69	11.50	$9.24X10^{-3}$
15 57	35		21.65	0.75	12.50	0.01005
16 02	40		25.65	0.80	13.33	0.01071
16 07	45		29.10	0.69	11.50	$9.24X10^{-3}$
16 12	50		32.00	0.58	9.67	$7.77X10^{-3}$
16 17	55		34.65	0.53	8.83	$7.10X10^{-3}$
16 22	60		37.65	0.60	10.00	$8.04X10^{-3}$

Constant Rate Of Flow For Steady State Condition : Q = 10.46 cm^3/sec

Coefficient Of Permeability For Steady State Condition : K = $8.41X10^{-3}$ cm/sec

OPEN - END PERMEABILITY TEST

PROJECT : G.I. At Upper Liwagu Mini Hydro Project Site HOLE No. LI-1

LOCATION Liwagu Intake DATE OF TEST 29-12-91 TESTED BY Ampahon & Will

GROUND ELEVATION 1049.91 m SIZE OF CASING NW CHECKED BY M. Liew

GEOLOGICAL CONDITION OF THE BOTTOM OF DRILL HOLE Grey fine-grained SANDSTONE

DEPTH FROM GROUND SURFACE TO THE BOTTOM OF CASING 830.00 cm

HEIGHT FROM GROUND SURFACE TO THE TOP OF CASING 40.50 cm

INTERNAL RADIUS OF CASING : r = 3.90 cm

GROUND TEMPERATURE 25 ^{o}C WATER TEMPERATURE 20 ^{o}C

DEPTH FROM GROUND SURFACE TO WATER SURFACE IN THE DRILL HOLE BEFORE TEST 35.50 cm

DEPTH FROM GROUND SURFACE TO WATER SURFACE IN THE DRILL HOLE AFTER TEST 13.0 cm

Time		Differential Head Of Water H (cm)	Water Volume			Coefficient Of Permeability K (cm/sec)
Clock Hr min	min		Accum. Flow (lt)	Diff. Flow (lt/min)	Constant Rate Of Flow Q (cm^3/sec)	
08 38	0		0			
08 43	5		7.10	1.42	23.67	0.01452
08 48	10		16.70	1.92	32.00	0.01963
08 53	15		24.10	1.48	24.67	0.01513
08 58	20		32.20	1.62	27.00	0.01656
09 03	25		39.70	1.50	27.00	0.01656
09 08	30	76	47.30	1.52	25.33	0.01554
09 13	35		55.10	1.56	26.00	0.01595
09 18	40		62.50	1.48	24.67	0.01513
09 23	45		69.40	1.38	23.00	0.01411
09 28	50		75.80	1.28	21.33	0.01308
09 33	55		85.95	2.03	33.83	0.02075
09 38	60		93.90	1.59	26.50	0.01626

Constant Rate Of Flow For Steady State Condition : Q = 26.25 cm^3/sec

Coefficient Of Permeability For Steady State Condition : K = 1.61×10^{-2} cm/sec

OPEN - END PERMEABILITY TEST

(Sheet 5 Of 5)

PROJECT : G.I. At Upper Liwagu Mini Hydro Project Site HOLE No. LI-1

LOCATION Liwagu Intake DATE OF TEST 30-12-91 TESTED BY Ampahon & Will

GROUND ELEVATION 1049.91 m SIZE OF CASING NW CHECKED BY M. Liew

GEOLOGICAL CONDITION OF THE BOTTOM OF DRILL HOLE Grey fine-grained SANDSTONE

DEPTH FROM GROUND SURFACE TO THE BOTTOM OF CASING 975.00 cm

HEIGHT FROM GROUND SURFACE TO THE TOP OF CASING 43.00 cm

INTERNAL RADIUS OF CASING : r = 3.9 cm

GROUND TEMPERATURE 25 ^{o}C WATER TEMPERATURE 20 ^{o}C

DEPTH FROM GROUND SURFACE TO WATER SURFACE IN THE DRILL HOLE BEFORE TEST 43 cm

DEPTH FROM GROUND SURFACE TO WATER SURFACE IN THE DRILL HOLE AFTER TEST 11 cm

Time		Differential Head Of Water H (cm)	Water Volume			Coefficient Of Permeability K (cm/sec)
Clock Hr min	min		Accum. Flow (lt)	Diff. Flow (lt/min)	Constant Rate Of Flow Q (cm^3/sec)	
09 43	0		0			
09 48	5		4.30	0.86	14.33	$7.77X10^{-3}$
09 53	10		8.05	0.75	12.50	$6.78X10^{-3}$
09 58	15		12.85	0.96	16.00	$8.67X10^{-3}$
10 03	20		16.70	0.77	12.83	$6.96X10^{-3}$
10 08	25		21.70	1.00	16.67	$9.04X10^{-3}$
10 13	30	86	25.60	0.78	13.00	$7.05X10^{-3}$
10 18	35		28.80	0.64	10.67	$5.78X10^{-3}$
10 23	40		32.70	0.78	13.00	$7.05X10^{-3}$
10 28	45		36.20	0.70	11.67	$6.33X10^{-3}$
10 33	50		41.00	0.96	16.00	$8.67X10^{-3}$
10 38	55		45.0	0.80	13.33	$7.23X10^{-3}$
10 43	60		49.80	0.96	16.00	$8.67X10^{-3}$

Constant Rate Of Flow For Steady State Condition : Q = 13.83 cm^3/sec

Coefficient Of Permeability For Steady State Condition : K = $7.50X10^{-3}$ cm/sec

OPEN - END PERMEABILITY TEST

(Sheet 1 Of 5)

PROJECT : G.I.At Upper Liwagu Mini Hydro Project Site HOLE No. LI-2

LOCATION Liwagu River Intake DATE OF TEST 3-1-92 TESTED BY LU

GROUND ELEVATION 1049.81 m SIZE OF CASING NW CHECKED BY M.Liew

GEOLOGICAL CONDITION OF THE BOTTOM OF DRILL HOLE Light grey slightly weathered fine-grained SANDSTONE

DEPTH FROM GROUND SURFACE TO THE BOTTOM OF CASING 263 cm

HEIGHT FROM GROUND SURFACE TO THE TOP OF CASING 20 cm

INTERNAL RADIUS OF CASING : r = 3.9 cm

GROUND TEMPERATURE 25 ^{o}C WATER TEMPERATURE 20 ^{o}C

DEPTH FROM GROUND SURFACE TO WATER SURFACE IN THE DRILL HOLE BEFORE TEST 131 cm

DEPTH FROM GROUND SURFACE TO WATER SURFACE IN THE DRILL HOLE AFTER TEST 115 cm

Time		Differential Head Of Water H (cm)	Water Volume			Coefficient Of Permeability K (cm/sec)
Clock Hr min	min		Accum. Flow (lt)	Diff. Flow (lt/min)	Constant Rate Of Flow Q (cm^3/sec)	
08 25	0		0			
08 30	5		16.20	3.24	54.00	0.0167
08 35	10		33.20	3.40	56.67	0.0175
08 40	15		49.50	3.26	54.33	0.0168
08 45	20		66.25	3.35	55.83	0.0172
08 50	25		81.85	3.12	52.00	0.0161
08 55	30	151	99.65	3.56	59.33	0.0183
09 00	35		117.65	3.60	60.00	0.0185
09 05	40		134.05	3.28	54.67	0.0169
09 10	45		151.50	3.49	58.17	0.0180
09 15	50		168.00	3.30	55.00	0.0169
09 20	55		183.70	3.14	52.33	0.0161
09 25	60		200.10	3.28	54.67	0.0169

Constant Rate Of Flow For Steady State Condition : Q = 55.58 cm^3/sec

Coefficient Of Permeability For Steady State Condition : K = 1.72×10^{-2} cm/sec

OPEN - END PERMEABILITY TEST

PROJECT : G.I. At Upper Liwagu Mini Hydro Project Site HOLE No. LI-2

LOCATION Liwagu River Intake DATE OF TEST 4-1-92 TESTED BY LU

GROUND ELEVATION 1049.81 m SIZE OF CASING NW CHECKED BY M.Liew

GEOLOGICAL CONDITION OF THE BOTTOM OF DRILL HOLE Light grey slightly weathered fine-grained SANDSTONE

