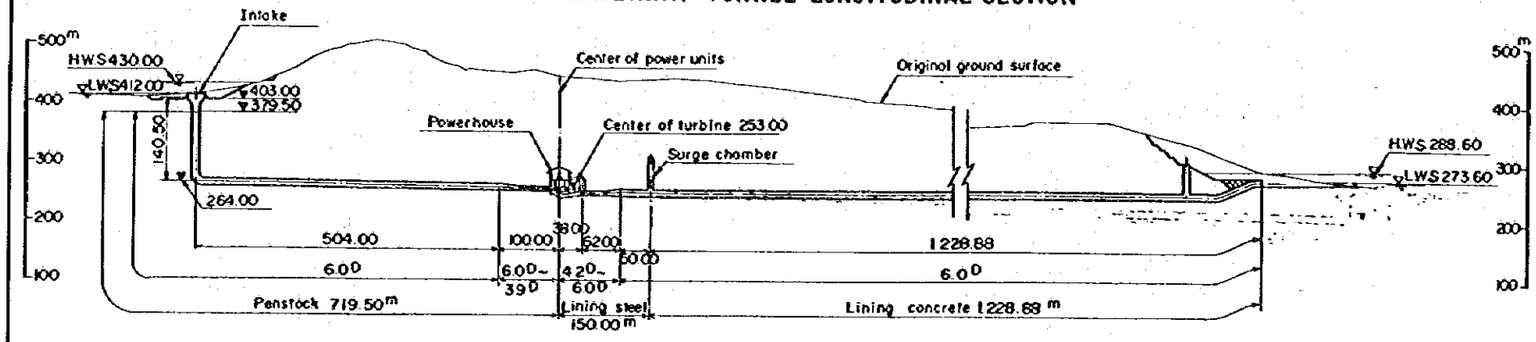
NO.1 WATERWAY TUNNEL LONGITUDINAL SECTION



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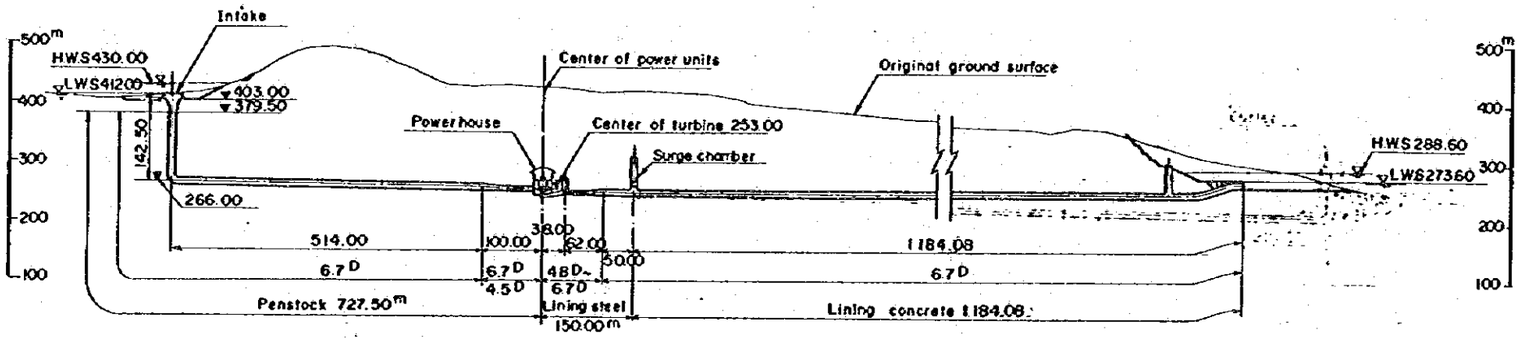
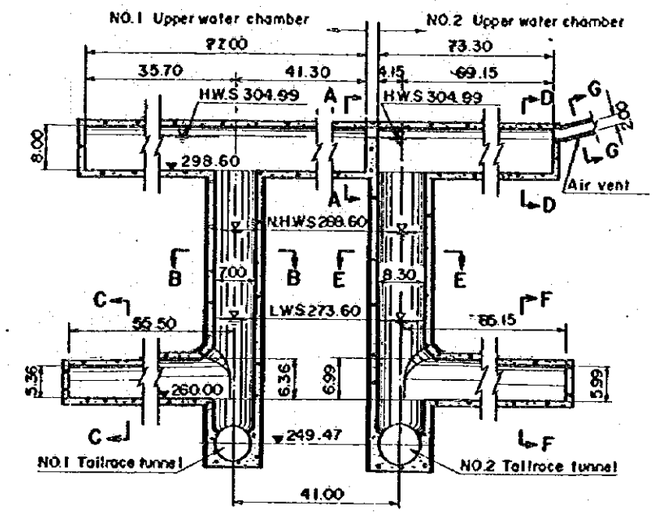


SURGE CHAMBER



WATERWAY TUNNEL TYPICAL SECTION

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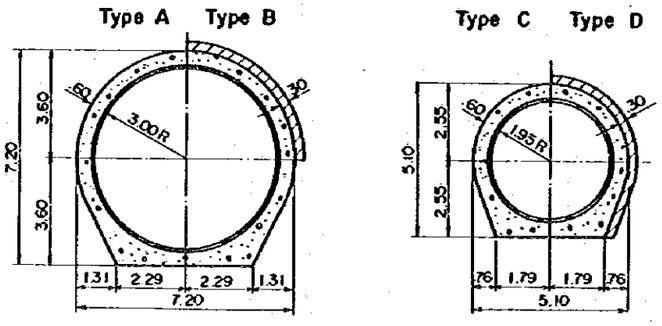
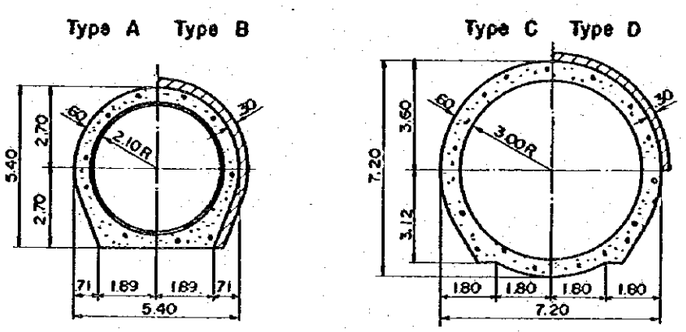


NO.1 TAILRACE TUNNEL



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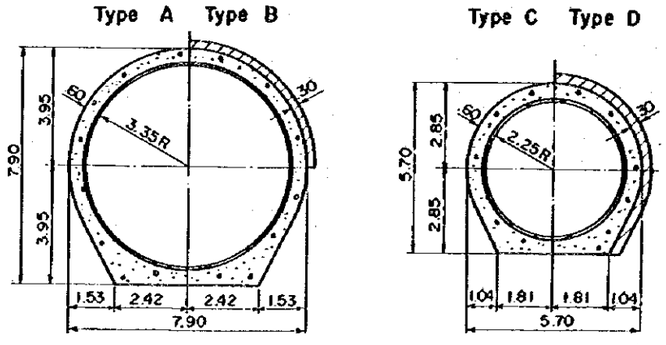

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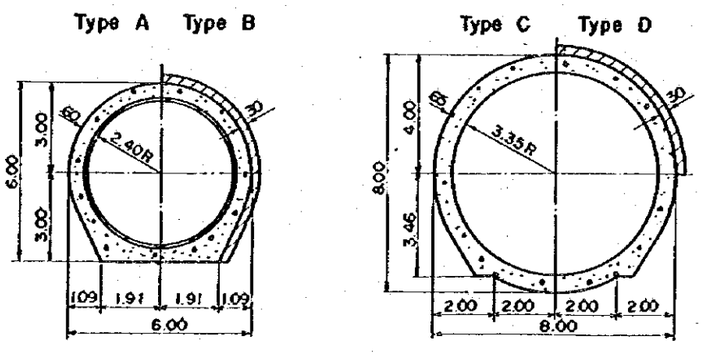

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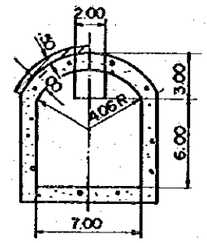

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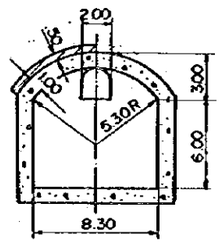

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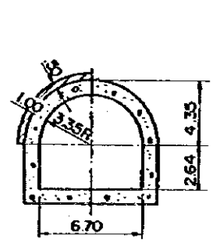

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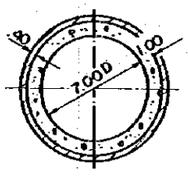

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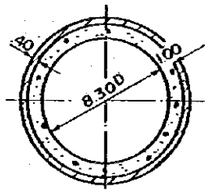

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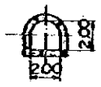
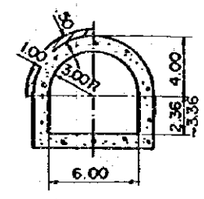
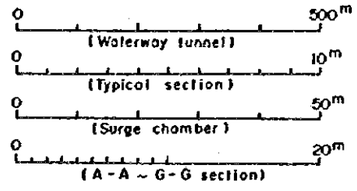


C-C SECTION





REPUBLIC OF TUNISIA
SOCIETE TUNISIENNE DE L'ELECTRICITE ET DU GAZ (STEG)

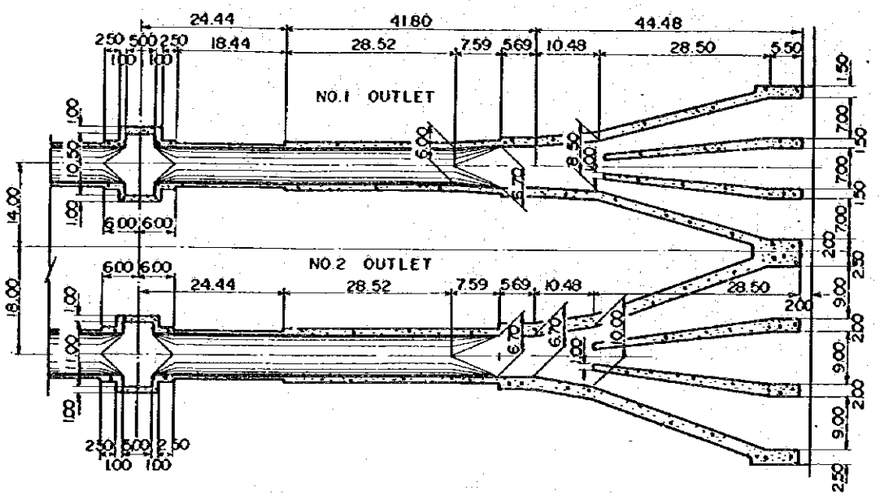
KASSEB PUMPED STORAGE PROJECT

WATERWAY TUNNEL AND SURGE CHAMBER

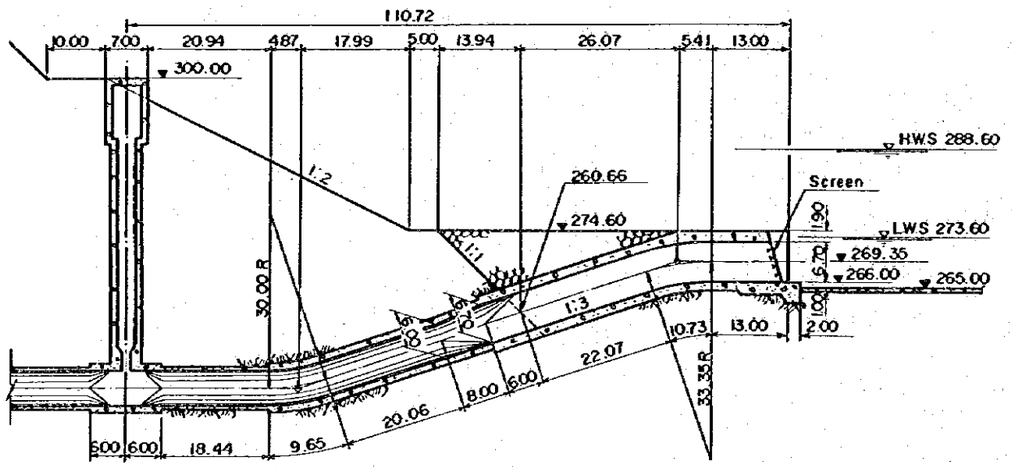
(Drawdown; 15 m)

Figure. 4 – 3 | March 1980

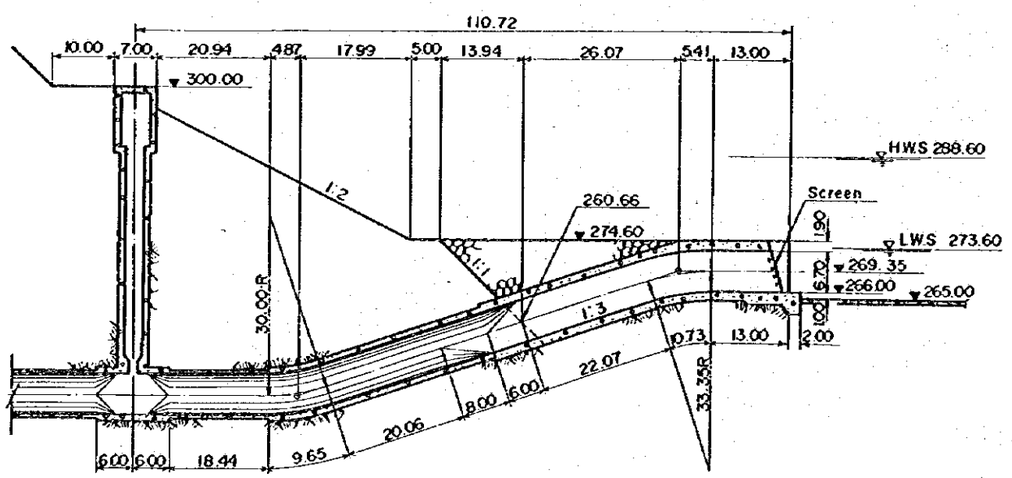
OUTLET PLAN



NO.1 OUTLET LONGITUDINAL SECTION



NO.2 OUTLET LONGITUDINAL SECTION



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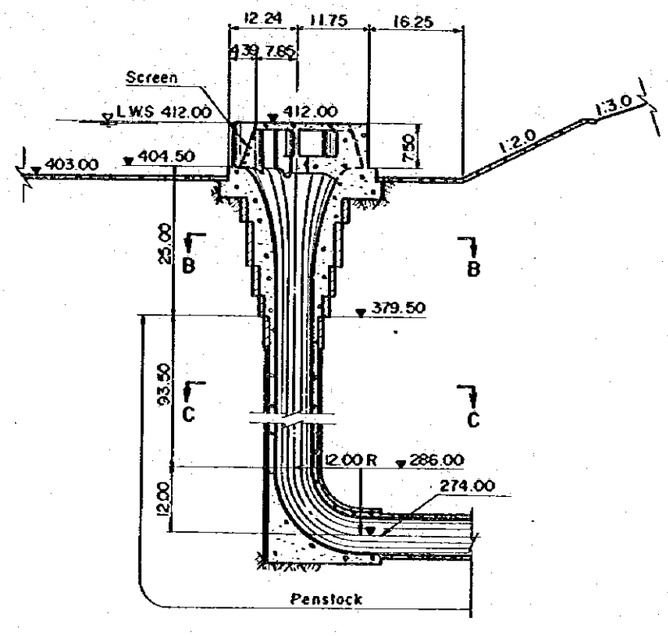
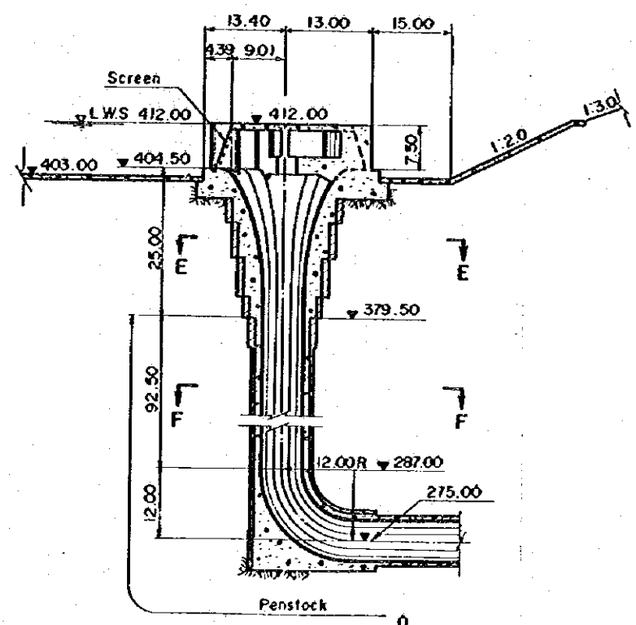
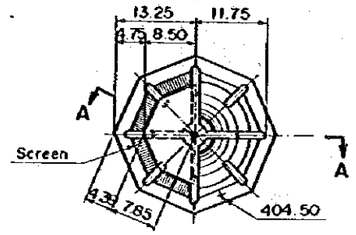


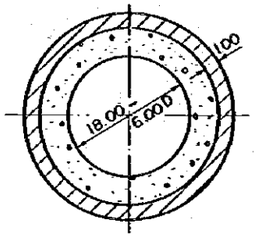
D-D SECTION



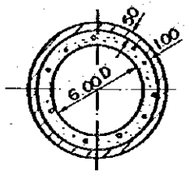
NO.1 INTAKE PLAN



B-B SECTION



C-C SECTION



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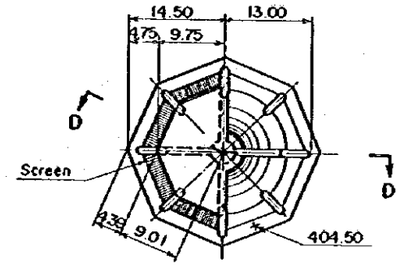

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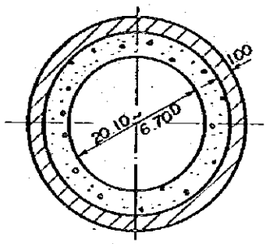
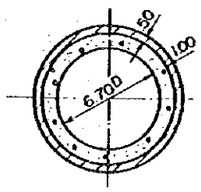


F-F SECTION



0 50m (Intake & Outlet)

0 20m (B-B, C-C, E-E & F-F section)

REPUBLIC OF TUNISIA
SOCIETE TUNISIENNE DE L'ELECTRICITE ET DU GAZ (STEG)

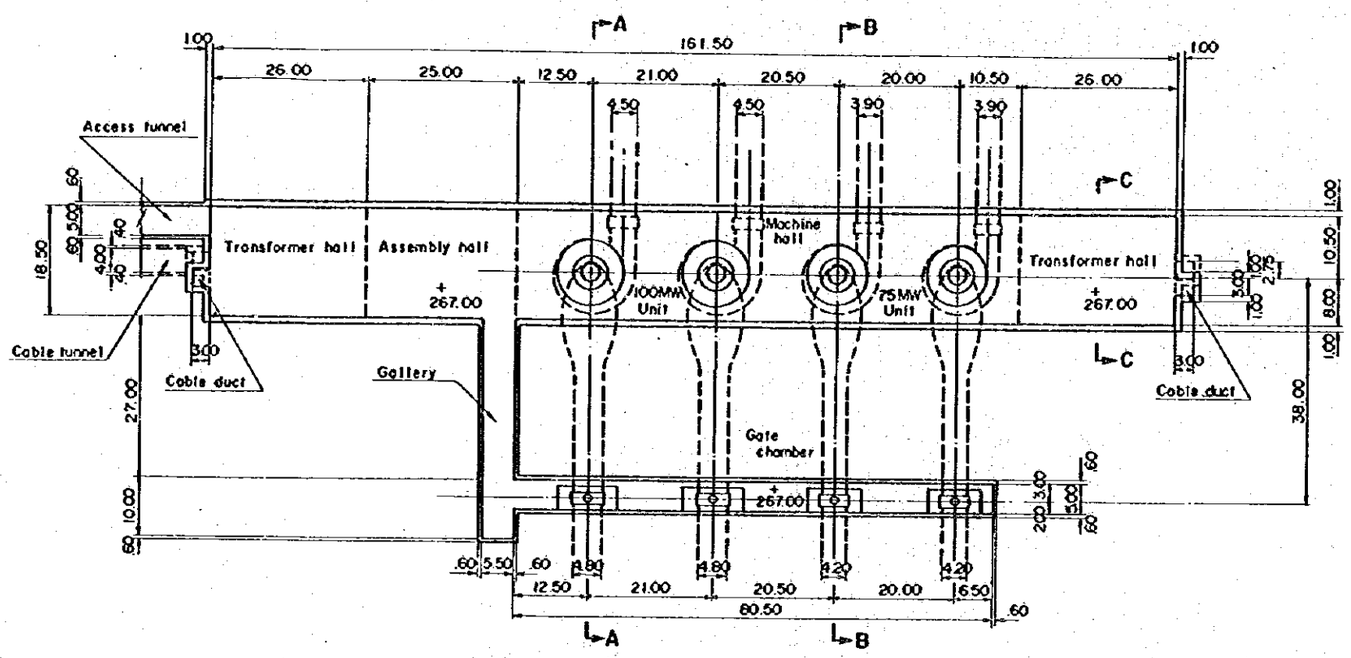
KASSEB PUMPED STORAGE PROJECT

INTAKE AND OUTLET

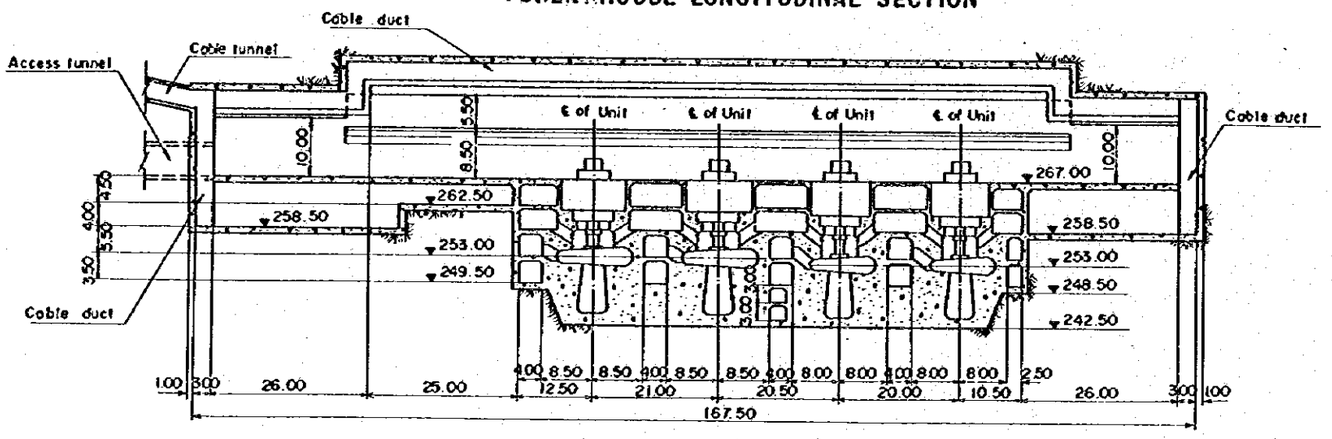
(Drawdown: 15 m)