DEPTH FROM GROUND SURFACE TO THE BOTTOM OF CASING 400 cm

HEIGHT FROM GROUND SURFACE TO THE TOP OF CASING 49 cm

INTERNAL RADIUS OF CASING : r = 3.90 cm

GROUND TEMPERATURE 25 ^{o}C WATER TEMPERATURE 20 ^{o}C

DEPTH FROM GROUND SURFACE TO WATER SURFACE IN THE DRILL HOLE BEFORE TEST 313 cm

DEPTH FROM GROUND SURFACE TO WATER SURFACE IN THE DRILL HOLE AFTER TEST 175 cm

Time		Differential Head Of Water H (cm)	Water Volume			Coefficient Of Permeability K (cm/sec)
Clock Hr min	min		Accum. Flow (lt)	Diff. Flow (lt/min)	Constant Rate Of Flow Q (cm^3/sec)	
09 05	0		0			
09 10	5		4.80	0.96	16.00	2.06×10^{-3}
09 15	10		10.00	1.04	17.33	2.23×10^{-3}
09 20	15		14.50	0.90	15.00	1.93×10^{-3}
09 25	20		19.60	1.02	17.00	2.19×10^{-3}
09 30	25		24.60	1.00	16.67	2.15×10^{-3}
09 35	30	362	29.35	0.95	15.83	2.04×10^{-3}
09 40	35		34.45	1.02	17.00	2.19×10^{-3}
09 45	40		39.45	1.00	16.67	2.15×10^{-3}
09 50	45		44.15	0.94	15.67	2.02×10^{-3}
09 55	50		48.65	0.90	15.00	1.93×10^{-3}
10 00	55		53.75	1.02	17.00	2.19×10^{-3}
10 05	60		59.05	1.06	17.67	2.28×10^{-3}

Constant Rate Of Flow For Steady State Condition : Q = 16.40 cm^3/sec

Coefficient Of Permeability For Steady State Condition : K = 2.11×10^{-3} cm/sec

OPEN - END PERMEABILITY TEST

PROJECT : G.I. At Upper Liwagu Mini Hydro Project Site HOLE No. LI-2

LOCATION Liwagu River Intake DATE OF TEST 5-1-92 TESTED BY LU

GROUND ELEVATION 1049.81 m SIZE OF CASING NW CHECKED BY M. Liew

GEOLOGICAL CONDITION OF THE BOTTOM OF DRILL HOLE Light grey slightly weathered fine-grained SANDSTONE

DEPTH FROM GROUND SURFACE TO THE BOTTOM OF CASING 652 cm

HEIGHT FROM GROUND SURFACE TO THE TOP OF CASING 39.5 cm

INTERNAL RADIUS OF CASING : r = 3.90 cm

GROUND TEMPERATURE 25 ^{o}C WATER TEMPERATURE 20 ^{o}C

DEPTH FROM GROUND SURFACE TO WATER SURFACE IN THE DRILL HOLE BEFORE TEST 403 cm

DEPTH FROM GROUND SURFACE TO WATER SURFACE IN THE DRILL HOLE AFTER TEST 188 cm

Time		Differential Head Of Water H (cm)	Water Volume			Coefficient Of Permeability K (cm/sec)
Clock Hr min	min		Accum. Flow (lt)	Diff. Flow (lt/min)	Constant Rate Of Flow Q (cm^3/sec)	
10 03	0		0			
10 08	5		12.50	2.50	41.67	4.39×10^{-3}
10 13	10		23.30	2.16	36.00	3.79×10^{-3}
10 18	15		35.75	2.49	41.50	4.37×10^{-3}
10 23	20		46.75	2.20	36.67	3.86×10^{-3}
10 28	25		60.20	2.69	44.83	4.72×10^{-3}
10 33	30	442.5	71.15	2.19	36.50	3.85×10^{-3}
10 38	35		82.65	2.30	38.33	4.04×10^{-3}
10 43	40		95.00	2.47	41.17	4.34×10^{-3}
10 48	45		108.00	2.60	43.33	4.57×10^{-3}
10 53	50		119.20	2.24	37.33	3.93×10^{-3}
10 58	55		131.50	2.46	41.00	4.32×10^{-3}
11 03	60		144.70	2.64	44.00	4.64×10^{-3}

Constant Rate Of Flow For Steady State Condition : Q = 40.19 cm^3/sec

Coefficient Of Permeability For Steady State Condition : K = 4.23×10^{-3} cm/sec

OPEN - END PERMEABILITY TEST

(Sheet 4 Of 5)

PROJECT : G.I. At Upper Liwagu Mini Hydro Project Site HOLE No. LI-2

LOCATION Liwagu River Intake DATE OF TEST 5-1-92 TESTED BY LU

GROUND ELEVATION 1049.81 m SIZE OF CASING NW CHECKED BY M. Liew

GEOLOGICAL CONDITION OF THE BOTTOM OF DRILL HOLE Light grey slightly weathered fine-grained SANDSTONE

DEPTH FROM GROUND SURFACE TO THE BOTTOM OF CASING 775 cm

HEIGHT FROM GROUND SURFACE TO THE TOP OF CASING 42 cm

INTERNAL RADIUS OF CASING : r = 3.90 cm

GROUND TEMPERATURE 25 ^{o}C WATER TEMPERATURE 20 ^{o}C

DEPTH FROM GROUND SURFACE TO WATER SURFACE IN THE DRILL HOLE BEFORE TEST 407 cm

DEPTH FROM GROUND SURFACE TO WATER SURFACE IN THE DRILL HOLE AFTER TEST 136 cm

Time		Differential Head Of Water H (cm)	Water Volume			Coefficient Of Permeability K (cm/sec)
Clock Hr min	min		Accum. Flow (lt)	Diff. Flow (lt/min)	Constant Rate Of Flow Q (cm^3/sec)	
14 26	0		0			
14 31	5		6.0	1.20	20.00	2.08×10^{-3}
14 36	10		12.80	1.36	22.67	2.35×10^{-3}
14 41	15		19.90	1.42	23.67	2.46×10^{-3}
14 46	20		26.30	1.28	21.33	2.21×10^{-3}
14 51	25		32.10	1.16	19.33	2.01×10^{-3}
14 56	30	449	38.85	1.35	22.50	2.34×10^{-3}
15 01	35		45.85	1.40	23.33	2.42×10^{-3}
15 06	40		52.35	1.30	21.67	2.25×10^{-3}
15 11	45		59.45	1.42	23.67	2.46×10^{-3}
15 16	50		65.40	1.19	19.83	2.06×10^{-3}
15 21	55		71.85	1.29	21.50	2.23×10^{-3}
15 26	60		78.70	1.37	22.83	2.37×10^{-3}

Constant Rate Of Flow For Steady State Condition : Q = 21.86 cm^3/sec

Coefficient Of Permeability For Steady State Condition : K = 2.27×10^{-3} cm/sec

OPEN - END PERMEABILITY TEST

(Sheet 5 Of 5)

PROJECT : G.I. At Upper Liwagu Mini Hydro Project Site HOLE No. LI-2

LOCATION Liwagu River Intake DATE OF TEST 6-1-92 TESTED BY LU

GROUND ELEVATION 1049.81 m SIZE OF CASING NW CHECKED BY M. Liew

GEOLOGICAL CONDITION OF THE BOTTOM OF DRILL HOLE Light grey slightly weathered fine-grained SANDSTONE

DEPTH FROM GROUND SURFACE TO THE BOTTOM OF CASING 964 cm

HEIGHT FROM GROUND SURFACE TO THE TOP OF CASING 33.5 cm

INTERNAL RADIUS OF CASING : r = 3.90 cm

GROUND TEMPERATURE 25 °C WATER TEMPERATURE 21 °C

DEPTH FROM GROUND SURFACE TO WATER SURFACE IN THE DRILL HOLE BEFORE TEST 387 cm

DEPTH FROM GROUND SURFACE TO WATER SURFACE IN THE DRILL HOLE AFTER TEST 93 cm

Time		Differential Head Of Water H (cm)	Water Volume			Coefficient Of Permeability K (cm/sec)
Clock Hr min	min		Accum. Flow (lt)	Diff. Flow (lt/min)	Constant Rate Of Flow Q (cm^3/sec)	
15 49	0		0			
15 54	5		18.30	3.66	61.00	$6.76x10^{-3}$
15 59	10		35.80	3.50	58.33	$6.47x10^{-3}$
16 04	15		53.60	3.56	59.33	$6.58x10^{-3}$
16 09	20		72.60	3.80	63.33	$7.02x10^{-3}$
16 14	25		89.10	3.30	55.00	$6.10x10^{-3}$
16 19	30	420.5	105.80	3.34	55.67	$6.17x10^{-3}$
16 24	35		123.80	3.60	60.00	$6.65x10^{-3}$
16 29	40		141.10	3.46	57.67	$6.39x10^{-3}$
16 34	45		155.60	2.90	48.33	$5.36x10^{-3}$
16 39	50		176.00	4.08	68.00	$7.54x10^{-3}$
16 44	55		192.85	3.37	56.17	$6.23x10^{-3}$
16 49	60		210.20	3.47	57.83	$6.41x10^{-3}$