Figure 4 - 4 | March 1980

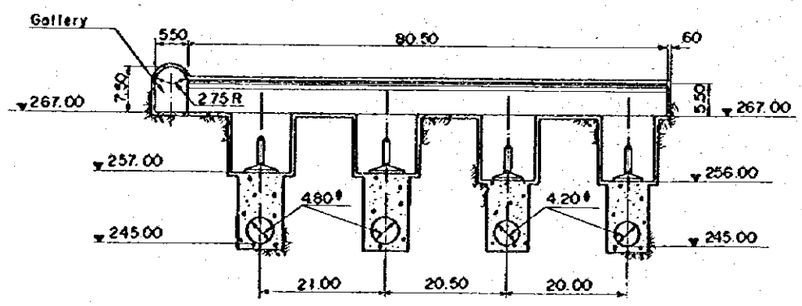
POWERPLANT PLAN



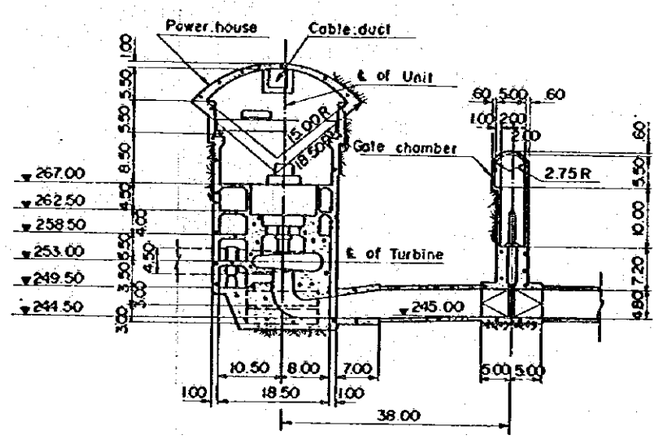
POWER HOUSE LONGITUDINAL SECTION



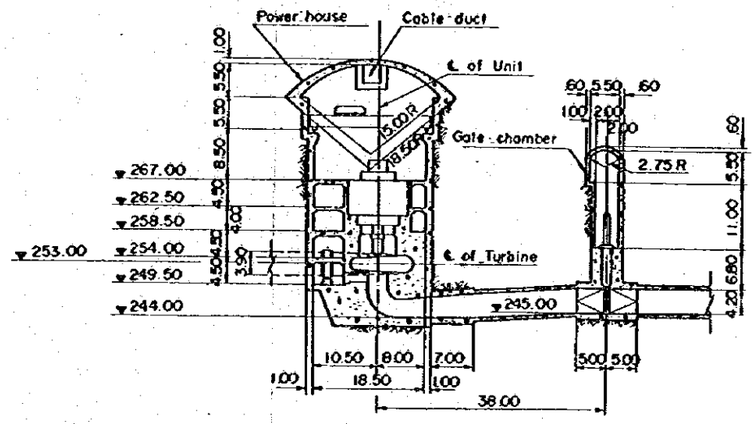
GATE CHAMBER LONGITUDINAL SECTION



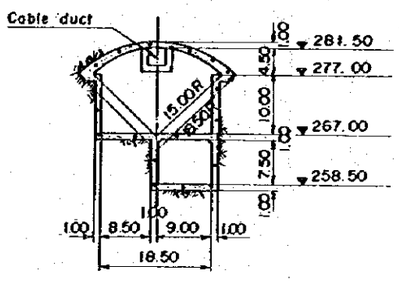
A-A SECTION (100MW SIDE)



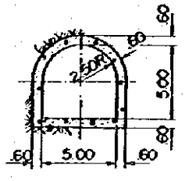
B-B SECTION (75MW SIDE)



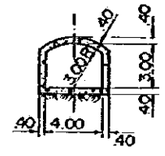
TRANSFORMER HALL(C-C) SECTION



ACCESS TUNNEL SECTION



CABLE TUNNEL SECTION



0 — 20m (Tunnel Section)

0 — 50m (Except Tunnel Section)

REPUBLIC OF TUNISIA
SOCIETE TUNISIENNE DE L'ELECTRICITE ET DU GAZ (STEG)

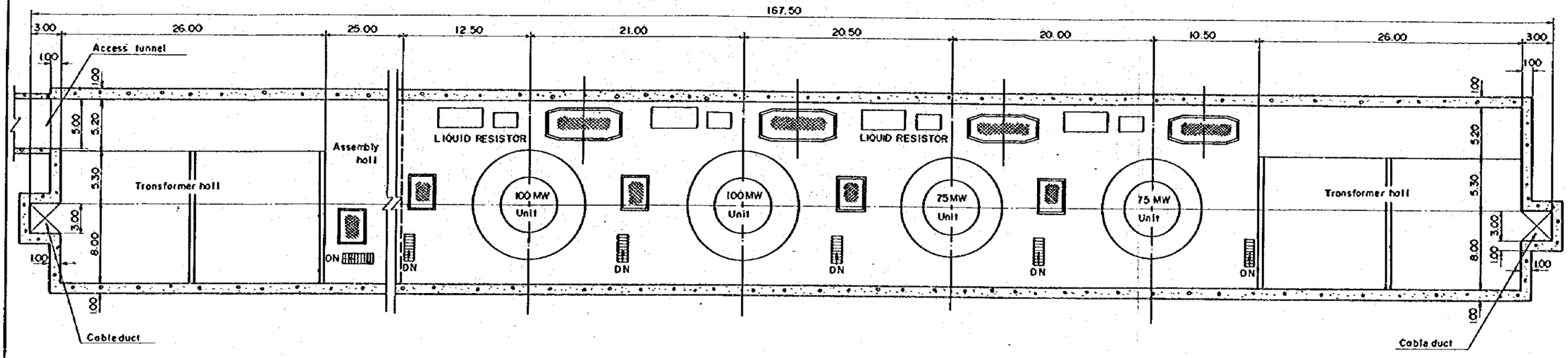
KASSEB PUMPED STORAGE PROJECT

POWER HOUSE (1-3)

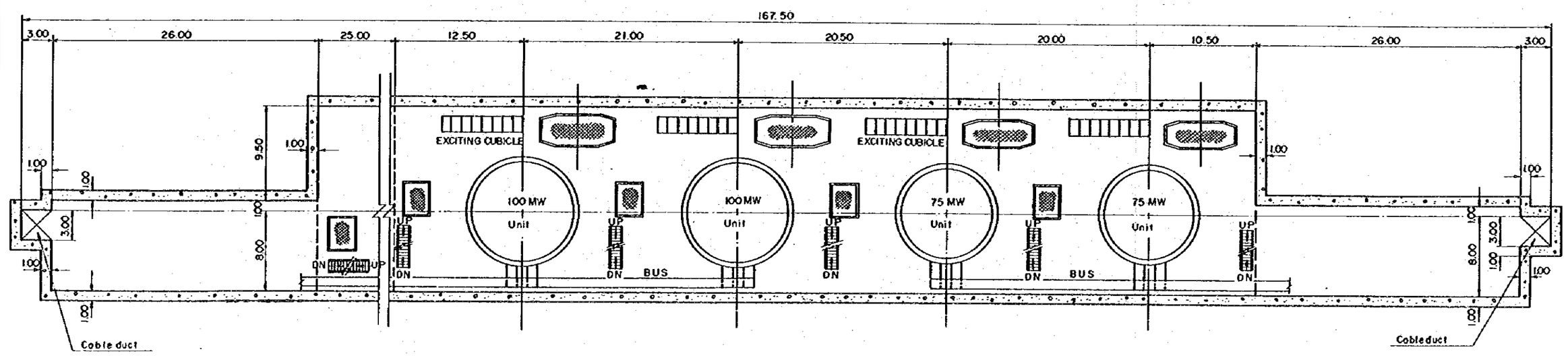
(Drawdown ,15m)

Figure. 4 – 5 | March 1980

EL. 267.00



EL. 262.50



REPUBLIC OF TUNISIA
SOCIETE TUNISIENNE DE L'ELECTRICITE ET DU GAZ (STEG)

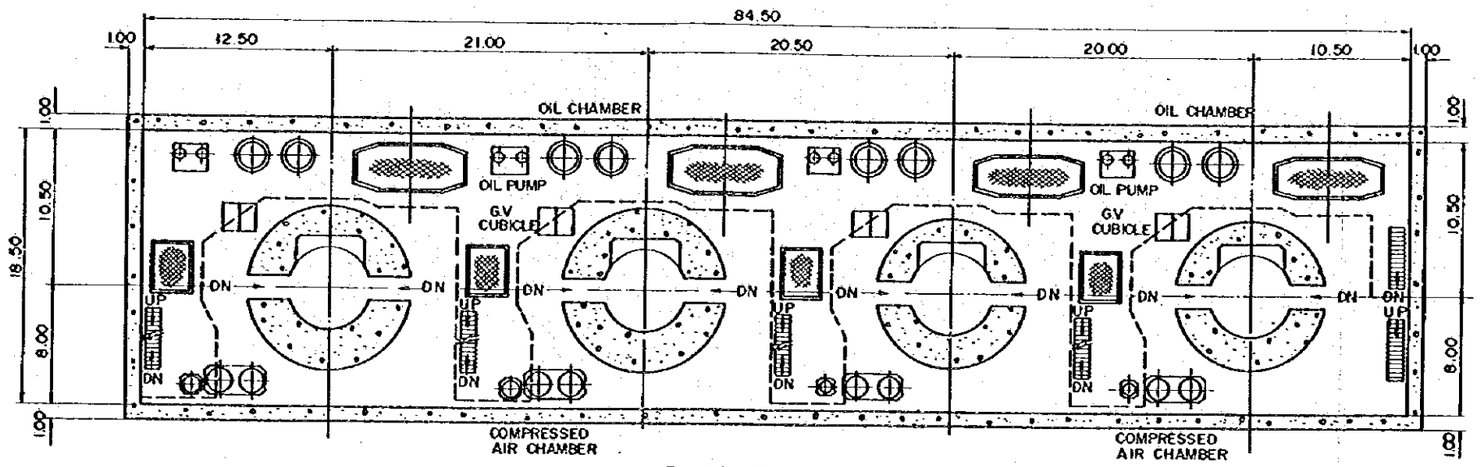
KASSEB PUMPED STORAGE PROJECT

POWER HOUSE (2-3)

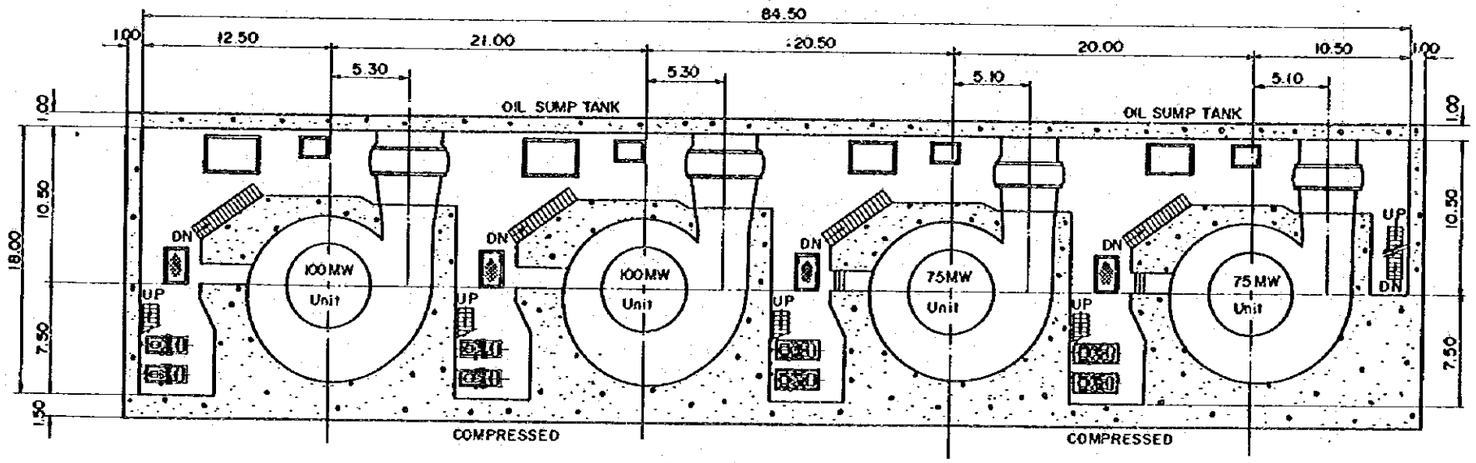
(Drawdown, 15m)

Figure 4 – 6 | March 1980

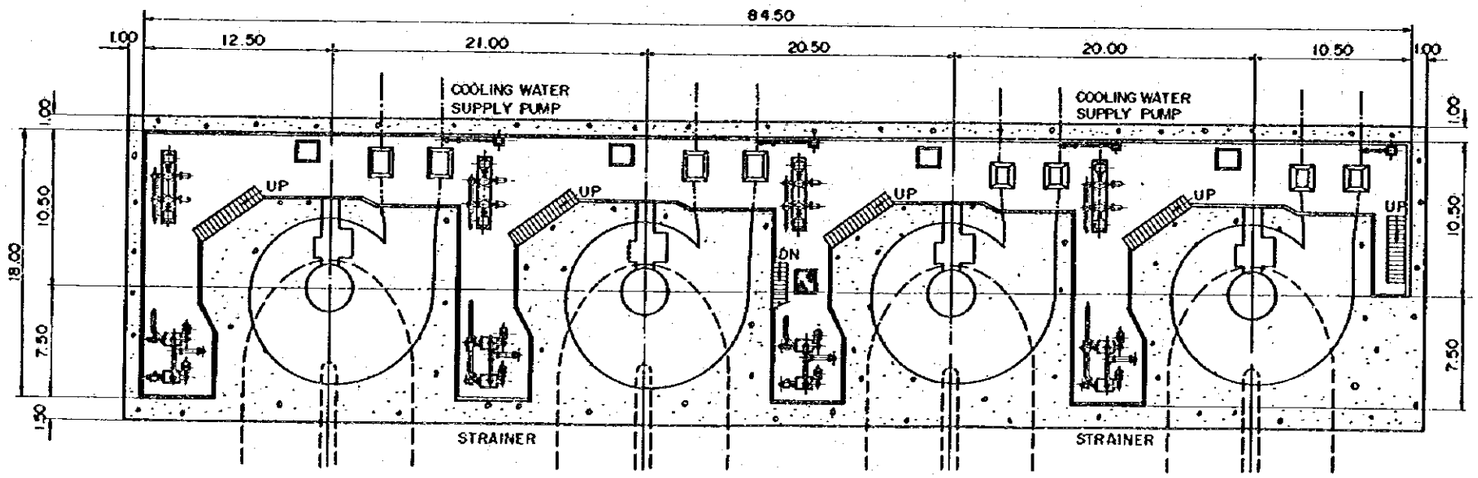
EL. 258.50



EL. 254.00



EL. 249.50



REPUBLIC OF TUNISIA
SOCIETE TUNISIENNE DE L'ELECTRICITE ET DU GAZ (STEG)

KASSEB PUMPED STORAGE PROJECT

POWER HOUSE (3-3)

(Drawdown, 15m)

Figure - 4 - 7 | March 1980

A P P E N D I X

APPENDIX 1	Summary of core boring in Kasseb project area. Geological log of drill hole.
APPENDIX 2	Permeability test in drill hole
APPENDIX 3	Log of test pit

APPENDIX 1

CONTENTS

Table App 1 - 1 Summary of Core Boring in Kasseb Project Area

Hole name	Co-ordinates X	Co-ordinates Y	Elevation	Bearing	Dip	Length	Over-burden	Core recovery	Pumped-in test	Commenced	Completed	Advance
			m		°	m	m	%	sect.			m/day
SB 10	87,047.44	78,644.03		N	45	50.0	3.4	76.9	7	17, Oct. 79	20, Dec. 79	0.78
SB 11	87,157.47	78,638.77		S	45	55.0	11.0	46.2	3	23, Oct. 79	07, Dec. 79	0.98
SB 12				-	90	30.6	3.1	67.2	-	16, Jul. 79	14, Aug. 79	1.02
SB 12 bis	87,246.77	78,641.06		-	90	30.0	2.9	70.2	3	19, Aug. 79	26, Sep. 79	0.77
SB 13	86,613.08	78,480.04		-	90	35.0	0.2	82.4	2	04, May. 79	30, May. 79	1.40
SB 14	87,692.10	77,872.81		-	90	35.0	2.2	97.2	4	08, Jun. 79	08, Jul. 79	1.13
SI 2	86,947.01	78,490.58		-	90	150.0	5.0	47.0	11	13, Jun. 79	14, Dec. 79	0.81
SU 11				-	90	70.0	3.0	50.4	6		23, Feb. 80	
		Total;	8 holes			455.6 meters		59.8 % in average				

Remarks

1/ Location; Damsite - - - SB 10, SB 11, SB 12 and SB 12 bis.
South saddle in upper reservoir area - - - SB 13.
North saddle in upper reservoir area - - - SB 14.
Intake site - - - SI 2. Outlet site - - - SU 11.

2/ Size of bore hole was mostly NX.

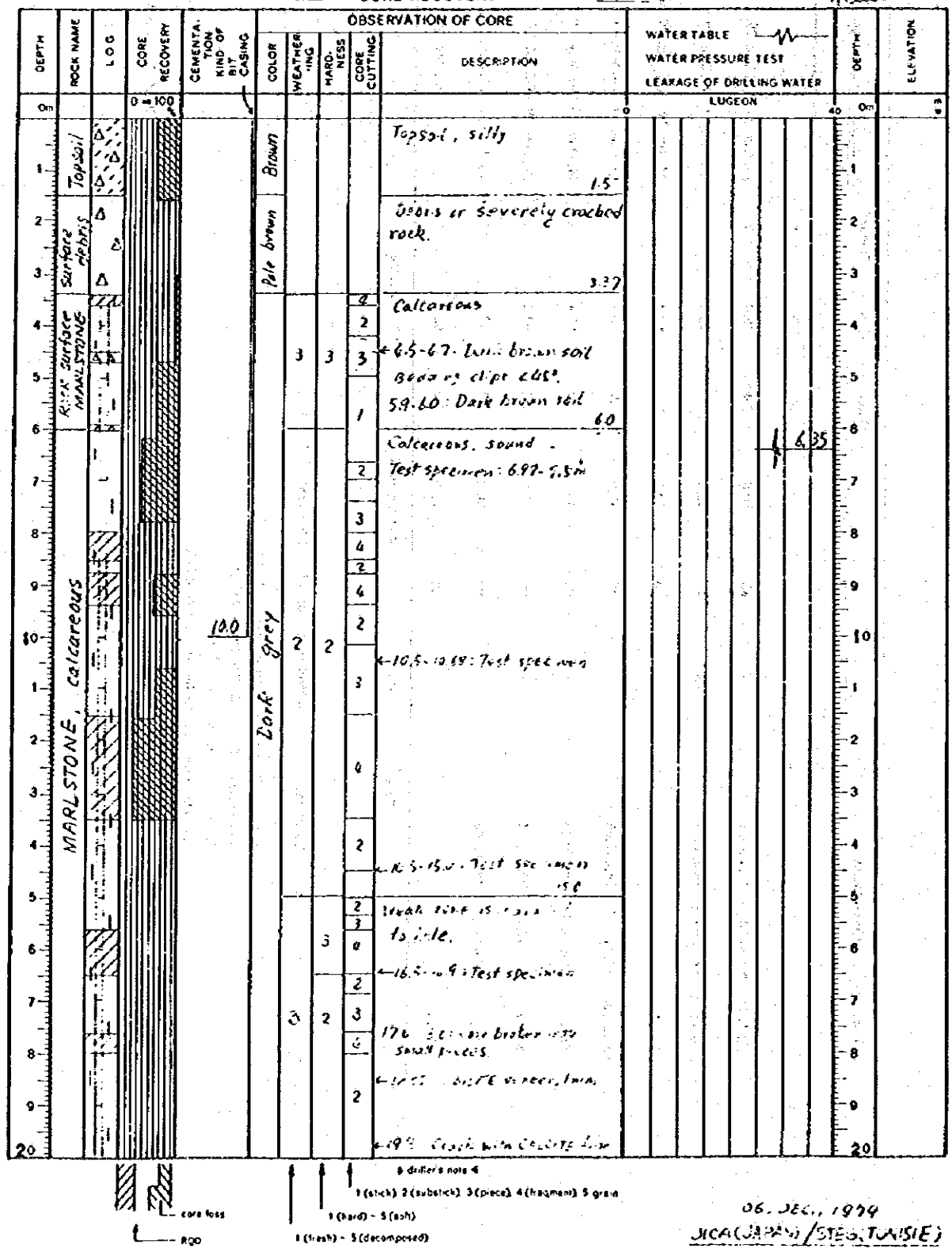
3/ Each elevation indicates that of the top of hole.

4/ Machines used in the boring works are shown below.
Model - - - Diamant Boart BELGIUM D.B. 250, Moscow Regional Economy Coun. L. USSR and Long year IHBO 246, U.S.A.

GEOLOGIC LOG OF DRILL HOLE

KASSEB PROJECT Damsite HOLE No. SB 10 (SHEET 1 OF 3)

LOCATION	left river side	DEPTH OF HOLE	50.0 m	COMMENCED	17-Oct-'79
ELEVATION	m	DEPTH OF OVERBURDEN	3.4 m	COMPLETED	20-Dec.-'79
COORDINATE	X 87,047.44 Y 78,644.03	LENGTH OF ROCK DRILLING	46.6 m	DRILLED BY	STEQ / EGTH
ANGLE FROM HORIZONTAL	45°	TOTAL LENGTH OF CORE	m	LOGGED BY	[illegible]
BEARING OF ANGLE HOLE	N	CORE RECOVERY	%		[illegible]

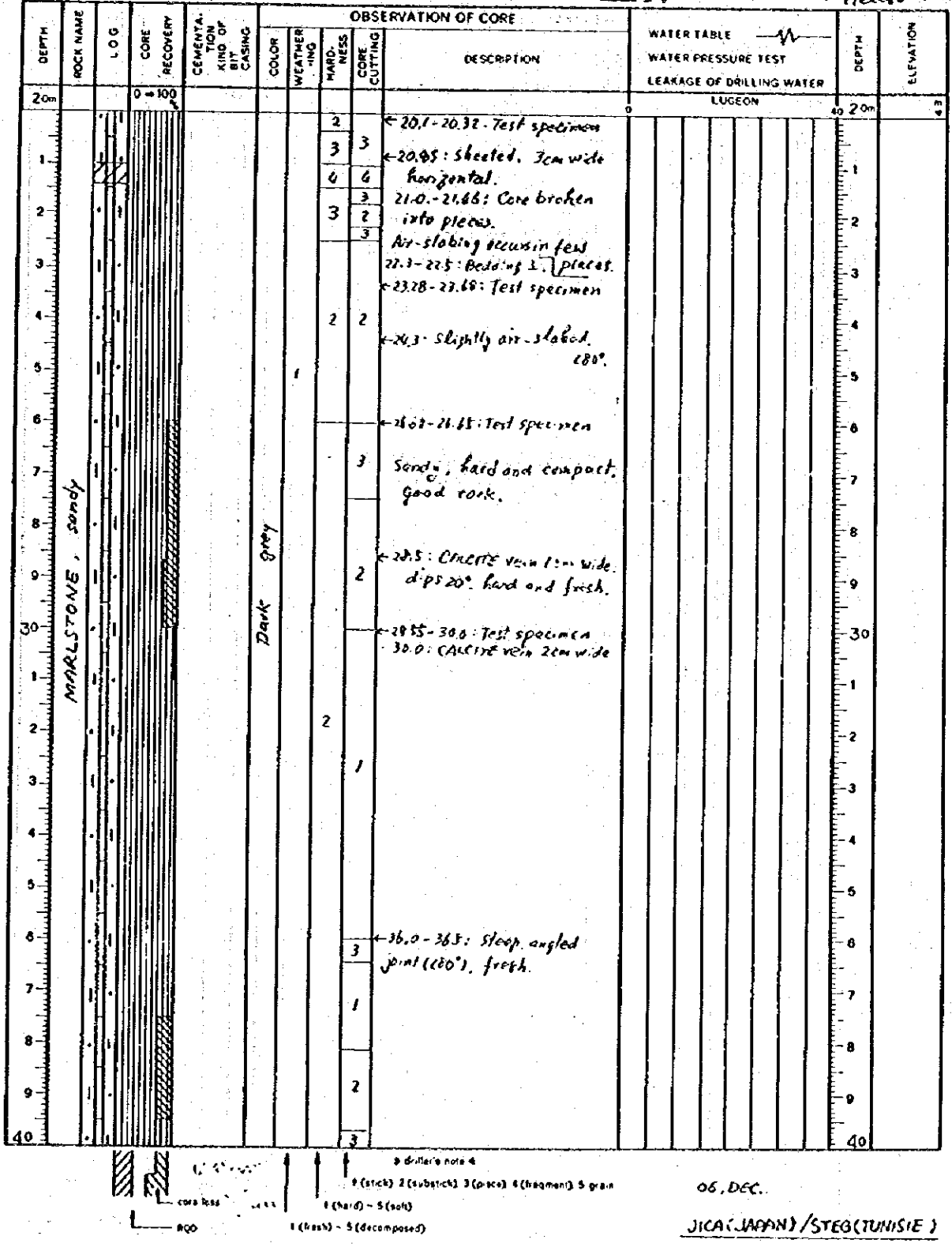


06. DEC., 1979
JICA (JAPAN) / STEG, TUNISIE
ELECTRIC POWER DEVELOPMENT CO., LTD.

GEOLOGIC LOG OF DRILL HOLE

KASSEB PROJECT Damsite HOLE No. SB 10 (SHEET 2 OF 3)

LOCATION	Left river side	DEPTH OF HOLE	50.0 m	COMMENCED	17-Oct.-'79
ELEVATION	m	DEPTH OF OVERBURDEN	3.4 m	COMPLETED	20-Dec.-'79
COORDINATE	X 87.047.44 Y 28.484.03	LENGTH OF ROCK DRILLING	46.6 m	DRILLED BY	STEG/EGTH
ANGLE FROM HORIZONTAL	45°	TOTAL LENGTH OF CORE	m	LOGGED BY	M. Guetouni Hebil
BEARING OF ANGLE HOLE	N	CORE RECOVERY	%		



06, DEC.

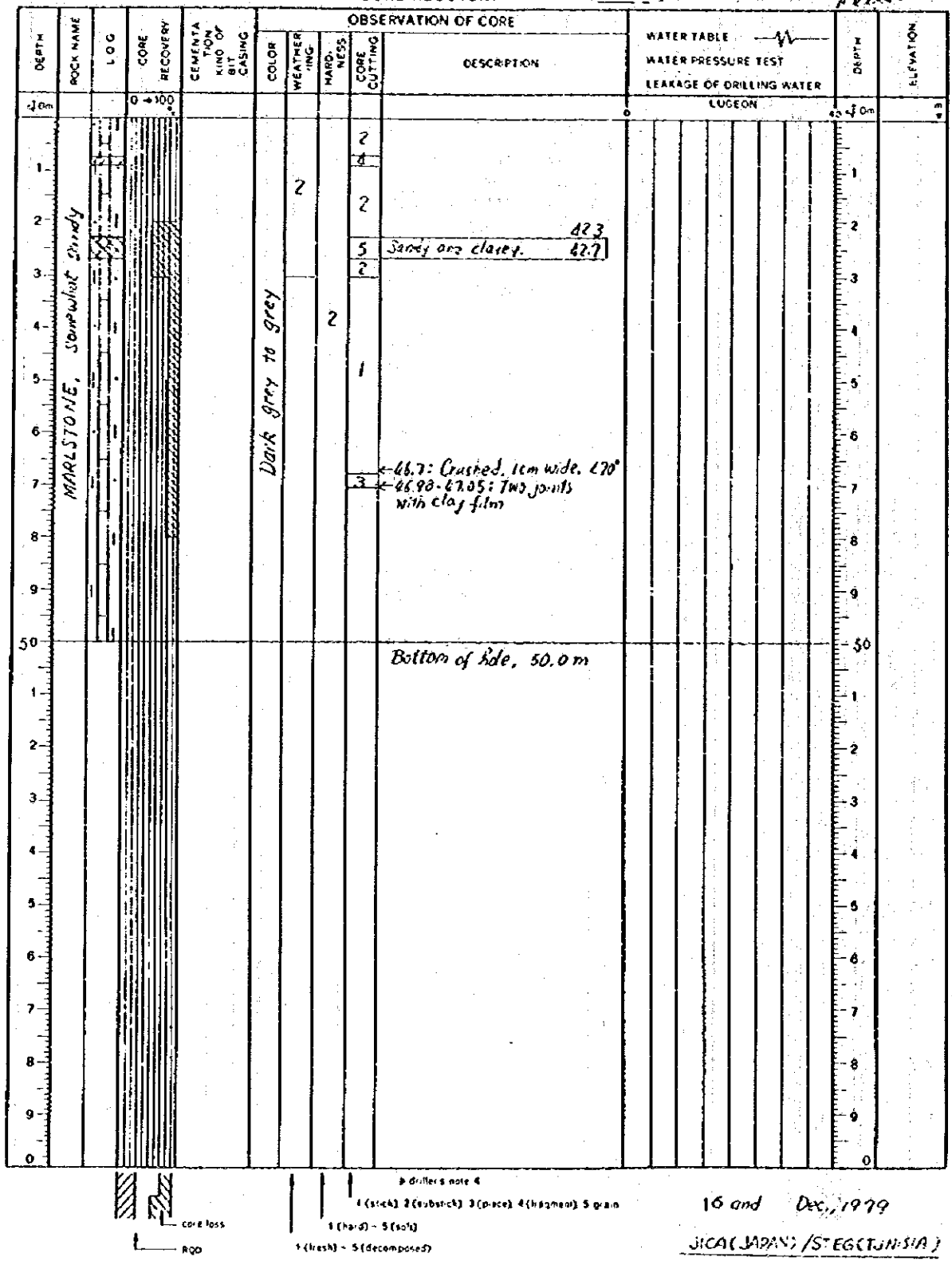
JICA (JAPAN) / STEG (TUNISIE)

ELECTRIC POWER DEVELOPMENT CO., LTD.

GEOLOGIC LOG OF DRILL HOLE

KASSEB PROJECT *Damsite* HOLE No. SB 10 (SHEET 3 OF 3)

LOCATION	*Left river side*	DEPTH OF HOLE	50.0 m	COMMENCED	17-Oct-'79
ELEVATION	m	DEPTH OF OVERBURDEN	3.4 m	COMPLETED	20-Dec-'79
COORDINATE	X 87,647.42 Y 78,494.03	LENGTH OF ROCK DRILLING	46.6 m	DRILLED BY	STEG/EGTH
ANGLE FROM HORIZONTAL	45°	TOTAL LENGTH OF CORE	m	LOGGED BY	Nishitomi Fellal
BEARING OF ANGLE HOLE	N	CORE RECOVERY	%		



GEOLOGIC LOG OF DRILL HOLE

KASEB PROJECT Damsite HOLE No. SB 11 (SHEET 1 OF 3)

LOCATION	Right river side	DEPTH OF HOLE	55.0 m	COMMENCED	23 - Oct - '79
ELEVATION	m	DEPTH OF OVERBURDEN	11.0 m	COMPLETED	07 - Dec. - '79
COORDINATE	X 87,157.47 Y 28,638.77	LENGTH OF ROCK DRILLING	44.0 m	DRILLED BY	STEG/EGTH
ANGLE FROM HORIZONTAL	45°	TOTAL LENGTH OF CORE	m	LOGGED BY	[illegible]
BEARING OF ANGLE HOLE	S	CORE RECOVERY	%		

DEPTH	ROCK NAME	LOG	CORE RECOVERY (0 → 100 %)	CEMENTATION / KIND OF BIT / CASING	COLOR	WEATHERING	HARDNESS	CORE CUTTING	DESCRIPTION	WATER TABLE / WATER PRESSURE TEST / LEAKAGE OF DRILLING WATER (LUGEON 0–40)	DEPTH	ELEVATION
0–3.0 m	CLAY				Brown - dark brown				Clay, cohesive, damp			
3.0–3.3 m	CLAY				Brown				3.0 – 3.3 LIMESTONE (fragment)			
3.3–11.0 m	CLAY				Brown				Clay, cohesive, damp. 3.2 – 9.2 : may be consists of LIMESTONE brecciated debris, in general			
11.0–15.6 m	MARLSTONE, calcareous				Grey				Highly weathered, disturbed, very soft, plastic [Test specimen: 11.0 - 11.36.] Containing few amount of limy particles which are white and completely weathered.			
15.6–19.50 m	MARLSTONE, calcareous				Grey				Disturbed rock, with steeply dipped foliation. Fault zone ?			
19.50–20 m	MARLSTONE, calcareous				Grey				Becoming slightly compact.			

Legend: core loss; RQD; driller's note 4; 1 (stick) 2 (substick) 3 (piece) 4 (fragment) 5 grain; 1 (hard) – 5 (soft); 1 (fresh) – 5 (decomposed)

05. Dec. 1979
JICA-JAPAN STEG(TUNISIE)

ELECTRIC POWER DEVELOPMENT CO., LTD.

GEOLOGIC LOG OF DRILL HOLE

KASSEB PROJECT Damsite HOLE No. SB 1' (SHEET 2 OF 3)

LOCATION	Right river side	DEPTH OF HOLE	55.0 m	COMMENCED	23-Oct-'79
ELEVATION	m	DEPTH OF OVERBURDEN	11.0 m	COMPLETED	07-Dec-'79
COORDINATE	X 87,157.47 Y 28,438.22	LENGTH OF ROCK DRILLING	44.0 m	DRILLED BY	STEG/EGTH
ANGLE FROM HORIZONTAL	45°	TOTAL LENGTH OF CORE	m	LOGGED BY	H. Suetomi, H. Kelli
BEARING OF ANGLE HOLE	S	CORE RECOVERY	%		

DEPTH	ROCK NAME	LOG	CORE RECOVERY (0 → 100)	CEMENTATION, KIND OF BIT, CASING	COLOR	WEATHERING	HARDNESS	CORE CUTTING	DESCRIPTION	WATER TABLE / WATER PRESSURE TEST / LEAKAGE OF DRILLING WATER (LUGEON 0–40)	DEPTH	ELEVATION
20 m – 31.0	MARLSTONE, calcareous				Grey	5	5	5	Disturbed rock. Breccia cemented clayey material. With few lenses and grains of CALCITE. Test specimen: 26.0-26.30. ← CALCITE veneer 3mm wide.		20 m	
31.0 – 40				32.0	Dark grey to black	2	2	4, 3, 4, 3, 4, 2, 3, 2, 4, 3, 2, 3, 2, 4	Compact and hard. ← Test specimen: 33.6-33.5 m. 34.65-34.8: CALCITE veinlets. 35.5: Crack coated with CALCITE veneer, ∠60°. 35.0-35.5: steep crack. ← Test specimen. 35.6-36.0 m. ← CALCITE veinlets. dp 60°. ← 39.1-39.5: Test specimen. ← 39.9. Core in fragments. 10cm		40	

core loss; RQD

1 (fresh) ~ 5 (decomposed)

1 (hard) ~ 5 (soft)

1 (stick) 2 (substick) 3 (piece) 4 (fragment) 5 grain

driller's note

05 and 11, Dec., 1979

JICA (JAPAN) STEG (TUNISIE)

ELECTRIC POWER DEVELOPMENT CO., LTD.

GEOLOGIC LOG OF DRILL HOLE

KASSEB PROJECT Damsite HOLE No SB 11 (SHEET 3 OF 3)

LOCATION Right river side
ELEVATION m
COORDINATE X 87,157.47 Y 78,138.72
ANGLE FROM HORIZONTAL 45°
BEARING OF ANGLE HOLE S

DEPTH OF HOLE 55.0 m
DEPTH OF OVERBURDEN 11.0 m
LENGTH OF ROCK DRILLING 44.0 m
TOTAL LENGTH OF CORE m
CORE RECOVERY %

COMMENCED 23-Oct-'79
COMPLETED 07-Dec-'79
DRILLED BY STEG/EGTH
LOGGED BY [illegible] Hellali

DEPTH	ROCK NAME	LOG	CORE RECOVERY (0–100)	CEMENTATION / KIND OF BIT / CASING	COLOR	WEATHERING	HARDNESS	CORE CUTTING	DESCRIPTION	WATER TABLE / WATER PRESSURE TEST / LEAKAGE OF DRILLING WATER (LUGEON)	DEPTH	ELEVATION
40m–45.0	MARLSTONE, calcareous				Dark grey	2	3 / 2 / 3	4 / 2 / 4	Short bar core is lifted in part. ⌐42.2: Joint coated with CALCITE film, ∠75°. ⌐42.8: Irregular crack, steepy inclined. 43.0–45.0: Core recovery is very poor. Core broken into fragments with clay. 45.0		40m	
45.0–55.0	MARLSTONE, foliated				Dull grey	5	5	5	Fault zone. Mostly clayey materials with rock fragments and particles in various places due to foliation. Some fragmental cores have pitted CALCITE small patches. ←51.0–52.0: Sheared and foliated core, ∠60°. CALCITE veinlets in some places. 55.0			
55.0									Bottom of hole, 55.0m			

Legend: core loss; RQD; 1 (fresh) – 5 (decomposed); 1 (hard) – 5 (soft); 1 (stick) 2 (substick) 3 (piece) 4 (fragment) 5 grain; driller's note 4

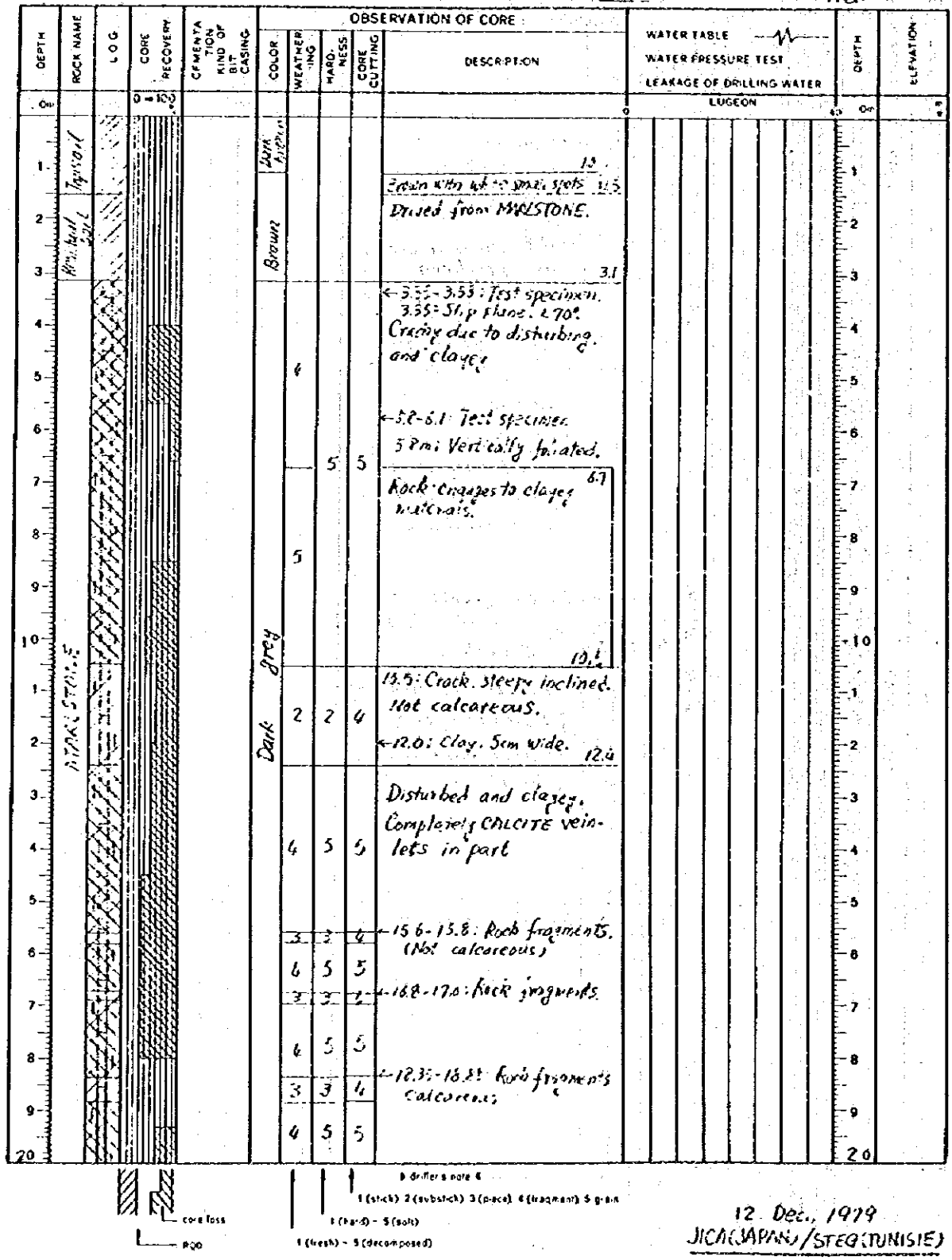
05, Dec, 1979
JICA (JAPAN) / STEG (TUNISIE)

ELECTRIC POWER DEVELOPMENT CO., LTD.