Constant Rate Of Flow For Steady State Condition : Q = 58.39 cm^3/sec

Coefficient Of Permeability For Steady State Condition : K = $6.47x10^{-3}$ cm/sec

OPEN - END PERMEABILITY TEST

(Sheet 1 of 6)

PROJECT : G.I. At Upper Liwagu Mini Hydro Project Site HOLE NO. LI-3

LOCATION Mesilau Intake DATE OF TEST 31-1-92 TESTED BY Will/LU

GROUND ELEVATION 1035.96 m SIZE OF CASING NW CHECKED BY M. Liew

GEOLOGICAL CONDITION OF THE BOTTOM OF DRILL HOLE Sandstone and adamellite cobbles

DEPTH FROM GROUND SURFACE TO THE BOTTOM OF CASING 200 cm

HEIGHT FROM GROUND SURFACE TO THE TOP OF CASING 52 cm

INTERNAL RADIUS OF CASING : r = 3.9 cm

GROUND TEMPERATURE 25 °C WATER TEMPERATURE 20 °C

DEPTH FROM GROUND SURFACE TO WATER SURFACE IN THE DRILL HOLE BEFORE TEST 47 cm

DEPTH FROM GROUND SURFACE TO WATER SURFACE IN THE DRILL HOLE AFTER TEST 31 cm

Time		Differential Head Of Water H (cm)	Water Volume			Coefficient Of Permeability K (cm/sec)
Clock Hr min	min		Accum. Flow (lt)	Diff. Flow (lt/min)	Constant Rate Of Flow Q (cm^3/sec)	
14 04	0		0.00			
14 09	5		10.00	2.00	33.33	0.0157
14 14	10		21.20	2.24	37.33	0.0176
14 19	15		32.40	2.24	37.33	0.0176
14 24	20		45.30	2.58	43	0.0202
14 29	25		57.50	2.44	40.67	0.0192
14 34	30	99	65.90	1.68	28	0.0132
14 39	35		77.70	2.36	39.33	0.0185
14 44	40		85.20	1.50	25	0.0118
14 49	45		97.40	2.44	40.67	0.0192
14 54	50		109.60	2.44	40.67	0.0192
14 59	55		122.30	2.54	42.33	0.0199
15 04	60		131.60	1.86	31	0.0146

Constant Rate Of Flow For Steady State Condition : Q = 36.56 cm^3/sec

Coefficient Of Permeability For Steady State Condition : K = 0.0172 cm/sec

OPEN - END PERMEABILITY TEST

(Sheet 2 Of 6)

PROJECT : G.I. At Upper Liwagu Mini Hydro Project Site HOLE No. LI-3

LOCATION Mesilau Intake DATE OF TEST 1-2-92 TESTED BY Will/LU

GROUND ELEVATION 1035.96 m SIZE OF CASING NW CHECKED BY M. Liew

GEOLOGICAL CONDITION OF THE BOTTOM OF DRILL HOLE Light grey fine-grained SANDSTONE

cobbles

DEPTH FROM GROUND SURFACE TO THE BOTTOM OF CASING 400 cm

HEIGHT FROM GROUND SURFACE TO THE TOP OF CASING 66 cm

INTERNAL RADIUS OF CASING : r = 3.9 cm

GROUND TEMPERATURE 25 ^{o}C WATER TEMPERATURE 20 ^{o}C

DEPTH FROM GROUND SURFACE TO WATER SURFACE IN THE DRILL HOLE BEFORE TEST 55 cm

DEPTH FROM GROUND SURFACE TO WATER SURFACE IN THE DRILL HOLE AFTER TEST 37 cm

Time		Differential Head Of Water H (cm)	Water Volume			Coefficient Of Permeability K (cm/sec)
Clock Hr min	min		Accum. Flow (lt)	Diff. Flow (lt/min)	Constant Rate Of Flow Q (cm^3/sec)	
12 01	0		0			
12 06	5		8.30	1.66	27.67	0.0107
12 11	10		19.50	2.24	37.33	0.0144
12 16	15		29.40	1.98	33.00	0.0127
12 21	20		43.10	2.24	45.67	0.0176
12 26	25		52.40	1.86	31.00	0.0119
12 31	30	121	63.70	2.26	37.67	0.0145
12 36	35		70.50	1.36	22.67	8.73×10^{-3}
12 41	40		80.00	1.90	31.67	0.0122
12 46	45		87.40	1.48	24.67	9.51×10^{-3}
12 51	50		96.50	1.82	30.33	0.0117
12 56	55		109.20	2.54	42.33	0.0163
13 01	60		122.20	2.60	43.33	0.0167

Constant Rate Of Flow For Steady State Condition : Q = 33.95 cm^3/sec

Coefficient Of Permeability For Steady State Condition : K = 0.0131 cm/sec

OPEN - END PERMEABILITY TEST

Sheet 3 of 6

PROJECT : G.I. At Upper Liwagu Mini Hydro Project Site HOLE NO. LI-3

LOCATION Mesilau Intake DATE OF TEST 2-2-92 TESTED BY Will/LU

GROUND ELEVATION 1035.96 m SIZE OF CASING NW CHECKED BY M. Liew

GEOLOGICAL CONDITION OF THE BOTTOM OF DRILL HOLE Light grey fine-grained SANDSTONE

DEPTH FROM GROUND SURFACE TO THE BOTTOM OF CASING 600 cm

HEIGHT FROM GROUND SURFACE TO THE TOP OF CASING 34 cm

INTERNAL RADIUS OF CASING : r = 3.9 cm

GROUND TEMPERATURE 25 ^{o}C WATER TEMPERATURE 20 ^{o}C

DEPTH FROM GROUND SURFACE TO WATER SURFACE IN THE DRILL HOLE BEFORE TEST 107 cm

DEPTH FROM GROUND SURFACE TO WATER SURFACE IN THE DRILL HOLE AFTER TEST 45 cm

Time		Differential Head Of Water H (cm)	Water Volume			Coefficient Of Permeability K (cm/sec)
Clock Hr min	min		Accum. Flow (lt)	Diff. Flow (lt/min)	Constant Rate Of Flow Q (cm^3/sec)	
09 10	0		0.00			
09 15	5		5.20	1.04	17.33	$5.73x10^{-3}$
09 20	10		12.00	1.36	22.67	$7.50x10^{-3}$
09 25	15		18.40	1.28	21.33	$7.05x10^{-3}$
09 30	20		26.70	1.66	27.67	$9.15x10^{-3}$
09 35	25		35.40	1.74	29.00	$9.59x10^{-3}$
09 40	30	141	43.10	1.54	25.67	$8.49x10^{-3}$
09 45	35		50.80	1.54	25.67	$8.49x10^{-3}$
09 50	40		56.30	1.10	18.33	$6.06x10^{-3}$
09 55	45		67.10	2.16	36	0.0119
10 00	50		77.30	2.04	34	0.0112
10 05	55		83.90	1.32	22	$7.27x10^{-3}$
10 10	60		90.20	1.26	21	$6.94x10^{-3}$

Constant Rate Of Flow For Steady State Condition : Q = 25.06 cm^3/sec

Coefficient Of Permeability For Steady State Condition : K = $8.29x10^{-3}$ cm/sec

OPEN - END PERMEABILITY TEST

(Sheet 4 Of 6)

PROJECT : G.I. At Upper Liwagu Mini Hydro Project Site HOLE No. LI-3

LOCATION Mesilau Intake DATE OF TEST 2-2-92 TESTED BY Will/ Lu

GROUND ELEVATION 1035.96 m SIZE OF CASING NW CHECKED BY M. Liew

GEOLOGICAL CONDITION OF THE BOTTOM OF DRILL HOLE Light grey fine-grained SANDSTONE