GEOLOGIC LOG OF DRILL HOLE

KASSEB PROJECT Damsite HOLE No SB 12 (SHEET 1 OF 2)

LOCATION	Right river side	DEPTH OF HOLE	30.6 m	COMMENCED	16 - Jul - '79
ELEVATION	m	DEPTH OF OVERBURDEN	3.1 m	COMPLETED	14 - Aug - '79
COORDINATE		LENGTH OF ROCK DRILLING	27.5 m	DRILLED BY	STEG/EGTH
ANGLE FROM HORIZONTAL	90°	TOTAL LENGTH OF CORE	m	LOGGED BY	[illegible] Diatome [illegible] Hellal
BEARING OF ANGLE HOLE		CORE RECOVERY	%		



12 Dec., 1979
JICA(JAPAN)/STEG(TUNISIE)
ELECTRIC POWER DEVELOPMENT CO., LTD.

GEOLOGIC LOG OF DRILL HOLE

KASSEB PROJECT Damsite HOLE No. SB 12 (SHEET 2 OF 2)

LOCATION	Right river side	DEPTH OF HOLE	30.6 m	COMMENCED	16 - Jul. - '79
ELEVATION	m	DEPTH OF OVERBURDEN	3.1 m	COMPLETED	14 - Aug - '79
COORDINATE	X / Y	LENGTH OF ROCK DRILLING	27.5 m	DRILLED BY	STEG/EGTH
ANGLE FROM HORIZONTAL	90°	TOTAL LENGTH OF CORE	m	LOGGED BY	H. Suetomi / H. Ueki
BEARING OF ANGLE HOLE		CORE RECOVERY	%		

DEPTH	ROCK NAME	LOG	CORE RECOVERY (0 → 100)	CEMENTATION, KIND OF BIT, CASING	COLOR	WEATHERING	HARDNESS	CORE CUTTING	DESCRIPTION	WATER TABLE / WATER PRESSURE TEST / LEAKAGE OF DRILLING WATER (LUGEON)	DEPTH	ELEVATION
20m – 20.5	MARLSTONE				Dark grey				Grey Calcareous. 20.5		20m	
20.5 – 21.5							5	5	21.5			
21.5 – 23.2						4	4	5	Core brittled and clayey. 23.2			
23.2 – 25.5							3 / 4	4	←23.2-23.4: Air-slaked. Shaly. Clayey but undisturbed rock. ←24.75-24.9: Clayey ←25.2: Slickensides. 25-25.3: Core into small pieces			
25.5 – 27.9						2	3	3 / 4 / 3	←27.5: Joint, fresh, ∠80° 27.9			
27.9 – 30.6	Shaly MARLSTONE					2	4	5	Shaly and air-slaked along foliation. Foliation; 0.5 to 2mm wide and dip of 80°. Clay 30.4 30.6		30 / 30.6	
30.6									Bottom of hole: 30.6m.			

Legend: core loss; RQD; 1 (fresh) ~ 5 (decomposed); 1 (hard) ~ 5 (soft); 1 (stick) 2 (substick) 3 (piece) 4 (fragment) 5 grain; driller's note

12, Dec., 1979
JICA (JAPAN) / STEG (TUNISIE)

ELECTRIC POWER DEVELOPMENT CO., LTD.

GEOLOGIC LOG OF DRILL HOLE

KASSEB PROJECT Damsite HOLE No. SB 2 bis (SHEET 1 OF 2)

LOCATION	Right bank	DEPTH OF HOLE	30.0 m	COMMENCED	19-Aug-'79
ELEVATION	m	DEPTH OF OVERBURDEN	2.9 m	COMPLETED	26-Sept-'79
COORDINATE	X 89,366.77 Y 78,461.86	LENGTH OF ROCK DRILLING	27.1 m	DRILLED BY	STEG/EGTH
ANGLE FROM HORIZONTAL	90°	TOTAL LENGTH OF CORE	m	LOGGED BY	[illegible]
BEARING OF ANGLE HOLE		CORE RECOVERY	%		[illegible]

DEPTH (m)	ROCK NAME	COLOR	WEATHERING	HARDNESS	CORE CUTTING	DESCRIPTION
0 – 1.70	Topsoil	Dark brown				With completely weathered small debris. Clayey, cohesive. 1.70
1.70 – 2.9	Residual soil	Brown				Derived from shaly MARLSTONE. 1.7-1.92: Test specimen at 2.90
2.9 – 4.3	MARLSTONE with bedding with shaly and sandy facies	Light grey	4	4	4	Sandy. Clayey in part. ←4.0: Clay, 10cm wide. 4.3
4.3 – 5.2		Dark grey	2	5	5	Shaly. Clayey in many plates.
5.2 – 5.4				4	4	←5.2-5.4: Sandy.
5.4 – 13.1				5	5	Generally fractured. ←6.5-6.7: Test specimen. ←8.17-8.32: Test specimen. ←10.25-10.66: Test specimen ←12.5-12.8: Air-slaking, core into grains. 20°. 13.1
13.1 – 14.4				2	3 / 4 / 3	←13.42-13.65: Test specimen. Sandy. Fractured.
14.4 – 15.5				3	4	
15.5 – 16.0				2	3	←15.65-15.85: Test specimen.
16.0 – 16.4				4	5	←16.0-16.4: Shaly
16.4 – 17.3				3	4	17.3
17.3 – 20				5	5	Disturbed. 20° at 17.76 17.4-17.62 Test specimen

OBSERVATION OF CORE — WATER TABLE; WATER PRESSURE TEST; LEAKAGE OF DRILLING WATER; LUGEON (0 – 40)

Legend: core loss; RQD; drillers note 4; 1 (stick) 2 (substick) 3 (piece) 4 (fragment) 5 grain; 1 (hard) – 5 (soft); 1 (fresh) – 5 (decomposed)

10, Dec., 1979
JICA (JAPAN) / STEG (TUNISIE)

ELECTRIC POWER DEVELOPMENT CO., LTD.

GEOLOGIC LOG OF DRILL HOLE

KASSEB PROJECT Damsite HOLE No. SB12 bis (SHEET 2 OF 2)

LOCATION Right bank
ELEVATION ____ m
COORDINATE X 87.245.77 Y 78.641.66
ANGLE FROM HORIZONTAL 90°
BEARING OF ANGLE HOLE ____

DEPTH OF HOLE 30.0 m
DEPTH OF OVERBURDEN 2.9 m
LENGTH OF ROCK DRILLING 27.1 m
TOTAL LENGTH OF CORE ____ m
CORE RECOVERY ____ %

COMMENCED 19-Aug-'79
COMPLETED 26-Sept-'79
DRILLED BY STEG/EGTH
LOGGED BY I. Suetomi, Helai

DEPTH	ROCK NAME	COLOR	WEATHERING	HARDNESS	CORE CUTTING	DESCRIPTION
20 m – 21	MARLSTONE	Grey		5	5	Disturbed zone.
				3	4	←20.85: Shear plane, ∠ 80°.
					5	←21.64-21.82: Test specimen.
24						←23.86-24.0: Test specimen.
25.2			2	2	3	25.2
				5	5	←25.8-26.2: Test specimen. 26.4
26.4 – 30.6		Dark grey to black		4	5	Shaly, air-slaked, with steep angled cracks.
					4	
					5	30.6
30						Bottom of hole: 30.00m Throughout core is calcareous.

CORE RECOVERY: 0 → 100 %
WATER TABLE; WATER PRESSURE TEST; LEAKAGE OF DRILLING WATER; LUGEON 0 – 40

Legend: core loss; RQD; 1 (fresh) - 5 (decomposed); 1 (hard) - 5 (soft); 1 (stick) 2 (substick) 3 (piece) 4 (fragment) 5 grain; driller's note 4

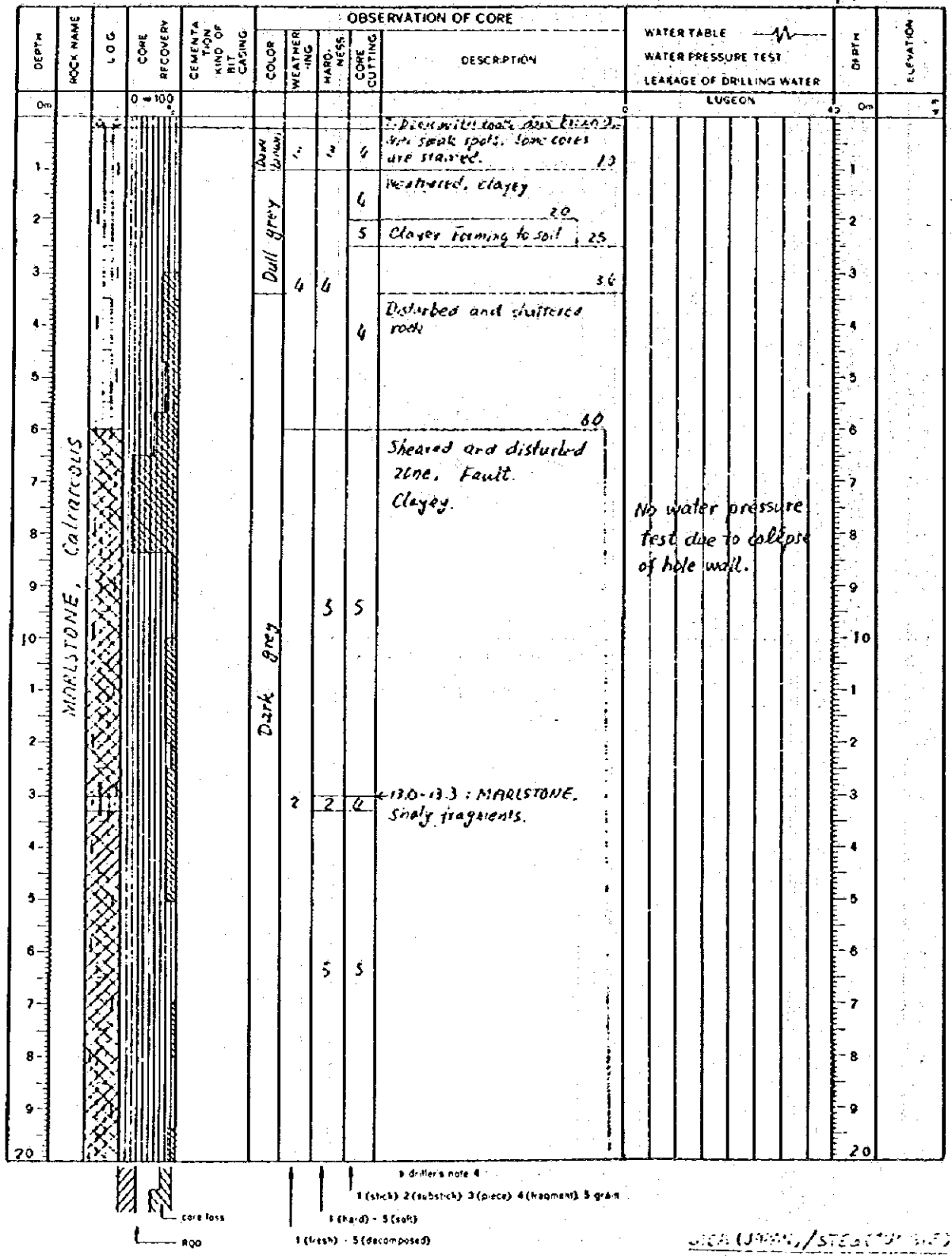
10, Dec., 1979
JICA(JAPAN)/STEG(TUNISIE)

ELECTRIC POWER DEVELOPMENT CO., LTD.

GEOLOGIC LOG OF DRILL HOLE

KASSEB PROJECT Reservoir area HOLE No. SB 13 (SHEET 1 OF 2)

LOCATION	Sarm saddle	DEPTH OF HOLE	35.1 m	COMMENCED	4-May-'19
ELEVATION	m	DEPTH OF OVERBURDEN	0.2 m	COMPLETED	30-May-'19
COORDINATE	X 85,519.08 Y 78,480.04	LENGTH OF ROCK DRILLING	34.9 m	DRILLED BY	STEG/EGTH
ANGLE FROM HORIZONTAL	90°	TOTAL LENGTH OF CORE	m	LOGGED BY	[illegible]
BEARING OF ANGLE HOLE		CORE RECOVERY	%		



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ELECTRIC POWER DEVELOPMENT CO., LTD.

GEOLOGIC LOG OF DRILL HOLE

KASSEB PROJECT: Reservoir area HOLE No. SB 13 (SHEET 2 OF 2)

LOCATION	South saddle	DEPTH OF HOLE	35.0 m	COMMENCED	4-May-'79
ELEVATION	m	DEPTH OF OVERBURDEN	0.2 m	COMPLETED	30-May-'79
COORDINATE	X 88,613.68 Y 78,480.04	LENGTH OF ROCK DRILLING	34.8 m	DRILLED BY	STEG/EGTH
ANGLE FROM HORIZONTAL	90°	TOTAL LENGTH OF CORE	m	LOGGED BY	H. Suetomi
BEARING OF ANGLE HOLE		CORE RECOVERY	%		H. Ikeda

Depth (m)	Rock name	Cementation / Kind of bit / Casing	Color	Weathering	Hardness	Core cutting	Description	Water pressure test / Lugeon
20–21.5	MARLSTONE, Calcareous	21.0	Pale grey	2	5	5	Fault zone. 21.5	No water pressure test due to collapse of hole wall.
21.5–22.3					5	4	←22.6-22.9: Test specimen. Very steeply foliated with slickensides. 22.3	
22.3–23.7					3	3		
					4	4	←23.7-24.0: Cracked & clayey.	24.0
–25.7					3	4	←24.65-24.9 Steepy cracks. 25.7	
25.7–27.0					4	5	Friable rock. foliated. ←26.65-26.8: Test specimen. 27.0	
27.0–29.0					4	5 / 4 / 3 / 4 / 4	27.10-27.4: Clayey but not disturbed. bedding and contact dips 45°. ←28.72-28.92: Test specimen. 29.0	
29.0–32.0					3 / 5 / 4 / 5	3 / 5 / 4 / 3 / 5	Most of core in pieces. irregular shaped. Clayey. Clayey.	
32.0–35.0					3	3 / 4 / 5 / 4	←32.1-32.26: Test specimen. ←32.5-32.8 " " ←32.9: Clayey. 10cm wide. Cracky rock. ←34.2 Slickensides. ←Not clayey 35.0	
35.0							Bottom of hole. 35.00m	

Legend: core loss; RQD; 1 (fresh) - 5 (decomposed); 1 (hard) - 5 (soft); 1 (stick) 2 (substick) 3 (piece) 4 (fragment) 5 grain; driller's note

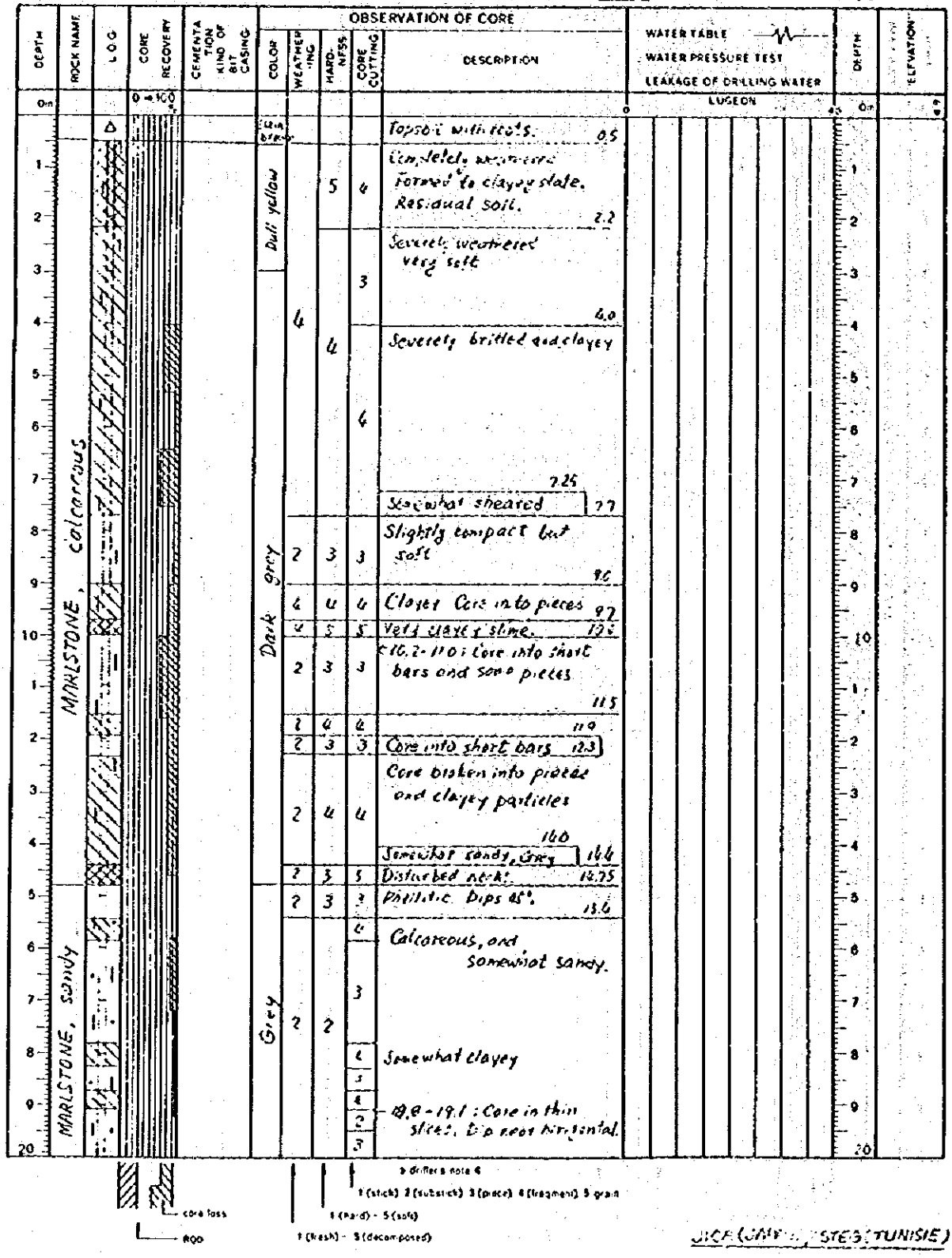
JICA (JAPAN) / STEG (TUNISIE)

ELECTRIC POWER DEVELOPMENT CO., LTD.

GEOLOGIC LOG OF DRILL HOLE

KASSEB PROJECT Reservoir area HOLE No. SB 14 (SHEET 1 OF 2)

LOCATION	North saddle	DEPTH OF HOLE	35.0 m	COMMENCED	09 - Jul. - '79
ELEVATION	m	DEPTH OF OVERBURDEN	2.2 m	COMPLETED	08 - Jul. - '79
COORDINATE	X 87,692.10 Y 77,872.81	LENGTH OF ROCK DRILLING	32.8 m	DRILLED BY	STEG/EGTH
ANGLE FROM HORIZONTAL	90°	TOTAL LENGTH OF CORE	m	LOGGED BY	[illegible]
BEARING OF ANGLE HOLE		CORE RECOVERY	%		



JICA (JAPAN) - STEG (TUNISIE)

ELECTRIC POWER DEVELOPMENT CO., LTD.

GEOLOGIC LOG OF DRILL HOLE

KASSEB PROJECT Reservoir area HOLE No. SB 14 (SHEET 2 OF 2)

LOCATION	North saddle	DEPTH OF HOLE	35.0 m	COMMENCED	03 - Jun. - '77
ELEVATION	m	DEPTH OF OVERBURDEN	2.2 m	COMPLETED	08 Jul. - '77
COORDINATE	X 87,692.10 Y 27,922.81	LENGTH OF ROCK DRILLING	32.8 m	DRILLED BY	STEG / EQTH
ANGLE FROM HORIZONTAL	90°	TOTAL LENGTH OF CORE	m	LOGGED BY	H. Gustomo H. Fisch
BEARING OF ANGLE HOLE		CORE RECOVERY	%		

DEPTH	ROCK NAME	LOG	CORE RECOVERY	CEMENTATION, KIND OF BIT, CASING	OBSERVATION OF CORE: COLOR	WEATHERING	HARDNESS	CORE CUTTING	DESCRIPTION
20m			0 → 100 %						
1	MARLSTONE, sandy				Light grey	2	2	2	Sandy and compact.
2									Somewhat phillitic, but very compact. 21.70 - 21.95: Slightly stained. 21.95
3								2	Sandy, massive, hard and compact.
4								4	
5								2	23.5: Crushed 1cm wide, dips 45°. 27.8
6						1	1	3	Silty MARLSTONE. Somewhat softer than Sandy facies 25.0
7								1	Sandy massive, and very hard. Good rock.
8									← 27.05 - 27.1. Shaly, dark grey somewhat soft. 27.7
9						3	3	3	Core broken and clayey 28.1
30						1	2	2	Sandy, hard and compact massive. 28.8 and 28.9: Bedding dips 60° and 70°.
1								4	← 29.9 - 30.6: Core in fragments 31.5
2						4	5	3	Disturbed rock, clayey Core recovery is very poor 31.85
3							2	2	Sandy, compact. ← 32.5 - Clayey band 5cm wide. ← 32.7 - 33.1: Steep crack not stained. 33.3
4	MARLSTONE calcareous					2	4	4	Foliated. Core parts into small grains due to air-slaking, at dip of 45°. But compact in natural. 35.0
5							5	5	Bottom of hole : 35.00m
6									
7									
8									
9									
0									

WATER TABLE
WATER PRESSURE TEST
LEAKAGE OF DRILLING WATER
LUGEON

DEPTH	ELEVATION
20m	
1	
2	
3	
4	
5	
6	
7	
8	
9	
30	
1	
2	
3	
4	
35	
6	
7	
8	
9	
0	

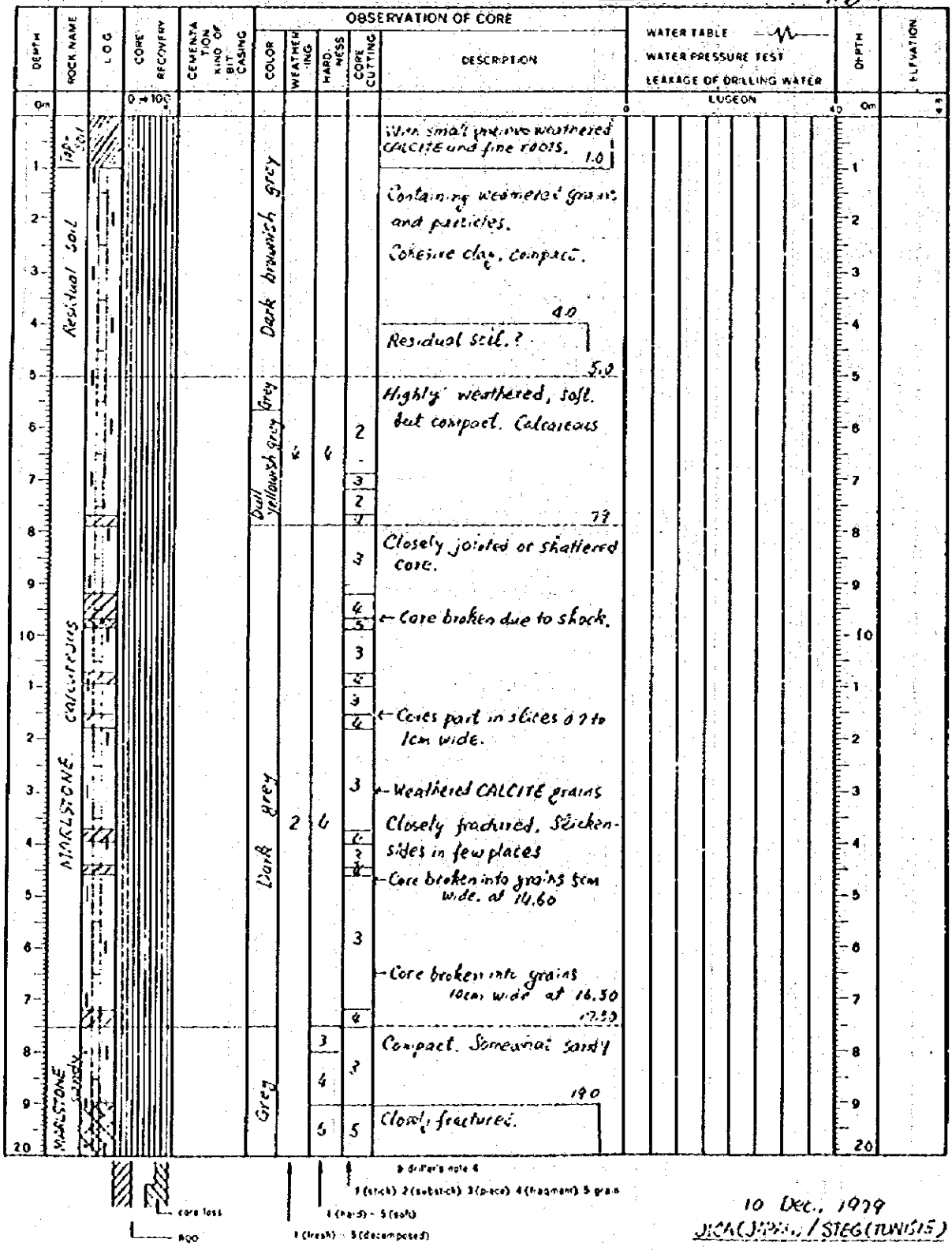
core loss
RQD
▶ drillers note 4
1 (slick) 2 (substick) 3 (piece) 4 (fragment) 5 grain
1 (hard) ~ 5 (soft)
1 (fresh) ~ 5 (decomposed)

H. Gustomo / STEG (TURKISE)
ELECTRIC POWER DEVELOPMENT CO., LTD.

GEOLOGIC LOG OF DRILL HOLE

KASSEB PROJECT Upper reservoir area HOLE No. S1 2 (SHEET 1 OF 8)

LOCATION	Intake site	DEPTH OF HOLE	150.0 m	COMMENCED	13 - Jul - '79
ELEVATION	m	DEPTH OF OVERBURDEN	5.0 m	COMPLETED	16 - Dec - '79
COORDINATE	X 85,967.01 Y 78,495.38	LENGTH OF ROCK DRILLING	145.0 m	DRILLED BY	STEG/EGTI
ANGLE FROM HORIZONTAL	90°	TOTAL LENGTH OF CORE	m	LOGGED BY	[illegible]
BEARING OF ANGLE HOLE		CORE RECOVERY	%		



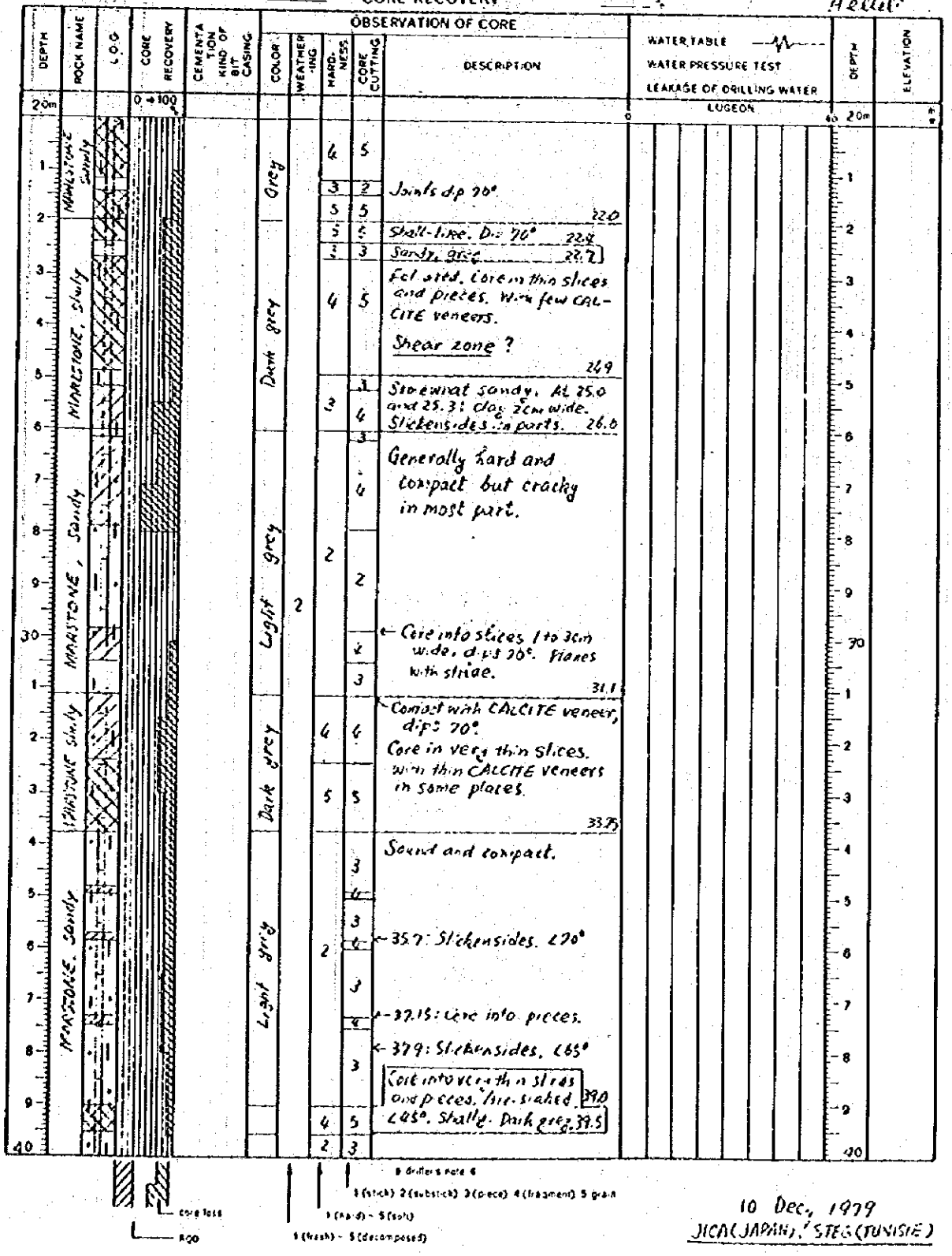
10 Dec., 1979
JICA(JAPAN) / STEG(TUNISIE)

ELECTRIC POWER DEVELOPMENT CO., LTD.

GEOLOGIC LOG OF DRILL HOLE

KASSEB PROJECT Upper reservoir area HOLE No. SI 2 (SHEET 2 OF 8)

LOCATION	Intake site	DEPTH OF HOLE	150.0 m	COMMENCED	13 - Jul - '79
ELEVATION	m	DEPTH OF OVERBURDEN	5.0 m	COMPLETED	14 - Dec - '79
COORDINATE		LENGTH OF ROCK DRILLING	145.0 m	DRILLED BY	STEG/EGTH
ANGLE FROM HORIZONTAL	90°	TOTAL LENGTH OF CORE	m	LOGGED BY	[illegible] Hellel
BEARING OF ANGLE HOLE		CORE RECOVERY	%		



10 Dec, 1979
JICA (JAPAN), STEG (TUNISIE)

ELECTRIC POWER DEVELOPMENT CO., LTD.

GEOLOGIC LOG OF DRILL HOLE

KASSEB PROJECT Upper reservoir area HOLE No. St-2 (SHEET 3 OF 9)

LOCATION Intake site
ELEVATION ____ m
COORDINATE ____
ANGLE FROM HORIZONTAL 90°
BEARING OF ANGLE HOLE ____

DEPTH OF HOLE 150.0 m
DEPTH OF OVERBURDEN 5.0 m
LENGTH OF ROCK DRILLING 165.0 m
TOTAL LENGTH OF CORE ____ m
CORE RECOVERY ____ %

COMMENCED ____
COMPLETED ____
DRILLED BY STEG/EGTH
LOGGED BY H. Suetomi, H. Leibi

DEPTH	ROCK NAME	COLOR	WEATHERING	HARDNESS	CORE CUTTING	DESCRIPTION
40–45	MARLSTONE, sandy	Light grey		3	4	With CALCITE veinlets. 40.25: Clay films.
				2		← CALCITE veinlet, ∠65°
						← CALCITE veinlet, ∠60°
					2	← 41.9: Joint: ∠70°
						← 42.5: Joint: ∠78°
					4	
					3	43.2
					5	Shaly, with slickensides 43.7
					4	44.0
					5	Shaly, slickensides 44.5
					3	Contact, ∠45° 44.9
45–60	MARLSTONE, Sandy	Dark grey	2	5	5	With many slickensides, core into very thin chips and fragments.
					3	Severely disturbed zone
						Air-slaking.
					5	← 49.3: CALCITE veinlets 0.5 and 0.2 cm wide, ∠80°
						52.95
						Sandy. Air-slaked.
				3	4	← 54.2 & 52.3: CALCITE veins 1.5 and 1 cm wide, ∠80°.
				2	3	54.9
				4	4	With many slickensides. Disturbed zone
					5	
					4	
				4	3	
				5	5	

WATER TABLE / WATER PRESSURE TEST / LEAKAGE OF DRILLING WATER — LUGEON 0–40

CORE RECOVERY 0 → 100 %; core loss; 100

Weathering: 1 (fresh) – 5 (decomposed); Hardness: 1 (hard) – 5 (soft); Core cutting: 1 (stick) 2 (substick) 3 (piece) 4 (fragment) 5 grain; 6 drillers note 4

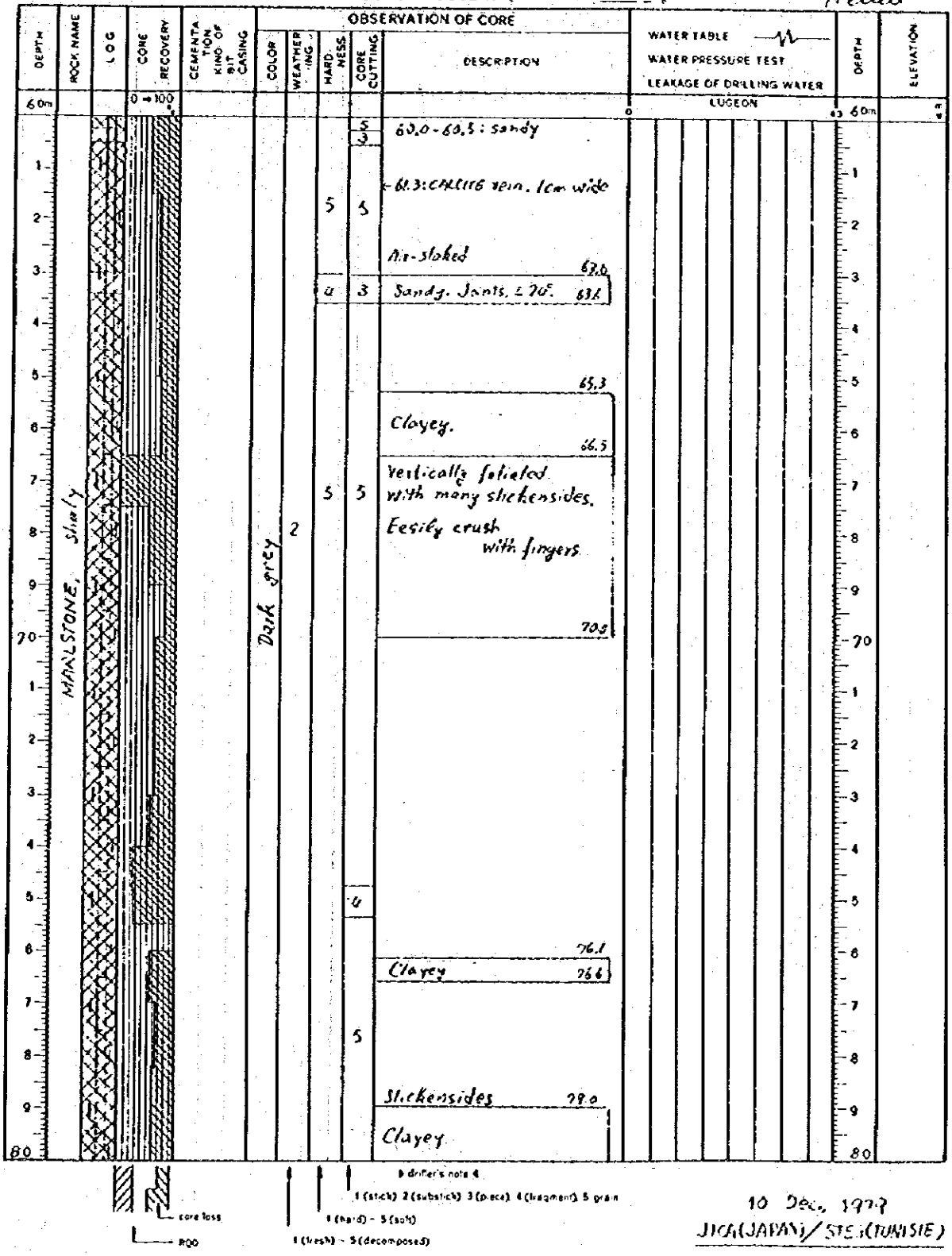
10 Dec. 1979
JICA, JAPAN / STEG (TUNISIE)

ELECTRIC POWER DEVELOPMENT CO., LTD.

GEOLOGIC LOG OF DRILL HOLE

KASSEB PROJECT Upper reservoir area HOLE No. S1 2 (SHEET 4 OF 9)

LOCATION	Intake site	DEPTH OF HOLE	150.9 m	COMMENCED	– –
ELEVATION	m	DEPTH OF OVERBURDEN	5.0 m	COMPLETED	– –
COORDINATE		LENGTH OF ROCK DRILLING	145.0 m	DRILLED BY	STEG/EGTH
ANGLE FROM HORIZONTAL	90°	TOTAL LENGTH OF CORE	m	LOGGED BY	Hamrouni Hellali
BEARING OF ANGLE HOLE		CORE RECOVERY	%		



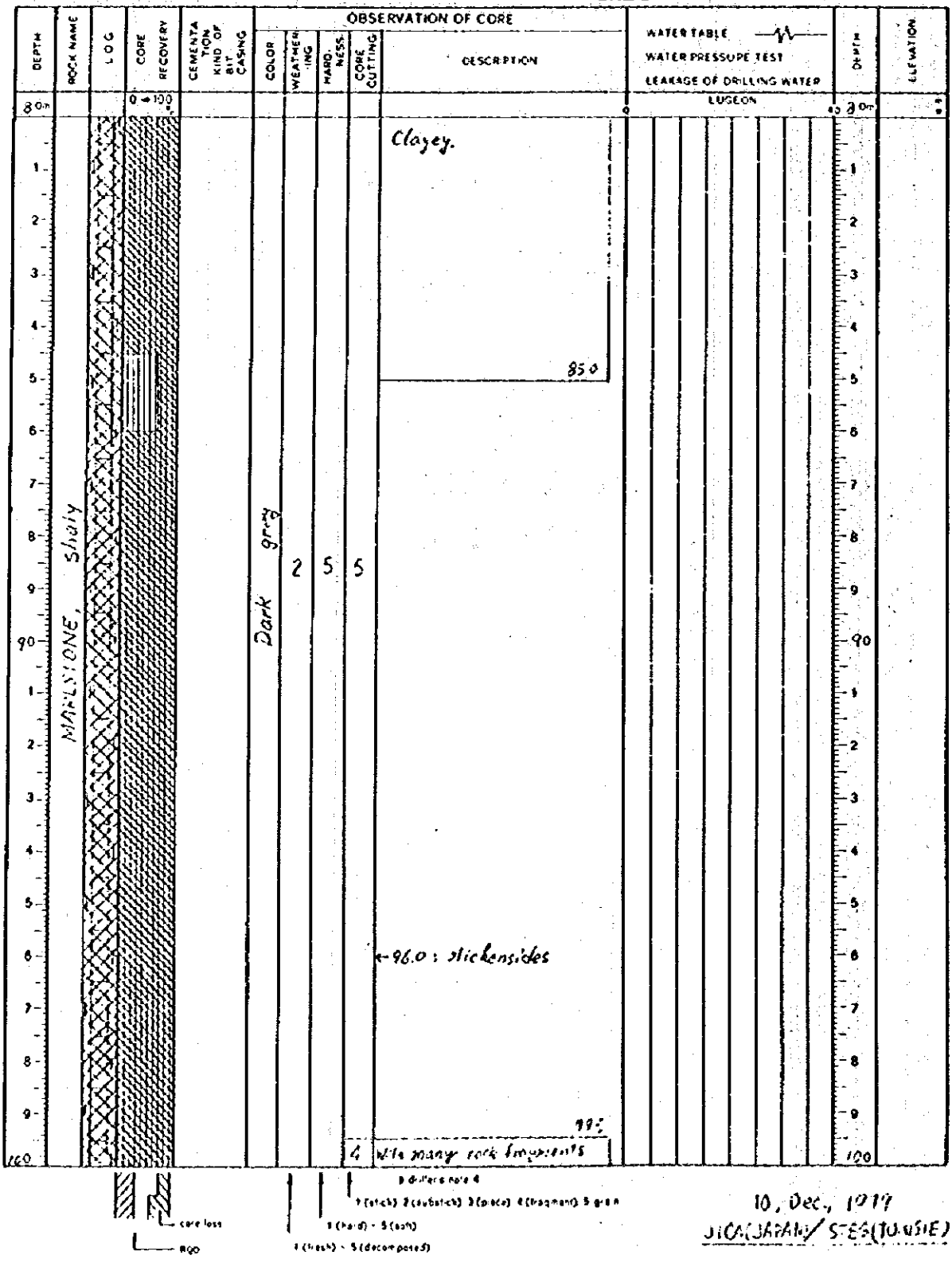
10 Dec. 1977
JICA(JAPAN)/STEG(TUNISIE)

ELECTRIC POWER DEVELOPMENT CO., LTD.

GEOLOGIC LOG OF DRILL HOLE

KASSEB PROJECT Upper reservoir area HOLE No. S: 2 (SHEET 5 OF 8)

LOCATION	Intake site	DEPTH OF HOLE	150.0 m	COMMENCED	- -
ELEVATION	m	DEPTH OF OVERBURDEN	5.0 m	COMPLETED	- -
COORDINATE		LENGTH OF ROCK DRILLING	145.0 m	DRILLED BY	STEG/EGTH
ANGLE FROM HORIZONTAL	90°	TOTAL LENGTH OF CORE	m	LOGGED BY	Inductomi
BEARING OF ANGLE HOLE		CORE RECOVERY	%		Malek

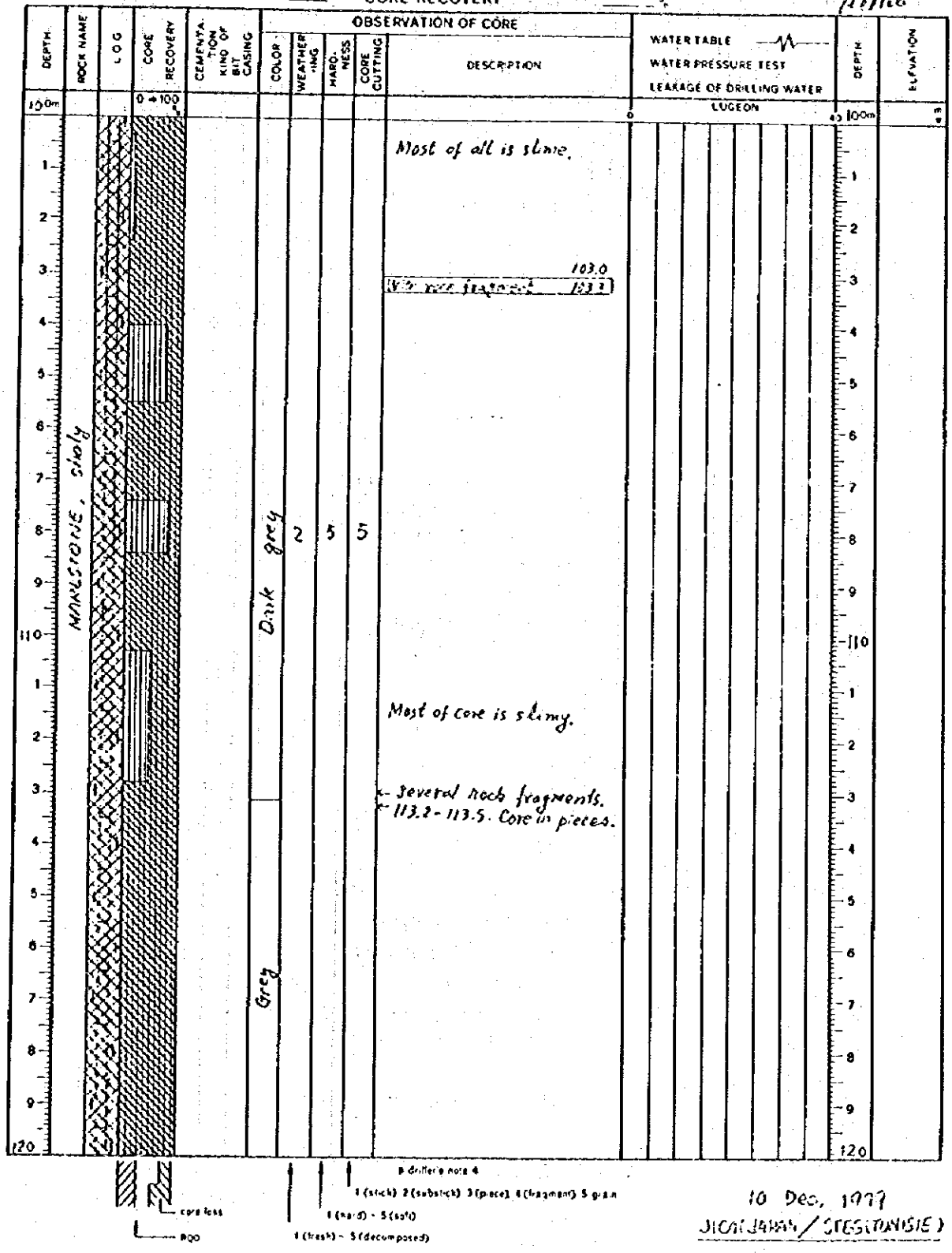


ELECTRIC POWER DEVELOPMENT CO., LTD.