DEPTH FROM GROUND SURFACE TO THE BOTTOM OF CASING 800 cm

HEIGHT FROM GROUND SURFACE TO THE TOP OF CASING 35 cm

INTERNAL RADIUS OF CASING : r = 3.9 cm

GROUND TEMPERATURE 25 ^{o}C WATER TEMPERATURE 20 ^{o}C

DEPTH FROM GROUND SURFACE TO WATER SURFACE IN THE DRILL HOLE BEFORE TEST 137 cm

DEPTH FROM GROUND SURFACE TO WATER SURFACE IN THE DRILL HOLE AFTER TEST 19 cm

Time		Differential Head Of Water H (cm)	Water Volume			Coefficient Of Permeability K (cm/sec)
Clock Hr min	min		Accum. Flow (lt)	Diff. Flow (lt/min)	Constant Rate Of Flow Q (cm^3/sec)	
17 05	0		0			
17 10	5		1.50	0.3	5.0	$1.36x10^{-3}$
17 15	10		2.70	0.24	4.0	$1.08x10^{-3}$
17 20	15		4.80	0.42	7.0	$1.90x10^{-3}$
17 25	20		5.80	0.20	3.33	$9.03x10^{-3}$
17 30	25		6.70	0.18	3.00	$8.13x10^{-4}$
17 35	30	172	8.30	0.32	5.33	$1.44x10^{-3}$
17 40	35		9.30	0.20	3.33	$9.03x10^{-4}$
17 45	40		10.80	0.30	5.00	$1.36x10^{-3}$
17 50	45		11.10	0.06	1.00	$2.71x10^{-4}$
17 55	50		12.90	0.36	6.00	$1.63x10^{-3}$
18 00	55		13.40	0.10	1.67	$4.53x10^{-4}$
18 05	60		15.30	0.38	6.33	$1.72x10^{-3}$

Constant Rate Of Flow For Steady State Condition : Q = 4.25 cm^3/sec

Coefficient Of Permeability For Steady State Condition : K = $1.15x10^{-3}$ cm/sec

OPEN - END PERMEABILITY TEST

(Sheet 5 of 6)

PROJECT : G.1. At Upper Liwagu Mini Hydro Project Site HOLE No. LI-3

LOCATION Mesilau Intake DATE OF TEST 3-2-92 TESTED BY Will/ Lu

GROUND ELEVATION 1035.96 m SIZE OF CASING NW CHECKED BY M. Liew

GEOLOGICAL CONDITION OF THE BOTTOM OF DRILL HOLE Light grey sine-grained SANDSTONE

DEPTH FROM GROUND SURFACE TO THE BOTTOM OF CASING 1000 cm

HEIGHT FROM GROUND SURFACE TO THE TOP OF CASING 45 cm

INTERNAL RADIUS OF CASING : r = 3.9 cm

GROUND TEMPERATURE 25 ^{o}C WATER TEMPERATURE 20 ^{o}C

DEPTH FROM GROUND SURFACE TO WATER SURFACE IN THE DRILL HOLE BEFORE TEST 92 cm

DEPTH FROM GROUND SURFACE TO WATER SURFACE IN THE DRILL HOLE AFTER TEST 12 cm

Time		Differential Head Of Water H (cm)	Water Volume			Coefficient Of Permeability K (cm/sec)
Clock Hr min	min		Accum. Flow (lt)	Diff. Flow (lt/min)	Constant Rate Of Flow Q (cm^3/sec)	
11 03	0		0			
11 08	5		1.10	0.22	3.67	1.25×10^{-3}
11 13	10		2.00	0.18	3.00	1.02×10^{-3}
11 18	15		2.80	0.16	2.67	9.09×10^{-4}
11 23	20		3.50	0.14	2.33	7.93×10^{-4}
11 28	25		4.50	0.20	3.33	1.13×10^{-3}
11 33	30	137	5.10	0.30	5.00	1.70×10^{-3}
11 38	35		6.00	0.18	3.00	1.02×10^{-3}
11 43	40		7.20	0.24	4.00	1.36×10^{-3}
11 48	45		8.40	0.24	4.00	1.36×10^{-3}
11 53	50		9.10	0.14	2.33	7.93×10^{-4}
11 58	55		10.00	0.18	3.00	1.02×10^{-3}
12 03	60		11.00	0.20	3.33	1.13×10^{-3}

Constant Rate Of Flow For Steady State Condition : Q = 3.31 cm^3/sec

Coefficient Of Permeability For Steady State Condition : K = 1.13×10^{-3} cm/sec

OPEN - END PERMEABILITY TEST

(Sheet 6 of 6)

PROJECT : G.I. At Upper Liwagu Mini Hydro Project Site HOLE No. LI-3

LOCATION Mesilau Intake DATE OF TEST 8-2-92 TESTED BY Will/LU

GROUND ELEVATION 1035.96 m SIZE OF CASING NW CHECKED BY M. Liew

GEOLOGICAL CONDITION OF THE BOTTOM OF DRILL HOLE Light grey fine-grained SANDSTONE

DEPTH FROM GROUND SURFACE TO THE BOTTOM OF CASING 1300 cm

HEIGHT FROM GROUND SURFACE TO THE TOP OF CASING 22 cm

INTERNAL RADIUS OF CASING : r = 3.9 cm

GROUND TEMPERATURE 25 °C WATER TEMPERATURE 20 °C

DEPTH FROM GROUND SURFACE TO WATER SURFACE IN THE DRILL HOLE BEFORE TEST 178 cm

DEPTH FROM GROUND SURFACE TO WATER SURFACE IN THE DRILL HOLE AFTER TEST 7 cm

Time		Differential Head Of Water H (cm)	Water Volume			Coefficient Of Permeability K (cm/sec)
Clock Hr min	min		Accum. Flow (lt)	Diff. Flow (lt/min)	Constant Rate Of Flow Q (cm^3/sec)	
10 41	0		0	0		
10 46	5		0.70	0.14	2.33	5.43×10^{-4}
10 51	10		1.80	0.22	3.67	8.55×10^{-4}
10 56	15		2.40	0.12	2.00	4.66×10^{-4}
11 01	20		3.40	0.20	3.33	7.76×10^{-4}
11 06	25		4.60	0.24	4.00	9.32×10^{-4}
11 11	30	200	5.90	0.26	4.33	1.01×10^{-3}
11 16	35		6.90	0.20	3.33	7.76×10^{-4}
11 21	40		7.50	0.12	2.00	4.66×10^{-4}
11 26	45		8.20	0.14	2.33	5.43×10^{-4}
11 31	50		9.00	0.16	2.67	6.22×10^{-4}
11 36	55		10.10	0.22	3.67	8.55×10^{-4}
11 41	60		11.00	0.18	3.00	6.99×10^{-4}

Constant Rate Of Flow For Steady State Condition : Q = 3.06 cm^3/sec

Coefficient Of Permeability For Steady State Condition : K = 7.13×10^{-4} cm/sec

OPEN - END PERMEABILITY TEST

PROJECT : G.I. At Upper Liwagu Mini Hydro Project Site HOLE No. LI-4

LOCATION Sg. Mesilau Intake DATE OF TEST 22-1-92 TESTED BY Will & Ampahon

GROUND ELEVATION 1035.34 m SIZE OF CASING NW CHECKED BY Michael Liew

GEOLOGICAL CONDITION OF THE BOTTOM OF DRILL HOLE Light grey SANDSTONE and ADAMELLITE boulders