GEOLOGIC LOG OF DRILL HOLE

KAISEB PROJECT Upper reservoir area HOLE No. S1 2 (SHEET 6 OF 8)

LOCATION	intake site	DEPTH OF HOLE	150.0 m	COMMENCED	- -
ELEVATION	m	DEPTH OF OVERBURDEN	5.1 m	COMPLETED	- -
COORDINATE		LENGTH OF ROCK DRILLING	145.0 m	DRILLED BY	STEG/EGTH
ANGLE FROM HORIZONTAL	73°	TOTAL LENGTH OF CORE	m	LOGGED BY	H. Watanabe / Hollab
BEARING OF ANGLE HOLE		CORE RECOVERY	%		



10 Dec. 1977
JICA/JAPAN / STEG/TUNISIE

ELECTRIC POWER DEVELOPMENT CO., LTD.

GEOLOGIC LOG OF DRILL HOLE

KASSEB PROJECT Upper reservoir area HOLE No. S: (SHEET 7 of 8)

LOCATION	Intake site	DEPTH OF HOLE	150.0 m	COMMENCED	
ELEVATION	m	DEPTH OF OVERBURDEN	5.0 m	COMPLETED	
COORDINATE		LENGTH OF ROCK DRILLING	145.0 m	DRILLED BY	STEG/EGTH
ANGLE FROM HORIZONTAL	90°	TOTAL LENGTH OF CORE	m	LOGGED BY	[illegible]
BEARING OF ANGLE HOLE		CORE RECOVERY	%		

DEPTH	ROCK NAME	LOG	CORE RECOVERY (0 → 100)	CEMENTATION, KIND OF BIT, CASING	COLOR	WEATHERING	HARDNESS	CORE CUTTING	DESCRIPTION	WATER TABLE / WATER PRESSURE TEST / LEAKAGE OF DRILLING WATER (LUGEON 0–40)	DEPTH	ELEVATION
120 m – 127.2	MARLSTONE, shaly				Grey	5	5	5; 4 (121.5–121.7); 5	121.5–121.7 platy core, ∠ 85°		120 m	
127.2 – 133.5					Dark grey	2	5	5-4	Core into thin plates and grains along steep cracks. Slickensides in various places. Core recovery very poor.			
133.5 – 135.0					Grey				Sandy fine grained shale.			
135.0 – 140					Dark grey	2	3	5-4	Core recovery is very poor. Core broken into small chips and fragments. Some cores are separated by foliation dipped 70° to 80°. ~138.9 Calcite veinlets		140	

Legend: core loss; RQD; 5 driller's note 4; 1 (stick) 2 (substick) 3 (piece) 4 (fragment) 5 grain; 1 (hard) – 5 (soft); 1 (fresh) – 5 (decomposed)

10 and 11 Dec., 1977
JICA, JAPAN / STEG (TUNISIE)

ELECTRIC POWER DEVELOPMENT CO., LTD.

GEOLOGIC LOG OF DRILL HOLE

KASSEB PROJECT Upper reservoir area HOLE No. S1 2 (SHEET 8 OF 8)

LOCATION	Intake site	DEPTH OF HOLE	150.0m	COMMENCED	- - -
ELEVATION	m	DEPTH OF OVERBURDEN	5.0 m	COMPLETED	- - -
COORDINATE		LENGTH OF ROCK DRILLING	145.0m	DRILLED BY	STEG/EGTH
ANGLE FROM HORIZONTAL	90°	TOTAL LENGTH OF CORE	m	LOGGED BY	[illegible] Suetomi
BEARING OF ANGLE HOLE		CORE RECOVERY	%		Helic

DEPTH	ROCK NAME	LOG	CORE RECOVERY	CEMENTATION KIND OF BIT CASING	OBSERVATION OF CORE: COLOR	WEATHERING	HARDNESS	CORE CUTTING	DESCRIPTION	WATER TABLE / WATER PRESSURE TEST / LEAKAGE OF DRILLING WATER: LUGEON	DEPTH	ELEVATION
14.0m			0 → 100 %							0	40.0m	
1–3	MARLSTONE				Dark grey	2	3	3-4	Core recovery is very poor. Core broken into small chips and fragments. Some cores are separated by foliation dipped 70° to 80°.			
6									116.0			
6–9	MARLS ONE, PARTLY MARLSTONE				Grey	5	5	5	Sandy slime.			
9									149.0			
9–150	MARLSTONE				Dark grey	2	3	4	Core recovery is very poor. Joint dips 45°.			
150									150.0 Bottom of hole, 150.0m			

core loss

RQD

▶ driller's note 4

1 (stick) 2 (substick) 3 (piece) 4 (fragment) 5 grain

1 (hard) - 5 (soft)

1 (fresh) - 5 (decomposed)

11, Dec., 1979

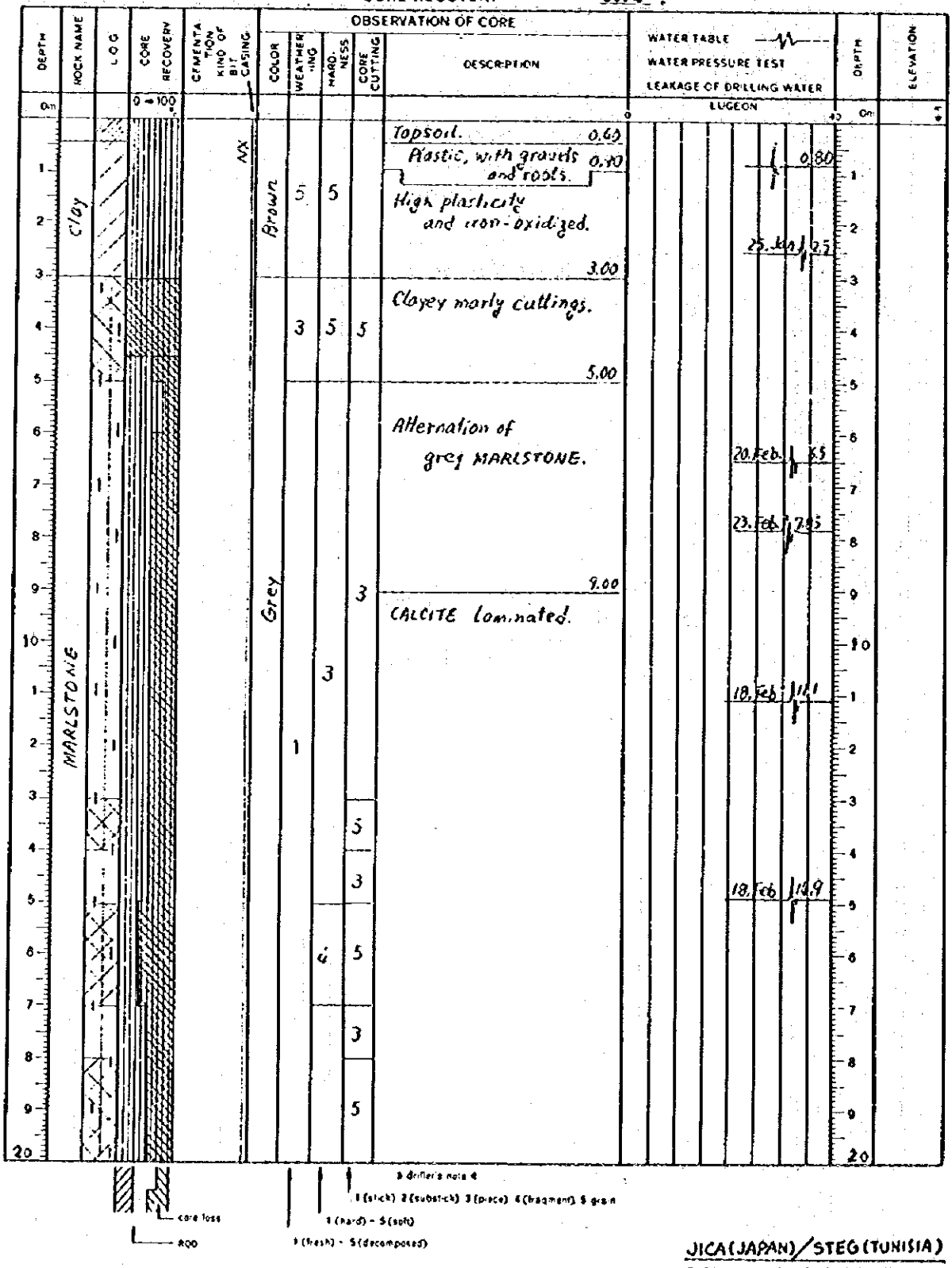
JICA(JAPAN) / STEG(TUNISIE)

ELECTRIC POWER DEVELOPMENT CO., LTD.

GEOLOGIC LOG OF DRILL HOLE

KASSEB PROJECT Outlet site HOLE No. SU 11 (SHEET 1 OF 4)

LOCATION		DEPTH OF HOLE 70.0 m	COMMENCED
ELEVATION m		DEPTH OF OVERBURDEN 3.0 m	COMPLETED 23-Feb.-'80
COORDINATE X: 79.632 Y: 85.689 (planned)		LENGTH OF ROCK DRILLING 67.0 m	DRILLED BY STEG/EGTH
ANGLE FROM HORIZONTAL 90°		TOTAL LENGTH OF CORE 33.8 m	LOGGED BY HELLALI
BEARING OF ANGLE HOLE		CORE RECOVERY 50.4 %	

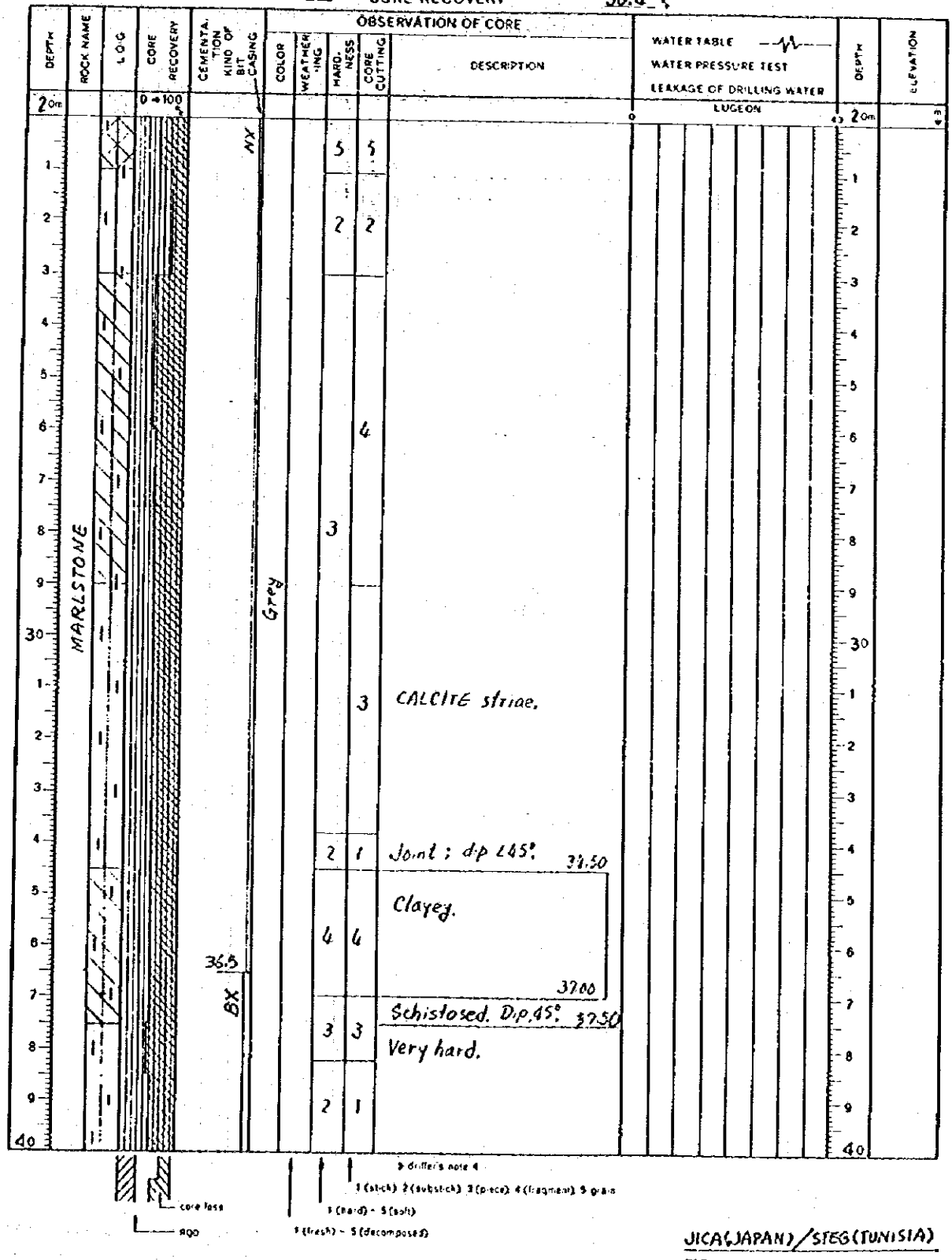


JICA (JAPAN) / STEG (TUNISIA)
ELECTRIC POWER DEVELOPMENT CO., LTD.
TOKYO JAPAN

GEOLOGIC LOG OF DRILL HOLE

KASSEB PROJECT Outlet site HOLE No. SU 11 (SHEET 2 OF 4)

LOCATION		DEPTH OF HOLE	70.0 m	COMMENCED	
ELEVATION	m	DEPTH OF OVERBURDEN	3.0 m	COMPLETED	23 - Feb - '80
COORDINATE		LENGTH OF ROCK DRILLING	67.0 m	DRILLED BY	STEG / EGTH
ANGLE FROM HORIZONTAL	90°	TOTAL LENGTH OF CORE	33.8 m	LOGGED BY	HELLALI
BEARING OF ANGLE HOLE		CORE RECOVERY	50.4 %		

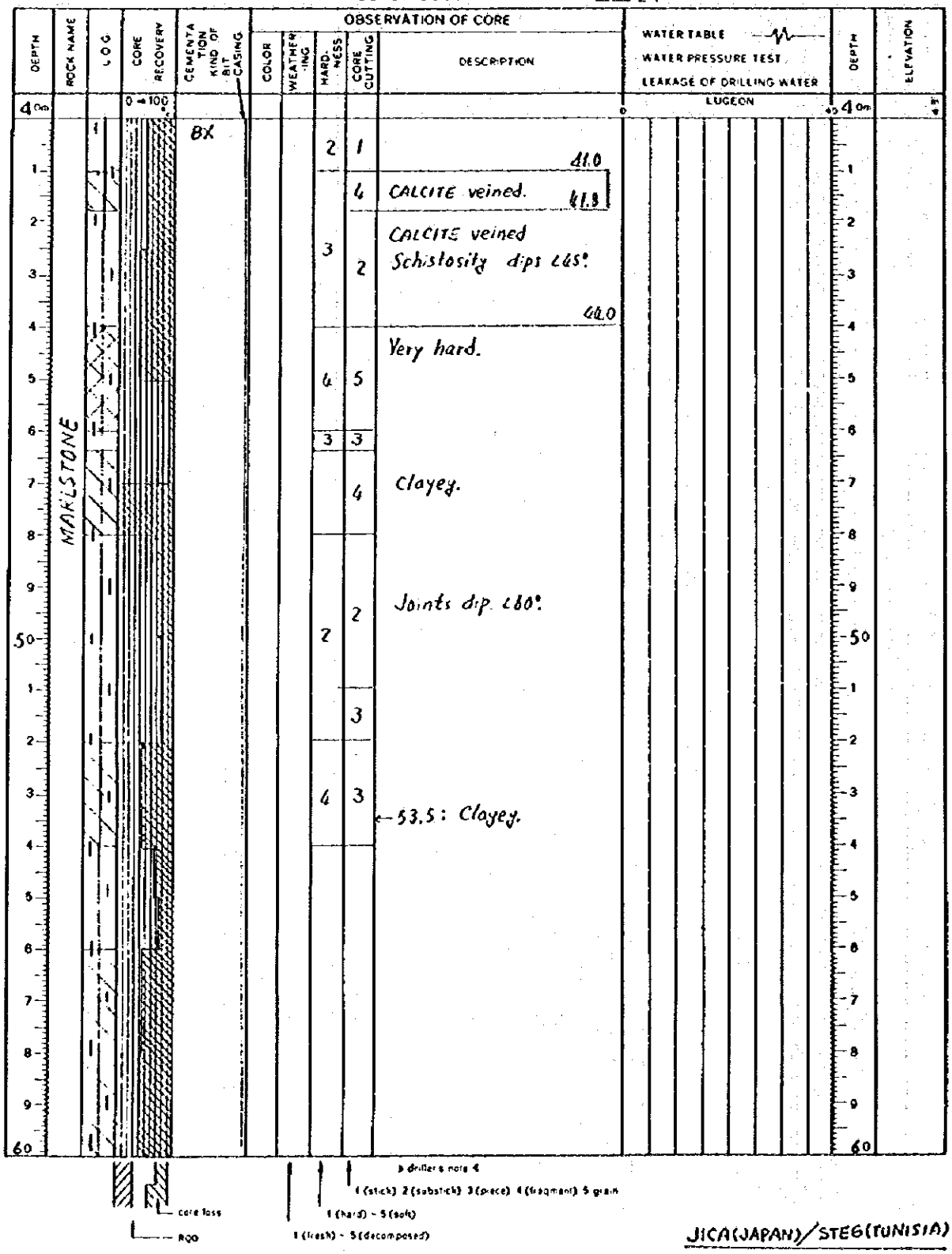


JICA (JAPAN) / STEG (TUNISIA)
ELECTRIC POWER DEVELOPMENT CO., LTD.
TOKYO, JAPAN

GEOLOGIC LOG OF DRILL HOLE

KASSEB PROJECT Outlet site HOLE No. SU11 (SHEET 3 OF 4)

LOCATION		DEPTH OF HOLE	70.0 m	COMMENCED	- -
ELEVATION	m	DEPTH OF OVERBURDEN	3.0 m	COMPLETED	- -
COORDINATE		LENGTH OF ROCK DRILLING	67.0 m	DRILLED BY	STEG/EGTH
ANGLE FROM HO. IZONTAL	90°	TOTAL LENGTH OF CORE	33.8 m	LOGGED BY	HELLALI
BEARING OF ANGLE HOLE		CORE RECOVERY	50.4 %		



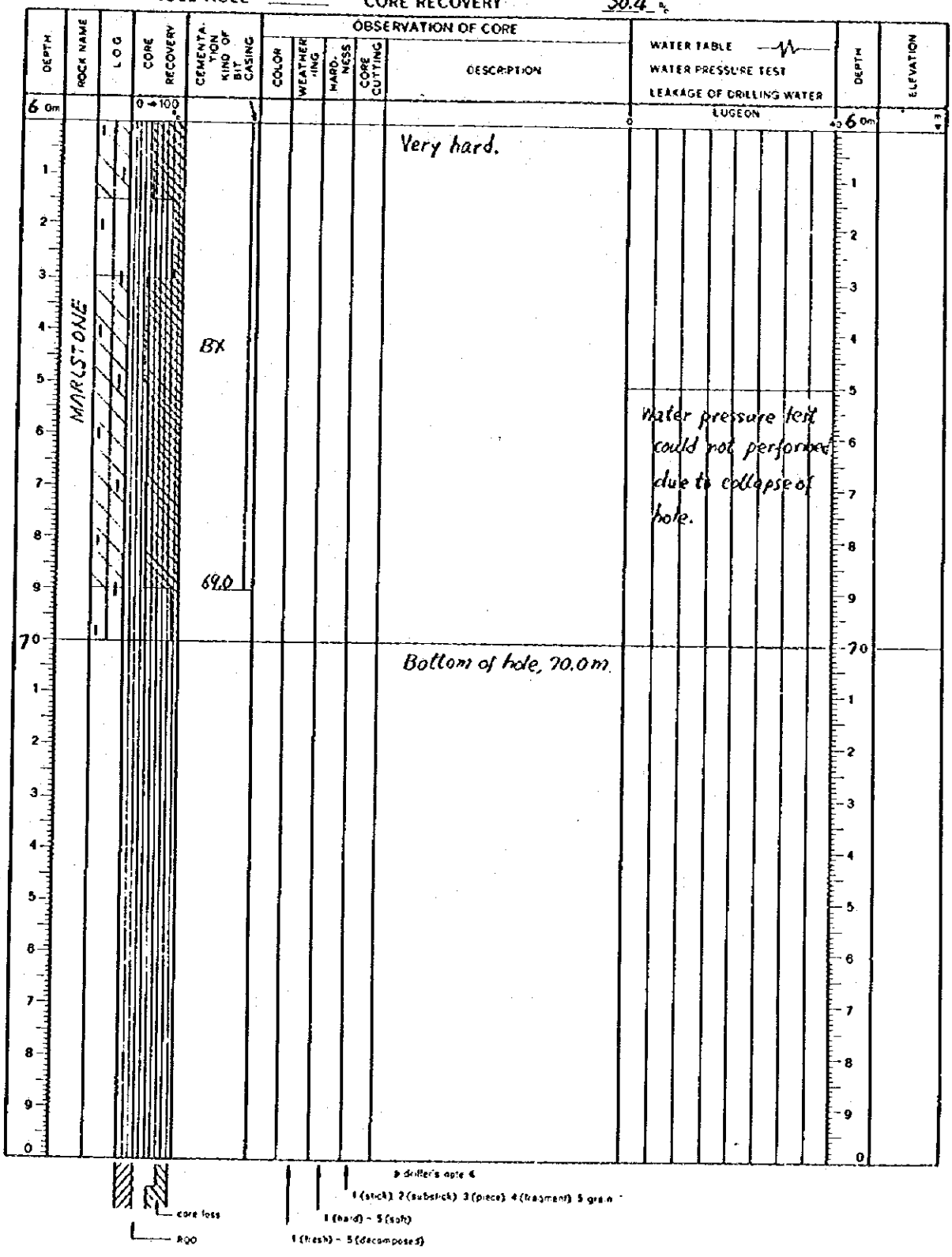
JICA(JAPAN)/STEG(TUNISIA)

ELECTRIC POWER DEVELOPMENT CO., LTD.
TOKYO JAPAN

GEOLOGIC LOG OF DRILL HOLE

KASSEB PROJECT Outlet site HOLE No. SU 11 (SHEET 4 OF 4)

LOCATION		DEPTH OF HOLE	70.0 m	COMMENCED	- - -
ELEVATION	m	DEPTH OF OVERBURDEN	3.0 m	COMPLETED	23-Feb.-'80
COORDINATE		LENGTH OF ROCK DRILLING	62.0 m	DRILLED BY	STEG/EGTH
ANGLE FROM HOLIZONTAL	90°	TOTAL LENGTH OF CORE	33.8 m	LOGGED BY	HELLALI
BEARING OF ANGLE HOLE		CORE RECOVERY	50.4 %		



ELECTRIC POWER DEVELOPMENT CO., LTD.
TOKYO, JAPAN

APPENDIX 2

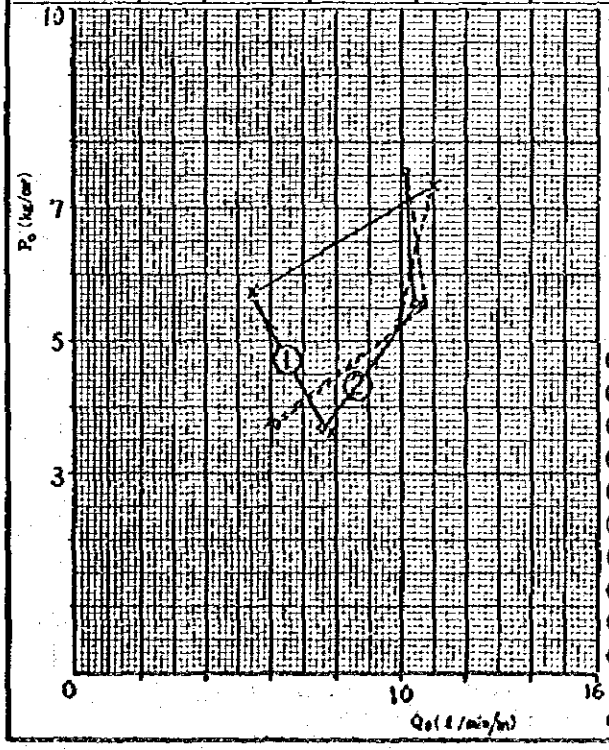
CONTENTS

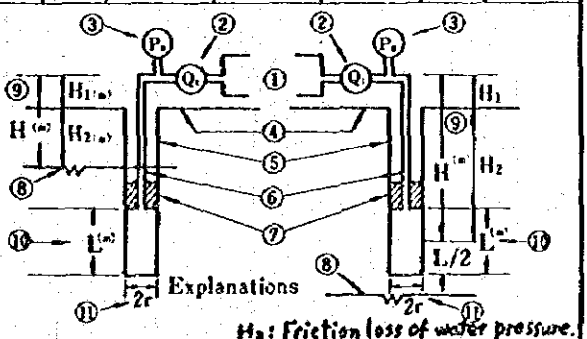
PERMEABILITY TEST IN DRILL HOLE (SHEET 1 OF 4)

KASSEB PROJECT Dansite HOLE No. SB 10

LOCATION		DEPTH OF HOLE 50.0 m	TEST DATE
ELEVATION m		DIAMETER OF HOLE NX cm	TESTED BY
COORDINATE X 87,247.38 Y 78,660.03		DRILLED DEPTH m	DRILLED BY
ANGLE FROM HORIZONTAL 45°		LEVEL OF WATER TABLE	CHECKED BY
BEARING OF ANGLE HOLE N		BEFORE.T. ① 8.4 ② 8.4 m AFTER.T. ① 9.6 ② 9.5 m	

Test section (m) From	To	L (m)	H_1 (m)	H_2 (m)	P_o (kg/cm²)	P (kg/cm²)	t (min)	Q_t (ℓ)	Q_o (ℓ/min/m)	L_u (Lugeon)	H_3 (m)	Remarks
① 10.0	15.0	5.0	0.3	8.50	3	3.70	10	380	7.6	20.5	1.85	
		〃	〃	〃	5	5.53	〃	520	10.4	18.8	3.46	
		〃	〃	〃	7	7.55	〃	505	10.1	13.4	3.25	
		〃	〃	〃	5	5.51	〃	535	10.7	19.4	3.45	
		〃	〃	〃	3	3.76	〃	310	6.2	16.5	1.23	
③ 15.0	20.0	5.0	0.3	8.50	3	3.61	10	390	7.8	21.6	2.71	
		〃	〃	〃	5	5.75	〃	270	5.4	9.4	1.33	
		〃	〃	〃	7	7.34	〃	550	11.0	15.0	5.38	
		〃	〃	〃	5	5.44	〃	500	10.0	13.4	4.[illegible]	
		〃	〃	〃	3	3.72	〃	300	6.0	15.1	1.63	





H_3: Friction loss of water pressure.

① : Pump
② : Flow meter
③ : Pressure gauge
④ : Ground surface
⑤ : Drill hole
⑥ : Injection pipe
⑦ : Packer
⑧ : Water table
⑨ : Hydrostatic head
⑩ : Length of test section
⑪ : Diamater of hole

P_o : Gauge pressure
H_1 : Height of Pressure gauge
H_2 : Depth of Ground water
P : Effective pressure
$P = P_o + H^{(m)}/10$, $H = H_1 + H_2 - H_3$
t : Injected time
Q_t : Water volume during time in "t"
Q_o : Water volume per one min.
: Lugeon value in ℓ/min/m/10 kg/cm²
L_u : Coefficient of permeability
K

ELECTRIC POWER DEVELOPMENT CO LTD TOKYO JAPAN

PERMEABILITY TEST IN DRILL HOLE (SHEET 2 OF 4)

KASSEB PROJECT Upper reservoir domain HOLE No. SB 10

LOCATION _____ DEPTH OF HOLE 56.0 m TEST DATE _____

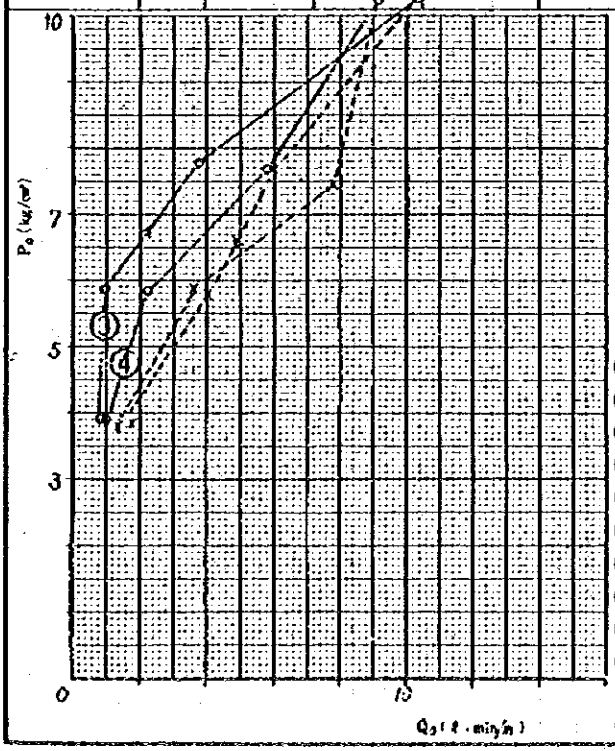
ELEVATION _____ m DIAMETER OF HOLE NX cm TESTED BY _____

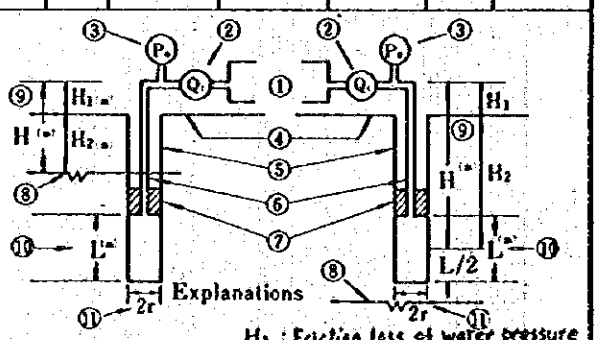
COORDINATE _____ DRILLED DEPTH _____ m DRILLED BY _____

ANGLE FROM HORIZONTAL _____ ° LEVEL OF WATER TABLE CHECKED BY _____

BEARING OF ANGLE HOLE _____ BEFORE T. 8.2 m AFTER T. 8.5 m

Test section (m) From	To	L (m)	H_1 (m)	H_2 (m)	P_o (kg/cm²)	P (kg/cm²)	t (min)	Q_t (ℓ)	Q_o (ℓ/min/m)	L_u (Lugeon)	H_3 (m)	Remarks
③ 20.0	25.3	5.3	0.3	8.60	3	3.89	10	40	0.8	2.06	0.04	
		〃	〃	〃	5	5.98	〃	50	1.0	1.70	0.05	
		〃	〃	〃	7	7.81	〃	190	3.8	4.87	0.82	
		〃	〃	〃	10	10.27	〃	520	10.4	10.13	8.17	
		〃	〃	〃	7	7.69	〃	300	6.0	7.80	2.05	
		〃	〃	〃	5	5.80	〃	205	4.0	6.90	0.91	
		〃	〃	〃	3	3.78	〃	70	1.4	3.70	1.12	
④ 25.3	33.0	5.9	0.3	8.60	3	3.88	10	50	1.0	2.58	0.07	
		〃	〃	〃	5	5.86	〃	110	2.2	3.75	0.34	
		〃	〃	〃	7	7.66	〃	290	5.8	7.57	2.34	
		〃	〃	〃	10	10.30	〃	460	9.2	8.93	5.88	
		〃	〃	〃	7	7.47	〃	390	7.8	10.44	4.23	
		〃	〃	〃	5	5.8	〃	180	3.6	6.21	0.90	
		〃	〃	〃	3	3.85	〃	90	1.8	4.66	2.26	





① : Pump
② : Flow meter
③ : Pressure gauge
④ : Ground surface
⑤ : Drill hole
⑥ : Injection pipe
⑦ : Packer
⑧ : Water table
⑨ : Hydrostatic head
⑩ : Length of test section
⑪ : Diamater of hole

H_3 : Friction loss of water pressure
P_o : Gauge pressure
H_1 : Height of Pressure gauge
H_2 : Depth of Ground water
P : Effective pressure
$P = P_o + H/10$, $H = H_1 + H_2 - H_3$
t : Injected time
Q_t : Water volume during time in "t"
Q_o : Water volume per one min.
: Lugeon value in ℓ/min/m/10 kg/cm²
L_u : Coefficient of permeability
K

ELECTRIC POWER DEVELOPMENT CO. LTD. TOKYO JAPAN

PERMEABILITY TEST IN DRILL HOLE (SHEET 3 OF 4)

KASSEB PROJECT Upper reservoir outsite HOLE No. SP

LOCATION ____ DEPTH OF HOLE 50.0 m TEST DATE ____

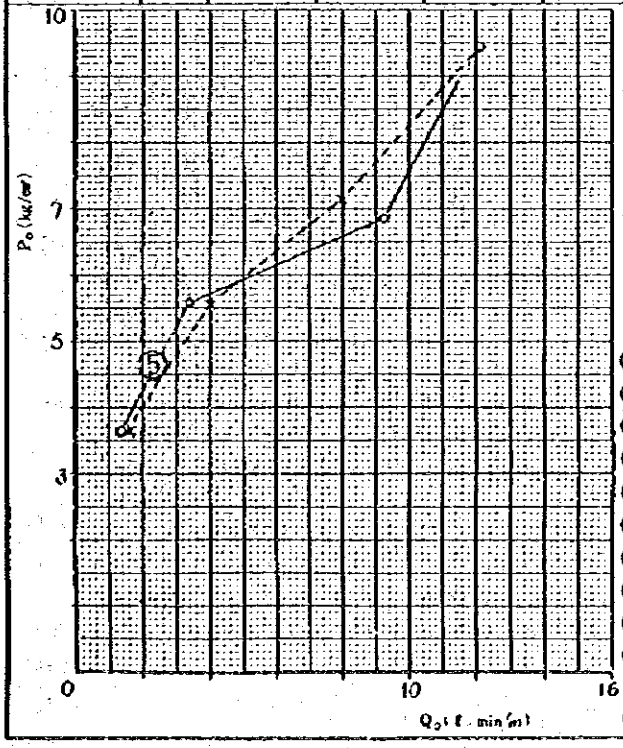
ELEVATION ____ m DIAMETER OF HOLE NX cm TESTED BY ____

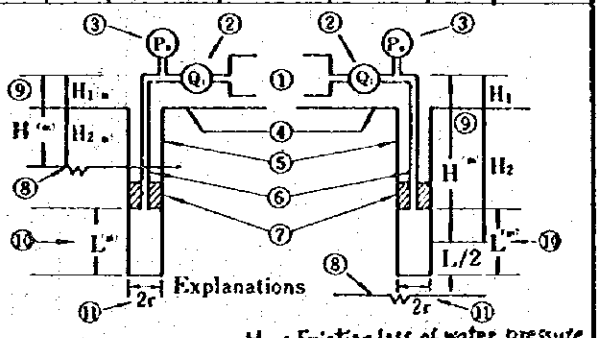
COORDINATE ____ DRILLED DEPTH ____ m DRILLED BY ____

ANGLE FROM HORIZONTAL ____ ° LEVEL OF WATER TABLE CHECKED BY ____

BEARING OF ANGLE HOLE ____ BEFORE T. ③ 6.5 / 6.25 m AFTER T. 6.5 / 6.25 m

Test section (m) From	To	L (m)	H_1 (m)	H_2 (m)	P_o (kg/cm²)	P (kg/cm²)	t (min)	Q_t (ℓ)	Q_o (ℓ/min/m)	L_u (Lugeon)	H_3 (m)	Remarks
③30.0	35.0	5.0	0.3	6.55	3	3.66	10	70	1.4	3.83	0.16	
		"	"	"	5	5.59	"	170	3.4	6.08	0.95	
		"	"	"	7	6.35	"	460	9.2	13.43	6.94	
		"	"	"	10	9.42	"	620	12.1	12.84	12.61	
		"	"	"	7	7.16	"	403	8.8	11.17	5.25	
		"	"	"	5	5.55	"	203	4.0	7.21	1.31	
		"	"	"	3	3.68	"	83	1.6	4.37	0.21	
⑤35.0	40.0	5.0	0.3	6.25	3	3.64	10	80	1.6	4.40	0.24	
		"	"	"	5	5.48	"	220	4.4	8.03	1.83	
		"	"	"	7	6.64	"	520	10.4	15.66	10.32	
		"	"	"	5	5.27	"	320	6.4	12.14	3.87	
		"	"	"	3	3.61	"	110	2.2	6.09	0.46	





Explanations

① : Pump
② : Flow meter
③ : Pressure gauge
④ : Ground surface
⑤ : Drill hole
⑥ : Injection pipe
⑦ : Packer
⑧ : Water table
⑨ : Hydrostatic head
⑩ : Length of test section
⑪ : Diamater of hole

H_3 : Friction loss of water pressure.
P_o : Gauge pressure
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P : Effective pressure
$P = P_o + H'' / 10$, $H = H_1 + H_2 - H_3$
t : Injected time
Q_t : Water volume during time in "t"
Q_o : Water volume per one min.
: Lugeon value in ℓ/min/m/10 kg/cm²
L_u : Coefficient of permeability
K

ELECTRIC POWER DEVELOPMENT CO., LTD. TOKYO JAPAN

PERMEABILITY TEST IN DRILL HOLE (SHEET 4 OF 4)

MASSEB PROJECT Upper reservoir dam site HOLE No. SB 10

LOCATION ____ DEPTH OF HOLE ____ m TEST DATE ____

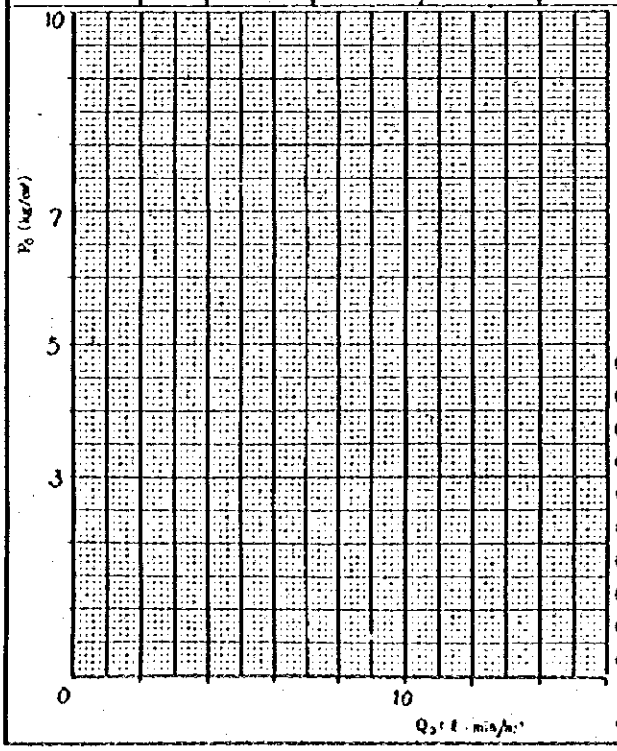
ELEVATION ____ m DIAMETER OF HOLE ____ cm TESTED BY ____

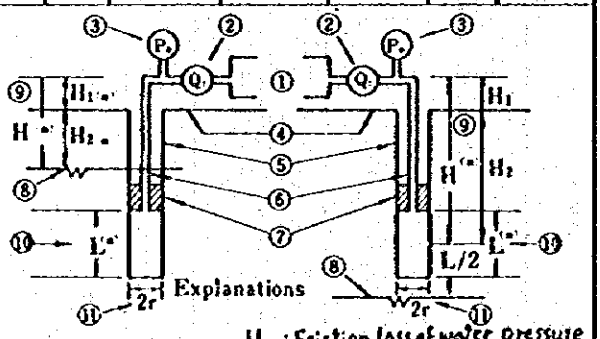
COORDINATE ____ DRILLED DEPTH ____ m DRILLED BY ____

ANGLE FROM HORIZONTAL ____ ° LEVEL OF WATER TABLE CHECKED BY ____

BEARING OF ANGLE HOLE ____ BEFORE T. ② ____ m AFTER T. ____ m

Test section (m) From	To	L (m)	H_1 (m)	H_2 (m)	P_o (kg/cm²)	P (kg/cm²)	t (min)	Q_t (ℓ)	Q_o (ℓ/min/m)	L_u (Lugeon)	H_3 (m)	Remarks
③ 40.0	45.0	5.0	0.3	6.25	3	3.56	10	150	3.0	8.43	0.96	
		〃	〃	〃	5	5.50	〃	190	3.8	6.91	1.55	
		〃	〃	〃	7	7.24	〃	310	6.2	8.56	4.11	
		〃	〃	〃	10	10.00	〃	390	7.8	7.8	6.51	
		〃	〃	〃	7	7.32	〃	280	5.6	7.65	3.35	
		〃	〃	〃	5	5.53	〃	170	3.4	6.15	1.24	
		〃	〃	〃	3	3.59	〃	120	2.4	6.69	0.62	
③												





① : Pump
② : Flow meter
③ : Pressure gauge
④ : Ground surface
⑤ : Drill hole
⑥ : Injection pipe
⑦ : Packer
⑧ : Water table
⑨ : Hydrostatic head
⑩ : Length of test section
⑪ : Diamater of hole