DEPTH FROM GROUND SURFACE TO THE BOTTOM OF CASING 200 cm

HEIGHT FROM GROUND SURFACE TO THE TOP OF CASING 61 cm

INTERNAL RADIUS OF CASING : r = 3.9 cm

GROUND TEMPERATURE 25 ^{o}C WATER TEMPERATURE 20 ^{o}C

DEPTH FROM GROUND SURFACE TO WATER SURFACE IN THE DRILL HOLE BEFORE TEST 15 cm

DEPTH FROM GROUND SURFACE TO WATER SURFACE IN THE DRILL HOLE AFTER TEST 15 cm

Time		Differential Head Of Water H (cm)	Water Volume			Coefficient Of Permeability K (cm/sec)
Clock Hr min	min		Accum. Flow (lt)	Diff. Flow (lt/min)	Constant Rate Of Flow Q (cm^3/sec)	
06 10	0		0			
06 15	5		4.2	0.84	14	$8.59X10^{-3}$
06 20	10		8.0	0.76	12.67	$7.77X10^{-3}$
06 25	15		12.0	0.80	13.33	$8.18X10^{-3}$
06 30	20		15.9	0.78	13.0	$7.97X10^{-3}$
06 35	25		19.4	0.70	11.67	$7.16X10^{-3}$
06 40	30	76	23.9	0.90	15	$9.20X10^{-3}$
06 45	35		28.5	0.92	15.33	$9.40X10^{-3}$
06 50	40		33.0	0.90	15	$9.20X10^{-3}$
06 55	45		38.1	1.02	17	0.0104
07 00	50		42.8	0.94	15.67	$9.61X10^{-3}$
07 05	55		46.7	0.78	13	$7.97X10^{-3}$
07 10	60		50.7	0.80	13.33	$8.18X10^{-3}$

Constant Rate Of Flow For Steady State Condition : Q = 14.08 cm^3/sec

Coefficient Of Permeability For Steady State Condition : K = $8.64X10^{-3}$ cm/sec

OPEN - END PERMEABILITY TEST

(Sheet 2 Of 6)

PROJECT : C.I. At Upper Liwagu Mini Hydro Project Site HOLE No. LI-4

LOCATION : Sg. Masilau Intake DATE OF TEST 22-1-92 TESTED BY Will & Ampahon

GROUND ELEVATION 1035.34 m SIZE OF CASING NW CHECKED BY M. Liew

GEOLOGICAL CONDITION OF THE BOTTOM OF DRILL HOLE Grey medium to coarse SAND

DEPTH FROM GROUND SURFACE TO THE BOTTOM OF CASING 400 cm

HEIGHT FROM GROUND SURFACE TO THE TOP OF CASING 86.5 cm

INTERNAL RADIUS OF CASING : r = 3.9 cm

GROUND TEMPERATURE 25 ^{o}C WATER TEMPERATURE 20 ^{o}C

DEPTH FROM GROUND SURFACE TO WATER SURFACE IN THE DRILL HOLE BEFORE TEST 20 cm

DEPTH FROM GROUND SURFACE TO WATER SURFACE IN THE DRILL HOLE AFTER TEST 20 cm

Time		Differential Head Of Water H (cm)	Water Volume			Coefficient Of Permeability K (cm/sec)
Clock Hr min	min		Accum. Flow (lt)	Diff. Flow (lt/min)	Constant Rate Of Flow Q (cm^3/sec)	
17 25	0		0			
17 30	5		2.50	0.5	8.3	$3.63X10^{-3}$
17 35	10		4.80	0.46	7.67	$3.36X10^{-3}$
17 40	15		7.30	0.5	8.33	$3.65X10^{-3}$
17 45	20		9.70	0.48	8.00	$3.50X10^{-3}$
17 50	25		12.10	0.48	8.00	$3.50X10^{-3}$
17 55	30	106.5	14.80	0.54	9.00	$3.94X10^{-3}$
18 00	35		17.30	0.50	8.33	$3.65X10^{-3}$
18 05	40		19.90	0.52	8.67	$3.80X10^{-3}$
18 10	45		22.10	0.44	7.33	$3.21X10^{-3}$
18 15	50		24.90	0.56	9.33	$4.08X10^{-3}$
18 20	55		27.50	0.52	8.67	$3.80X10^{-3}$
18 25	60		29.90	0.48	8.00	$3.50X10^{-3}$

Constant Rate Of Flow For Steady State Condition : Q = 8.30 cm^3/sec

Coefficient Of Permeability For Steady State Condition : K = $3.63X10^{-3}$ cm/sec

OPEN - END PERMEABILITY TEST

(Sheet 3 of 6)

PROJECT : G.I. At Upper Liwagu Mini Hydro Project Site BOREHOLE No. LI-4

LOCATION Sg. Mesilau Intake DATE OF TEST 24-1-92 TESTED BY Will & Ampahon

GROUND ELEVATION 1035.34 m SIZE OF CASING NW CHECKED BY M. Liew

GEOLOGICAL CONDITION OF THE BOTTOM OF DRILL HOLE Lighy grey mottled black ADAMELLITE boulders

DEPTH FROM GROUND SURFACE TO THE BOTTOM OF CASING 600 cm

HEIGHT FROM GROUND SURFACE TO THE TOP OF CASING 76 cm

INTERNAL RADIUS OF CASING : r = 3.9 cm

GROUND TEMPERATURE 25 ^{o}C WATER TEMPERATURE 20 ^{o}C

DEPTH FROM GROUND SURFACE TO WATER SURFACE IN THE DRILL HOLE BEFORE TEST 26 cm

DEPTH FROM GROUND SURFACE TO WATER SURFACE IN THE DRILL HOLE AFTER TEST 24 cm

Time		Differential Head Of Water H (cm)	Water Volume			Coefficient Of Permeability K (cm/sec)
Clock Hr min	min		Accum. Flow (lt)	Diff. Flow (lt/min)	Constant Rate Of Flow Q (cm^3/sec)	
10 05	0		0			
10 10	5		0.40	0.08	1.33	$6.08X10^{-4}$
10 15	10		0.75	0.07	1.17	$5.35X10^{-4}$
10 20	15		1.20	0.09	1.5	$6.86X10^{-4}$
10 25	20		1.62	0.084	1.4	$6.40X10^{-4}$
10 30	25		2.06	0.088	1.47	$6.72X10^{-4}$
10 35	30	102	2.47	0.082	1.37	$6.26X10^{-4}$
10 40	35		2.89	0.084	1.40	$6.40X10^{-4}$
10 45	40		3.32	0.086	1.43	$6.54X10^{-4}$
10 50	45		3.76	0.088	1.47	$6.72X10^{-4}$
10 55	50		4.18	0.084	1.40	$6.40X10^{-4}$
11 00	55		4.56	0.076	1.27	$5.80X10^{-4}$
11 05	60		4.92	0.072	1.20	$5.48X10^{-4}$

Constant Rate Of Flow For Steady State Condition : Q = 1.37 cm^3/sec

Coefficient Of Permeability For Steady State Condition : K = $6.26X10^{-4}$ cm/sec

OPEN - END PERMEABILITY TEST

(Sheet 4 of 6)

PROJECT : G.I. At Upper Liwagu Mini Hydro Project Site HOLE No. LI-4

LOCATION Sg. Mesilau Intake DATE OF TEST 25-1-92 TESTED BY Will & Ampahon

GROUND ELEVATION 1035.34 m SIZE OF CASING NW CHECKED BY M. Liew

GEOLOGICAL CONDITION OF THE BOTTOM OF DRILL HOLE Light grey fine-grained SANDSTONE

DEPTH FROM GROUND SURFACE TO THE BOTTOM OF CASING 800 cm

HEIGHT FROM GROUND SURFACE TO THE TOP OF CASING 64 cm

INTERNAL RADIUS OF CASING : r = 3.9 cm

GROUND TEMPERATURE 25 °C WATER TEMPERATURE 20 °C

DEPTH FROM GROUND SURFACE TO WATER SURFACE IN THE DRILL HOLE BEFORE TEST 22 cm

DEPTH FROM GROUND SURFACE TO WATER SURFACE IN THE DRILL HOLE AFTER TEST 4 cm

Time		Differential Head Of Water H (cm)	Water Volume			Coefficient Of Permeability K (cm/sec)
Clock Hr min	min		Accum. Flow (lt)	Diff. Flow (lt/min)	Constant Rate Of Flow Q (cm^3/sec)	
09 02	0		0			
09 07	5		0.25	0.05	0.83	$4.50X10^{-4}$
09 12	10		0.50	0.05	0.83	$4.50X10^{-4}$
09 17	15		0.74	0.048	0.80	$4.34X10^{-4}$
09 22	20		1.00	0.052	0.87	$4.72X10^{-4}$
09 27	25		1.30	0.06	1.00	$5.42X10^{-4}$
09 32	30	86	1.58	0.056	0.93	$5.04X10^{-4}$
09 37	35		1.83	0.05	0.83	$4.50X10^{-4}$
09 42	40		2.03	0.04	0.67	$3.63X10^{-4}$
09 47	45		2.25	0.044	0.73	$3.96X10^{-4}$
09 52	50		2.50	0.05	0.83	$4.50X10^{-4}$
09 57	55		2.75	0.05	0.83	$4.50X10^{-4}$
10 02	60		2.95	0.04	0.67	$3.63X10^{-4}$

Constant Rate Of Flow For Steady State Condition : Q = 0.82 cm^3/sec

Coefficient Of Permeability For Steady State Condition : K = $4.45X10^{-4}$ cm/sec

OPEN - END PERMEABILITY TEST

PROJECT : G.I. At Upper Liwagu Mini Hydro Project Site HOLE No. LI-4

LOCATION Sg. Mesilau Intake DATE OF TEST 25-1-92 TESTED BY Will & Ampahon

GROUND ELEVATION 1035.34 m SIZE OF CASING NW CHECKED BY M. Liew

GEOLOGICAL CONDITION OF THE BOTTOM OF DRILL HOLE Light grey fine-grained SANDSTONE

DEPTH FROM GROUND SURFACE TO THE BOTTOM OF CASING 1000 cm

HEIGHT FROM GROUND SURFACE TO THE TOP OF CASING 60 cm

INTERNAL RADIUS OF CASING : r = 3.9 cm

GROUND TEMPERATURE 25 ^{o}C WATER TEMPERATURE 20 ^{o}C

DEPTH FROM GROUND SURFACE TO WATER SURFACE IN THE DRILL HOLE BEFORE TEST 27 cm

DEPTH FROM GROUND SURFACE TO WATER SURFACE IN THE DRILL HOLE AFTER TEST 3 cm

Time		Differential Head Of Water H (cm)	Water Volume			Coefficient Of Permeability K (cm/sec)
Clock Hr min	min		Accum. Flow (lt)	Diff. Flow (lt/min)	Constant Rate Of Flow Q (cm^3/sec)	
16 41	0		0			
16 46	5		0.20	0.04	0.67	$3.59X10^{-4}$
16 51	10		0.40	0.04	0.67	$3.59X10^{-4}$
16 56	15		0.60	0.04	0.67	$3.59X10^{-4}$
17 01	20		0.80	0.04	0.67	$3.59X10^{-4}$
17 06	25		1.05	0.05	0.83	$4.45X10^{-4}$
17 11	30	87	1.25	0.04	0.67	$3.59X10^{-4}$
17 16	35		1.45	0.04	0.67	$3.59X10^{-4}$
17 21	40		1.65	0.04	0.67	$3.59X10^{-4}$
17 26	45		1.90	0.05	0.83	$4.45X10^{-4}$
17 31	50		2.20	0.06	1.00	$5.36X10^{-4}$
17 36	55		2.45	0.05	0.83	$4.45X10^{-4}$
17 41	60		2.68	0.046	0.77	$4.13X10^{-4}$

Constant Rate Of Flow For Steady State Condition : Q = 0.75 cm^3/sec

Coefficient Of Permeability For Steady State Condition : K = $4.02X10^{-4}$ cm/sec

OPEN - END PERMEABILITY TEST

(Sheet 6 Of 6)

PROJECT : G.I. At Upper Liwagu Mini Hydro Project Site HOLE No. LI-4

LOCATION Sg. Mesilau Intake DATE OF TEST 26-1-92 TESTED BY Will & Ampahon

GROUND ELEVATION 1035.34 m SIZE OF CASING NW CHECKED BY M. Liew

GEOLOGICAL CONDITION OF THE BOTTOM OF DRILL HOLE Light grey fine-grained SANDSTONE

DEPTH FROM GROUND SURFACE TO THE BOTTOM OF CASING 1200 cm

HEIGHT FROM GROUND SURFACE TO THE TOP OF CASING 66 cm

INTERNAL RADIUS OF CASING : r = 3.9 cm

GROUND TEMPERATURE 25 ^{o}C WATER TEMPERATURE 20 ^{o}C

DEPTH FROM GROUND SURFACE TO WATER SURFACE IN THE DRILL HOLE BEFORE TEST 0.10 cm

DEPTH FROM GROUND SURFACE TO WATER SURFACE IN THE DRILL HOLE AFTER TEST 5 cm

Time		Differential Head Of Water H (cm)	Water Volume			Coefficient Of Permeability K (cm/sec)
Clock Hr min	min		Accum. Flow (lt)	Diff. Flow (lt/min)	Constant Rate Of Flow Q (cm^3/sec)	
17 03	0		0			
17 08	5		0.5	0.1	1.67	$1.18X10^{-3}$
17 13	10		0.9	0.08	1.33	$9.38X10^{-4}$
17 18	15		1.40	0.1	1.67	$1.17X10^{-3}$
17 23	20		1.45	0.01	0.17	$1.19X10^{-4}$
17 28	25		1.80	0.07	1.17	$8.25X10^{-4}$
17 33	30	66.10	2.20	0.08	1.33	$9.38X10^{-4}$
17 38	35		2.58	0.076	1.27	$8.96X10^{-4}$
17 43	40		3.00	0.084	1.4	$9.87X10^{-4}$
17 48	45		3.35	0.07	1.17	$8.25X10^{-4}$
17 53	50		3.80	0.09	1.5	$1.06X10^{-3}$
17 58	55		4.20	0.08	1.33	$9.38X10^{-4}$
18 03	60		4.55	0.07	1.17	$8.25X10^{-4}$

Constant Rate Of Flow For Steady State Condition : Q = 1.265 cm^3/sec

Coefficient Of Permeability For Steady State Condition : K = $2.93X10^{-3}$ cm/sec

OPEN - END PERMEABILITY TEST

(Sheet 1 Of 5)

PROJECT : G.I. At Upper Liwagu Mini Hydro Project Site HOLE No. LT-1

LOCATION Head pond DATE OF TEST 18-1-92 TESTED BY Litto

GROUND ELEVATION 1031.62 m SIZE OF CASING NW CHECKED BY Michael Liew

GEOLOGICAL CONDITION OF THE BOTTOM OF DRILL HOLE Yellowish brown sandy silty CLAY with weathered sandstone fragments

DEPTH FROM GROUND SURFACE TO THE BOTTOM OF CASING 200 cm

HEIGHT FROM GROUND SURFACE TO THE TOP OF CASING 73 cm

INTERNAL RADIUS OF CASING : r = 3.9 cm

GROUND TEMPERATURE 25 °C WATER TEMPERATURE 20 °C

DEPTH FROM GROUND SURFACE TO WATER SURFACE IN THE DRILL HOLE BEFORE TEST 78 cm

DEPTH FROM GROUND SURFACE TO WATER SURFACE IN THE DRILL HOLE AFTER TEST 0 cm

Time		Differential Head Of Water H (cm)	Water Volume			Coefficient Of Permeability K (cm/sec)
Clock Hr min	min		Accum. Flow (lt)	Diff. Flow (lt/min)	Constant Rate Of Flow Q (cm^3/sec)	
08 50	0		0			
08 55	5		0			
09 00	10		0			
09 05	15		0			
09 10	20		0			
09 15	25		0			
09 20	30		0			
09 25	35		0			
09 30	40	151	0.2	0.04	0.67	$1.14X10^{-4}$
09 35	45		0.2	0		
09 40	50		0.2	0		
09 45	55		0.2	0		
09 50	60		0.2	0		

Constant Rate Of Flow For Steady State Condition : Q = 0.67 cm^3/sec

Coefficient Of Permeability For Steady State Condition : K = $1.14X10^{-4}$ cm/sec

OPEN - END PERMEABILITY TEST

(Sheet 2 Of 5)

PROJECT : G.I. At Upper Liwagu Mini Hydro Project Site HOLE No. LT-1

LOCATION Head Pond DATE OF TEST 18-1-92 TESTED BY Litto

GROUND ELEVATION 1031.62 m SIZE OF CASING NW CHECKED BY M. Liew

GEOLOGICAL CONDITION OF THE BOTTOM OF DRILL HOLE Dark grey sandy silty CLAY

DEPTH FROM GROUND SURFACE TO THE BOTTOM OF CASING 500 cm

HEIGHT FROM GROUND SURFACE TO THE TOP OF CASING 64 cm

INTERNAL RADIUS OF CASING : r = 3.9 cm

GROUND TEMPERATURE 25 ^{o}C WATER TEMPERATURE 20 ^{o}C

DEPTH FROM GROUND SURFACE TO WATER SURFACE IN THE DRILL HOLE BEFORE TEST 207 cm

DEPTH FROM GROUND SURFACE TO WATER SURFACE IN THE DRILL HOLE AFTER TEST 0 cm

Time		Differential Head Of Water H (cm)	Water Volume			Coefficient Of Permeability K (cm/sec)
Clock Hr min	min		Accum. Flow (lt)	Diff. Flow (lt/min)	Constant Rate Of Flow Q (cm^3/sec)	
17 35	0		0			-
17 40	5		0			-
17 45	10		0			-
17 50	15		0			-
17 55	20		0			-
18 00	25		0			-
18 05	30	271	0			-
18 10	35		0			-
18 15	40		0			-
18 20	45		0			-
18 25	50		0			-
18 30	55		0			-
18 35	60		0			-

Constant Rate Of Flow For Steady State Condition : Q = - cm^3/sec

Coefficient Of Permeability For Steady State Condition : K = - cm/sec

OPEN - END PERMEABILITY TEST

PROJECT : G.I. At Upper Liwagu Mini Hydro Project Site HOLE No. LT-1

LOCATION Head pond DATE OF TEST 19-1-92 TESTED BY Litto

GROUND ELEVATION 1031.62 m SIZE OF CASING NW CHECKED BY M. Liew

GEOLOGICAL CONDITION OF THE BOTTOM OF DRILL HOLE Grey SILTSTONE

DEPTH FROM GROUND SURFACE TO THE BOTTOM OF CASING 600 cm

HEIGHT FROM GROUND SURFACE TO THE TOP OF CASING 57 cm

INTERNAL RADIUS OF CASING : r = 3.9 cm

GROUND TEMPERATURE 25 °C WATER TEMPERATURE 20 °C

DEPTH FROM GROUND SURFACE TO WATER SURFACE IN THE DRILL HOLE BEFORE TEST 213 cm

DEPTH FROM GROUND SURFACE TO WATER SURFACE IN THE DRILL HOLE AFTER TEST 3 cm

Time		Differential Head Of Water H (cm)	Water Volume			Coefficient Of Permeability K (cm/sec)
Clock Hr min	min		Accum. Flow (lt)	Diff. Flow (lt/min)	Constant Rate Of Flow Q (cm^3/sec)	
10 11	0		0	0		
10 16	5		0.2	0.04	0.67	$1.76X10^{-3}$
10 21	10		0.2	0		
10 26	15		0.2	0		
10 31	20		0.4	0.04	0.67	$1.76X10^{-3}$
10 36	25		0.4	0		
10 41	30	270	0.6	0.04	0.67	$1.76X10^{-3}$
10 46	35		0.6	0		
10 51	40		0.6	0		
10 56	45		0.8	0.04	0.67	$1.76X10^{-3}$
11 01	50		0.8	0		
11 06	55		0.8	0		
11 11	60		0.8	0		

Constant Rate Of Flow For Steady State Condition : Q = 0.67 cm^3/sec

Coefficient Of Permeability For Steady State Condition : K = $1.76X10^{-3}$ cm/sec

OPEN - END PERMEABILITY TEST

PROJECT : G.I. At Upper Liwagu Mini Hydro Project Site HOLE No. LT-1

LOCATION Head pond DATE OF TEST 19-1-92 TESTED BY Litto

GROUND ELEVATION 1031.62 m SIZE OF CASING NW CHECKED BY M. Liew

GEOLOGICAL CONDITION OF THE BOTTOM OF DRILL HOLE Brown sandy silty CLAY

DEPTH FROM GROUND SURFACE TO THE BOTTOM OF CASING 800 cm

HEIGHT FROM GROUND SURFACE TO THE TOP OF CASING 43 cm

INTERNAL RADIUS OF CASING : r = 3.9 cm

GROUND TEMPERATURE 25 ^{o}C WATER TEMPERATURE 20 ^{o}C

DEPTH FROM GROUND SURFACE TO WATER SURFACE IN THE DRILL HOLE BEFORE TEST 2.21 cm

DEPTH FROM GROUND SURFACE TO WATER SURFACE IN THE DRILL HOLE AFTER TEST 0 cm

Time		Differential Head Of Water H (cm)	Water Volume			Coefficient Of Permeability K (cm/sec)
Clock Hr min	min		Accum. Flow (lt)	Diff. Flow (lt/min)	Constant Rate Of Flow Q (cm^3/sec)	
17 29	0		0			
17 34	5		0			
17 39	10		0			
17 44	15	45.21	0.2	0.04	0.67	$1.18X10^{-4}$
17 49	20		0.2	0		
17 54	25		0.4	0.04	0.67	$1.18X10^{-4}$
17 59	30		0.4	0		
18 04	35		0.4	0		
18 09	40		0.4	0		
18 14	45		0.6	0.04	0.67	$1.18X10^{-4}$
18 19	50		0.6	0		
18 24	55		0.6	0		
18 29	60		0.6	0		

Constant Rate Of Flow For Steady State Condition : Q = 0.67 cm^3/sec

Coefficient Of Permeability For Steady State Condition : K = $1.18X10^{-4}$ cm/sec

OPEN - END PERMEABILITY TEST

(Sheet 5 Of 5)

PROJECT : G.I. At Upper Liwagu Mini Hydro Project Site HOLE No. LT-1

LOCATION Head pond DATE OF TEST 20-1-92 TESTED BY Litto

GROUND ELEVATION 1031.62 m SIZE OF CASING NW CHECKED BY M. Liew

GEOLOGICAL CONDITION OF THE BOTTOM OF DRILL HOLE Brownish grey SILTSTONE

DEPTH FROM GROUND SURFACE TO THE BOTTOM OF CASING 1000 cm

HEIGHT FROM GROUND SURFACE TO THE TOP OF CASING 30 cm

INTERNAL RADIUS OF CASING : r = 3.9 cm

GROUND TEMPERATURE 25 °C WATER TEMPERATURE 20 °C

DEPTH FROM GROUND SURFACE TO WATER SURFACE IN THE DRILL HOLE BEFORE TEST 177 cm

DEPTH FROM GROUND SURFACE TO WATER SURFACE IN THE DRILL HOLE AFTER TEST 5 cm

Time		Differential Head Of Water H (cm)	Water Volume			Coefficient Of Permeability K (cm/sec)
Clock Hr min	min		Accum. Flow (lt)	Diff. Flow (lt/min)	Constant Rate Of Flow Q (cm^3/sec)	
12 10	0		0			
12 15	5		0.2	0.04	0.67	
12 20	10		0.4	0.04	0.67	
12 25	15		0.6	0.04	0.67	
12 30	20		0.9	0.06	1.00	
12 35	25	207	1.2	0.06	1.00	0.72
12 40	30		1.5	0.06	1.00	
12 45	35		1.6	0.02	0.33	
12 50	40		1.8	0.04	0.67	
12 55	45		2.0	0.04	0.67	
13 00	50		2.2	0.04	0.67	
13 05	55		2.4	0.04	0.67	
13 10	60		2.6	0.04	0.67	

Constant Rate Of Flow For Steady State Condition : Q = 0.72 cm^3/sec

Coefficient Of Permeability For Steady State Condition : K = 1.62 x 10^{-4} cm/sec

OPEN - END PERMEABILITY TEST

(Sheet 1 Of 5)

PROJECT : G.I. At Upper Liwagu Mini Hydro Project Site HOLE No. LT-2

LOCATION Head Pond DATE OF TEST 11-1-92 TESTED BY Ampahon & Litto

GROUND ELEVATION 1035.53 m SIZE OF CASING NW CHECKED BY M. Liew

GEOLOGICAL CONDITION OF THE BOTTOM OF DRILL HOLE Grey weathered SANDSTONE

DEPTH FROM GROUND SURFACE TO THE BOTTOM OF CASING 250 cm

HEIGHT FROM GROUND SURFACE TO THE TOP OF CASING 35 cm

INTERNAL RADIUS OF CASING : r = 3.90 cm

GROUND TEMPERATURE 25 ^{o}C WATER TEMPERATURE 20 ^{o}C

DEPTH FROM GROUND SURFACE TO WATER SURFACE IN THE DRILL HOLE BEFORE TEST 204 cm

DEPTH FROM GROUND SURFACE TO WATER SURFACE IN THE DRILL HOLE AFTER TEST 53 cm

Time		Differential Head Of Water H (cm)	Water Volume			Coefficient Of Permeability K (cm/sec)
Clock Hr min	min		Accum. Flow (lt)	Diff. Flow (lt/min)	Constant Rate Of Flow Q (cm^3/sec)	
16 07	0		0			
16 12	5		4	0.8	13.33	$2.60X10^{-3}$
16 17	10		6	0.4	6.67	$1.30X10^{-3}$
16 22	15		8	0.4	6.67	$1.30X10^{-3}$
16 27	20		11	0.6	10.00	$1.95X10^{-3}$
16 32	25		15	0.8	13.33	$2.60X10^{-3}$
16 37	30	239	17	0.4	6.67	$1.30X10^{-3}$
16 42	35		19	0.4	6.67	$1.30X10^{-3}$
16 47	40		21	0.4	6.67	$1.30X10^{-3}$
16 52	45		25	0.8	13.33	$2.60X10^{-3}$
16 57	50		26	0.2	3.33	$6.50X10^{-3}$
17 02	55		27	0.2	3.33	$6.50X10^{-3}$
17 07	60		31	0.8	13.33	$2.60X10^{-3}$

Constant Rate Of Flow For Steady State Condition : Q = 8.61 cm^3/sec

Coefficient Of Permeability For Steady State Condition : K = $1.68X10^{-3}$ cm/sec

OPEN - END PERMEABILITY TEST

PROJECT : G.1. At Upper Liwagu Mini Hydro Project Site HOLE No. LT-2

LOCATION Head Pond DATE OF TEST 12-1-92 TESTED BY Ampahon & Litto

GROUND ELEVATION 1035.53 m SIZE OF CASING NW CHECKED BY M. Liew

GEOLOGICAL CONDITION OF THE BOTTOM OF DRILL HOLE Grey weathered SANDSTONE

DEPTH FROM GROUND SURFACE TO THE BOTTOM OF CASING 400 cm

HEIGHT FROM GROUND SURFACE TO THE TOP OF CASING 61 cm

INTERNAL RADIUS OF CASING : r = 3.90 cm

GROUND TEMPERATURE 25 °C WATER TEMPERATURE 20 °C

DEPTH FROM GROUND SURFACE TO WATER SURFACE IN THE DRILL HOLE BEFORE TEST 287 cm

DEPTH FROM GROUND SURFACE TO WATER SURFACE IN THE DRILL HOLE AFTER TEST 47 cm

Time		Differential Head Of Water H (cm)	Water Volume			Coefficient Of Permeability K (cm/sec)
Clock Hr min	min		Accum. Flow (lt)	Diff. Flow (lt/min)	Constant Rate Of Flow Q (cm^3/sec)	
14 30	0		0			
14 35	5		0.4	0.08	1.33	$1.78X10^{-4}$
14 40	10		0.8	0.08	1.33	$1.78X10^{-4}$
14 45	15		1.10	0.06	1.00	$1.34X10^{-4}$
14 50	20		1.50	0.08	1.33	$1.78X10^{-4}$
14 55	25		1.80	0.06	1.00	$1.34X10^{-4}$
15 00	30	348	2.30	0.10	1.67	$2.24X10^{-4}$
15 05	35		2.70	0.08	1.33	$1.78X10^{-4}$
15 10	40		3.0	0.06	1.00	$1.34X10^{-4}$
15 15	45		3.25	0.05	0.83	$1.11X10^{-4}$
15 20	50		3.60	0.07	1.17	$1.57X10^{-4}$
15 25	55		4.15	0.11	1.83	$2.45X10^{-4}$
15 30	60		4.55	0.08	1.33	$1.78X10^{-4}$

Constant Rate Of Flow For Steady State Condition : Q = 1.26 cm^3/sec

Coefficient Of Permeability For Steady State Condition : K = $1.69X10^{-4}$ cm/sec

OPEN - END PERMEABILITY TEST

PROJECT : G.I. At Upper Liwagu Mini Hydro Project Site HOLE No. LT-2

LOCATION Head Pond DATE OF TEST 13-1-92 TESTED BY Ampahon & Litto

GROUND ELEVATION 1035.53 m SIZE OF CASING NW CHECKED BY M. Liew

GEOLOGICAL CONDITION OF THE BOTTOM OF DRILL HOLE Grey weathered SANDSTONE

DEPTH FROM GROUND SURFACE TO THE BOTTOM OF CASING 600 cm

HEIGHT FROM GROUND SURFACE TO THE TOP OF CASING 89 cm

INTERNAL RADIUS OF CASING : r = 3.90 cm

GROUND TEMPERATURE 25 °C WATER TEMPERATURE 20 °C

DEPTH FROM GROUND SURFACE TO WATER SURFACE IN THE DRILL HOLE BEFORE TEST 354 cm

DEPTH FROM GROUND SURFACE TO WATER SURFACE IN THE DRILL HOLE AFTER TEST 103 cm

Time		Differential Head Of Water H (cm)	Water Volume			Coefficient Of Permeability K (cm/sec)
Clock Hr min	min		Accum. Flow (lt)	Diff. Flow (lt/min)	Constant Rate Of Flow Q (cm^3/sec)	
12 52	0		0			
12 57	5		0.80	0.16	2.67	$2.78X10^{-4}$
13 02	10		2.00	0.24	4.00	$4.21X10^{-4}$
13 07	15		3.00	0.20	3.33	$3.50X10^{-4}$
13 12	20		3.80	0.16	2.67	$2.81X10^{-4}$
13 17	25		5.20	0.28	4.67	$4.91X10^{-4}$
13 22	30	443	5.95	0.15	2.50	$2.63X10^{-4}$
13 27	35		6.75	0.16	2.67	$2.81X10^{-4}$
13 32	40		7.95	0.24	4.00	$4.21X10^{-4}$
13 37	45		8.95	0.20	3.33	$3.50X10^{-4}$
13 42	50		10.05	0.22	3.67	$3.86X10^{-4}$
13 47	55		10.95	0.18	3.00	$3.16X10^{-4}$
13 52	60		12.10	0.23	3.83	$4.03X10^{-4}$

Constant Rate Of Flow For Steady State Condition : Q = 3.36 cm^3/sec

Coefficient Of Permeability For Steady State Condition : K = $3.54X10^{-4}$ cm/sec

OPEN - END PERMEABILITY TEST

(Sheet 4 of 5)

PROJECT : G.I. At Upper Liwagu Mini Hydro Project Site HOLE No. LT-2

LOCATION Head Pond DATE OF TEST 13-1-92 TESTED BY Ampahon & Litto

GROUND ELEVATION 1035.53 m SIZE OF CASING NW CHECKED BY M. Liew

GEOLOGICAL CONDITION OF THE BOTTOM OF DRILL HOLE Reddish brown sandy silty CLAY

DEPTH FROM GROUND SURFACE TO THE BOTTOM OF CASING 800 cm

HEIGHT FROM GROUND SURFACE TO THE TOP OF CASING 40 cm

INTERNAL RADIUS OF CASING : r = 3.90 cm

GROUND TEMPERATURE 25 ^{o}C WATER TEMPERATURE 20 ^{o}C

DEPTH FROM GROUND SURFACE TO WATER SURFACE IN THE DRILL HOLE BEFORE TEST 203 cm

DEPTH FROM GROUND SURFACE TO WATER SURFACE IN THE DRILL HOLE AFTER TEST 15 cm

Time		Differential Head Of Water H (cm)	Water Volume			Coefficient Of Permeability K (cm/sec)
Clock Hr min	min		Accum. Flow (lt)	Diff. Flow (lt/min)	Constant Rate Of Flow Q (cm^3/sec)	
16 45	0		0			
16 50	5		0	0		
16 55	10		0.10	0.02	0.33	6.33×10^{-5}
17 00	15		0.10	0		
17 05	20		0.15	0.01	0.17	3.26×10^{-5}
17 10	25		0.15	0		
17 15	30	243	0.20	0.01	0.17	3.26×10^{-5}
17 20	35		0.20	0		
17 25	40		0.20	0		
17 30	45		0.25	0.01	0.17	3.26×10^{-5}
17 35	50		0.25	0		
17 40	55		0.25	0		
17 45	60		0.25	0		

Constant Rate Of Flow For Steady State Condition : Q = 0.21 cm^3/sec

Coefficient Of Permeability For Steady State Condition : K = 4.03×10^{-5} cm/sec