H_3 : Friction loss of water pressure
P_o : Gauge pressure
H_1 : Height of Pressure gauge
H_2 : Depth of Ground water
P : Effective pressure
$P = P_o + H'/10$, $H = H_1 + H_2 - H_3$
t : injected time
Q_t : Water volume during time in "t"
Q_o : Water volume per one min.
: Lugeon value in ℓ/min/m/10 kg/cm²
L_u : Coefficient of permeability
K

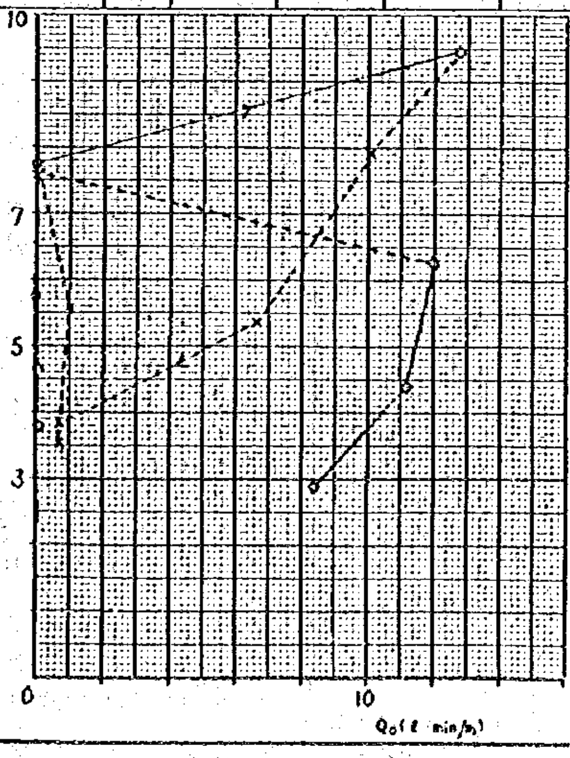
PERMEABILITY TEST IN DRILL HOLE (SHEET 1 OF 2)

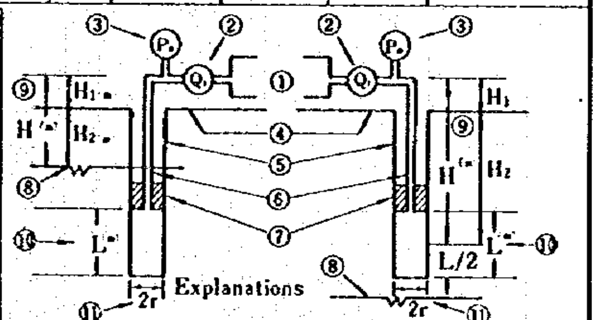
KASSEB PROJECT Upper reservoir damsite HOLE No. SB 11

LOCATION Damsite
DEPTH OF HOLE 55.0 m
TEST DATE
ELEVATION m
DIAMETER OF HOLE

NX cm
TESTED BY
COORDINATE X 87.??7.47, Y 72.638.77
DRILLED DEPTH m
DRILLED BY
ANGLE FROM HORIZONTAL 65°
LEVEL OF WATER TABLE
CHECKED BY
BEARING OF ANGLE HOLE S
BEFORE.T. ① 8.2 ② 7.0 m AFTER.T. 6.6 / 8.2 m

Test section (m) From – To	L (m)	H_1 (m)	H_2 (m)	P_o (kg/cm²)	P (kg/cm²)	t (min)	Q_t (ℓ)	Q_o (ℓ/min/m)	L_u (Lugeon)	H_3 (m)	Remarks
①30.0-35.0	5.0	0.3	7.4	3	3.77	10		0.02	0.05	–	
	"	"	"	5	5.77	"	0	0	0	0	
	"	"	"	7	7.77	"	0	0	0	0	
	"	"	"	10	9.43	"	640	12.8	13.58	13.43	
	"	"	"	7	6.93	"	505	10.1	14.57	8.36	
	"	"	"	5	5.36	"	330	6.6	12.31	3.57	
	"	"	"	3	3.77	"	38	0.76	2.02	0.05	
②35.0-40.0	5.0	0.3	5.6	3	2.92	10	420	8.4	28.77	6.67	
	"	"	"	5	4.40	"	560	11.2	25.45	11.86	
	"	"	"	7	6.23	"	600	12.0	19.26	13.61	
	"	"	"	10	Water pressure did not rise up to 10 kg/cm².						
	"	"	"	7	7.59	10	1	0.02	0.03	–	
	"	"	"	5	5.58	"	50	1	1.79	0.09	
	"	"	"	3	3.58	"	35	0.7	1.96	0.05	





H_3 : Friction loss of water pressure.

① : Pump
② : Flow meter
③ : Pressure gauge
④ : Ground surface
⑤ : Drill hole
⑥ : Injection pipe
⑦ : Packer
⑧ : Water table
⑨ : Hydrostatic head
⑩ : Length of test section
⑪ : Diamater of hole

P_o : Gauge pressure
H_1 : Height of Pressure gauge
H_2 : Depth of Ground water
P : Effective pressure
$P = P_o + H/10$, $H = H_1 + H_2 - H_3$
t : Injected time
Q_t : Water volume during time in "t"
Q_o : Water volume per one min.
: Lugeon value in ℓ/min/m/10 kg/cm²
L_u : Coefficient of permeability K

ELECTRIC POWER DEVELOPMENT CO. LTD. TOKYO JAPAN

PERMEABILITY TEST IN DRILL HOLE (SHEET 2 OF 2)

KASSEB PROJECT Upper reservoir dam site HOLE No. SB 11

LOCATION _____ DEPTH OF HOLE 55.0 m TEST DATE _____

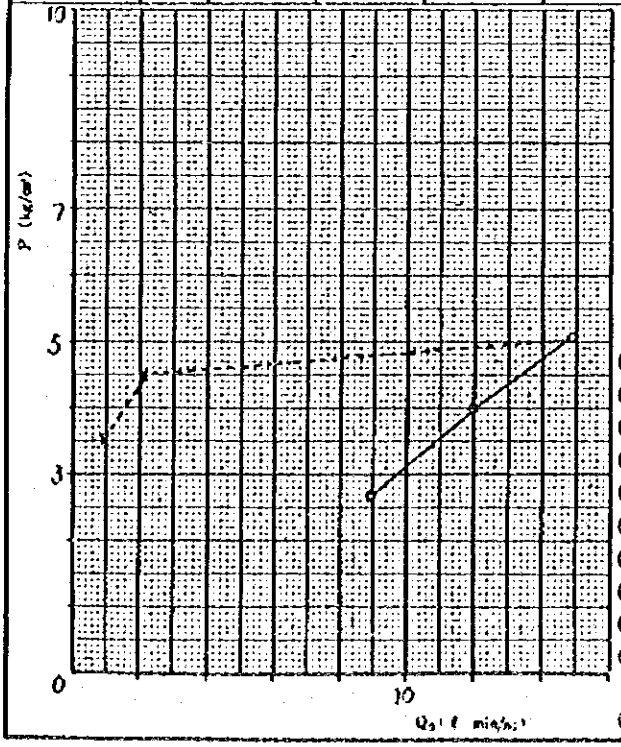
ELEVATION _____ m DIAMETER OF HOLE NX cm TESTED BY _____

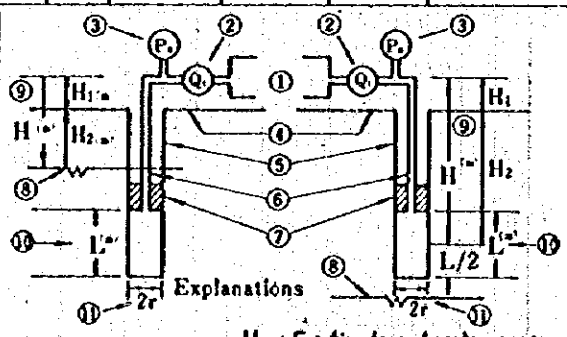
COORDINATE _____ DRILLED DEPTH _____ m DRILLED BY _____

ANGLE FROM HORIZONTAL _____ ° LEVEL OF WATER TABLE CHECKED BY _____

BEARING OF ANGLE HOLE _____ BEFORE T. ② 7.2 m AFTER T. 7.8 m

Test section (m) From	To	L (m)	H_1 (m)	H_2 (m)	P_o (kg/cm²)	P (kg/cm²)	t (min)	Q_t (ℓ)	Q_o (ℓ/min/m)	L_u (Lugeon)	H_3 (m)	Remarks
③ 40.0	45.0	5.0	0.3	5.9	3	2.69	10	442	8.84	32.86	8.36	
		〃	〃	〃	5	3.98	〃	601	12.02	30.20	15.66	
		〃	〃	〃	7	5.15	〃	765	14.3	28.93	23.76	
		〃	〃	〃	10	Water pressure did not rise up to 10 kg/cm².						
		〃	〃	〃	7							
		〃	〃	〃	5	5.48	10	105	2.1	3.83	0.47	
		〃	〃	〃	3	3.52	〃	48	0.96	2.73	0.10	





① : Pump
② : Flow meter
③ : Pressure gauge
④ : Ground surface
⑤ : Drill hole
⑥ : Injection pipe
⑦ : Packer
⑧ : Water table
⑨ : Hydrostatic head
⑩ : Length of test section
⑪ : Diamater of hole

H_3 : Friction loss of water pressure,
P_o : Gauge pressure
H_1 : Height of Pressure gauge
H_2 : Depth of Ground water
P : Effective pressure
$P = P_o + H'' / 10$, $H = H_1 + H_2 - H_3$
t : Injected time
Q_t : Water volume during time in "t"
Q_o : Water volume per one min.
: Lugeon value in ℓ/min/m/10 kg/cm²
L_u : Coefficient of permeability
K

ELECTRIC POWER DEVELOPMENT CO. LTD. TOKYO JAPAN

PERMEABILITY TEST IN DRILL HOLE (SHEET 1 OF 2)

KASSEB PROJECT Upper reservoir damsite HOLE No. SE 2 bis

LOCATION _____ DEPTH OF HOLE 33.0 m TEST DATE _____

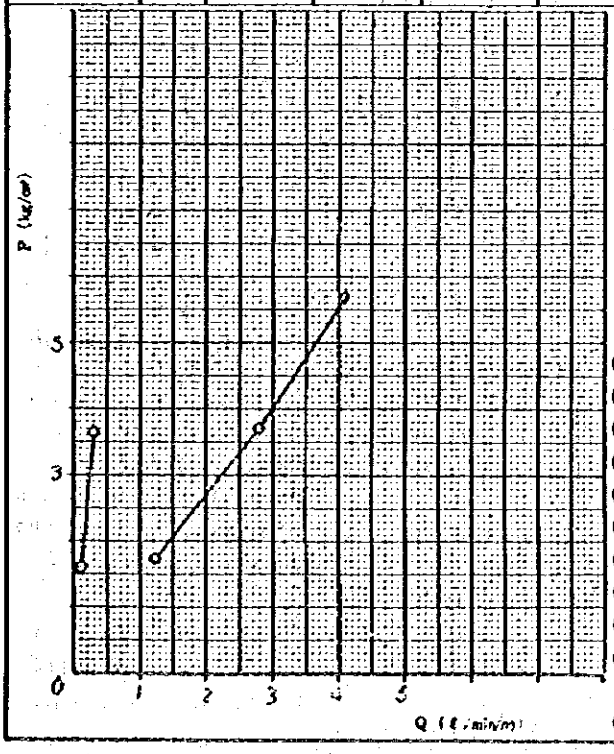
ELEVATION _____ m DIAMETER OF HOLE NX cm TESTED BY _____

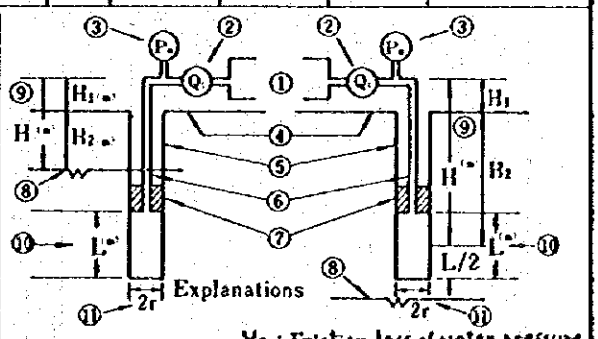
COORDINATE _____ DRILLED DEPTH _____ m DRILLED BY _____

ANGLE FROM HORIZONTAL 90° LEVEL OF WATER TABLE CHECKED BY _____

BEARING OF ANGLE HOLE — BEFORE T. ①4.0 ②4.7 m AFTER T. 6.0 7.3 m

Test section (m) From	To	L (m)	H_1 (m)	H_2 (m)	P_o (kg/cm²)	P (kg/cm²)	t (min)	Q_t (ℓ)	Q_o (ℓ/min/m)	L_u (Lugeon)	H_3 (m)	Remarks
① 12.0	15.0	5.0	0.3	7.0	1	1.73	10	61	1.22	7.05	0.05	
		〃	〃	〃	3	3.71	〃	140	2.8	2.55	0.25	
		〃	〃	〃	5	5.68	〃	205	4.1	2.22	0.54	
		Water table is at 7m deep in this hole.										
② 23.0	25.0	5.0	0.3	6.0	1	1.63	10	5	0.1	0.61	—	
		〃	〃	〃	3	3.63	〃	15	0.3	0.83	—	





① : Pump
② : Flow meter
③ : Pressure gauge
④ : Ground surface
⑤ : Drill hole
⑥ : Injection pipe
⑦ : Packer
⑧ : Water table
⑨ : Hydrostatic head
⑩ : Length of test section
⑪ : Diamater of hole

H_3 : Friction loss of water pressure
P_o : Gauge pressure
H_1 : Height of Pressure gauge
H_2 : Depth of Ground water
P : Effective pressure
$P = P_o + H'/10$, $H = H_1 + H_2 - H_3$
t : Injected time
Q_t : Water volume during time in "t"
Q_o : Water volume per one min.
: Lugeon value in ℓ/min/m/10 kg/cm²
L_u : Coefficient of permeability
K

PERMEABILITY TEST IN DRILL HOLE (SHEET 2 OF 2)

KASSEP PROJECT Upper reservoir damsite HOLE No. SB (2 bis

LOCATION _____ DEPTH OF HOLE 33.0 m TEST DATE _____

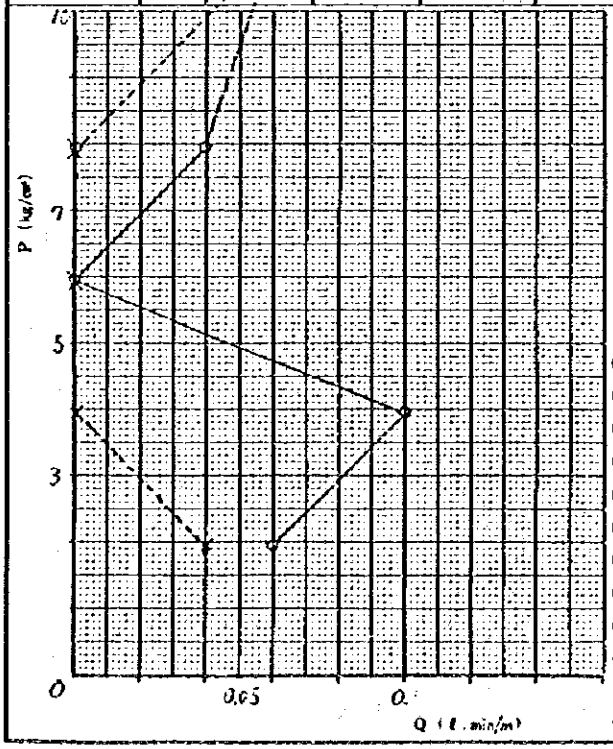
ELEVATION _____ m DIAMETER OF HOLE NX cm TESTED BY _____

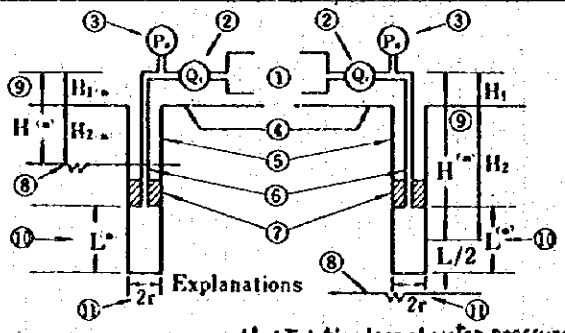
COORDINATE _____ DRILLED DEPTH _____ m DRILLED BY _____

ANGLE FROM HORIZONTAL 90° LEVEL OF WATER TABLE CHECKED BY _____

BEARING OF ANGLE HOLE _____ BEFORE T. ③ m AFTER T. 9.0 m

Test section (m) From	To	L (m)	H_1 (m)	H_2 (m)	P_o (kg/cm²)	P (kg/cm²)	t (min)	Q_t (ℓ)	Q_o (ℓ/min/m)	L_u (Lugeon)	H_3 (m)	Remarks
③ 28.0	33.0	5.0	0.3	9.0	1	1.93	10	3	0.06	0.31	–	
		〃	〃	〃	3	3.93	〃	5	0.1	0.25	–	
		〃	〃	〃	5	5.93	〃	0	0	0	0	
		〃	〃	〃	7	7.93	〃	2	0.04	0.05	–	
		〃	〃	〃	10	10.93	〃	3	0.06	0.05	–	
		〃	〃	〃	7	7.93	〃	0	0	0	0	
		〃	〃	〃	5	5.93	〃	0	0	0	0	
		〃	〃	〃	3	3.93	〃	0	0	0	0	
		〃	〃	〃	1	1.93	〃	2	0.04	0.21	–	





① : Pump
② : Flow meter
③ : Pressure gauge
④ : Ground surface
⑤ : Drill hole
⑥ : Injection pipe
⑦ : Packer
⑧ : Water table
⑨ : Hydrostatic head
⑩ : Length of test section
⑪ : Diamater of hole

H_3 : Friction loss of water pressure
P_o : Gauge pressure
H_1 : Height of Pressure gauge
H_2 : Depth of Ground water
P : Effective pressure
$P = P_o + H'' / 10$, $H = H_1 + H_2 - H_3$
t : Injected time
Q_t : Water volume during time in "t"
Q_o : Water volume per one min.
: Lugeon value in ℓ/min/m/10 kg/cm²
L_u : Coefficient of permeability
K

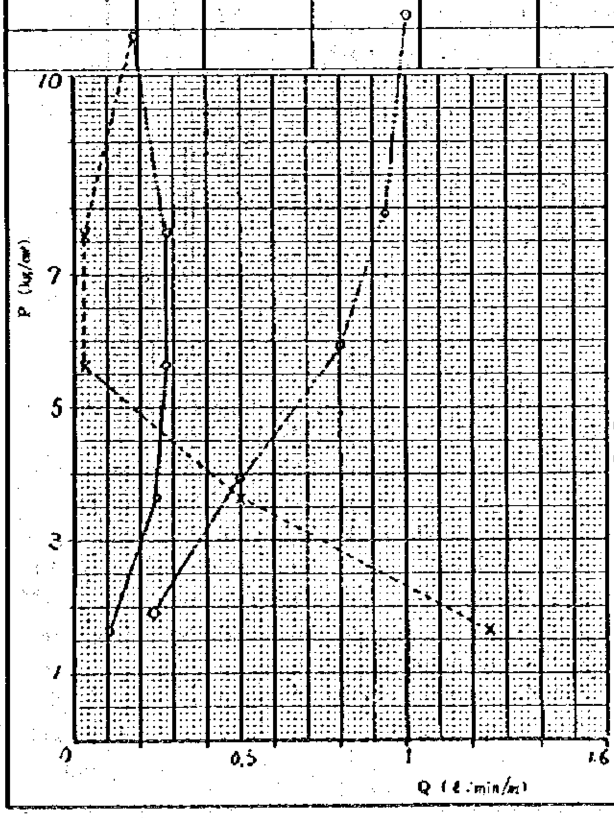
ELECTRIC POWER DEVELOPMENT CO. LTD. TOKYO JAPAN

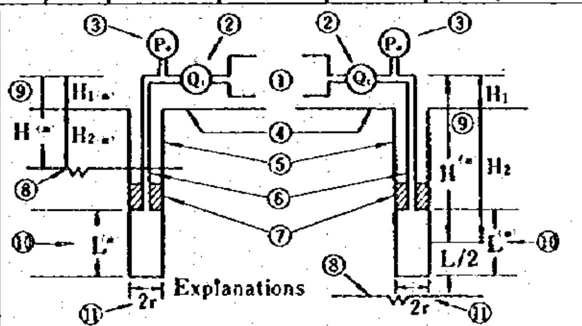
PERMEABILITY TEST IN DRILL HOLE (SHEET 1 OF 1)

KASSEB PROJECT Upper reservoir dam site HOLE No. SB 13

LOCATION	DEPTH OF HOLE 35.2 m	TEST DATE
ELEVATION m	DIAMETER OF HOLE NX cm	TESTED BY
COORDINATE X 86.613.08 Y 70.493.61	DRILLED DEPTH m	DRILLED BY
ANGLE FROM HORIZONTAL 90°	LEVEL OF WATER TABLE BEFORE T. ① 8.0 ② 5.0 m AFTER T. 10.0 5.5 m	CHECKED BY
BEARING OF ANGLE HOLE		

Test section (m) From To	L (m)	H_1 (m)	H_2 (m)	P_o (kg/cm²)	P (kg/cm²)	t (min)	Q_t (l)	Q_o (l/min/m)	L_u (Lugeon)	H_3 (m)	Remarks
① 24.0-29.0	5.0	0.3	9.0	1	1.93	10	12	0.24	1.26	–	
	"	"	"	3	3.93	10	25	0.5	1.27	0.02	
	"	"	"	5	5.93	10	40	0.8	1.35	0.04	
	"	"	"	7	7.92	10	47	0.94	1.19	0.06	
	"	"	"	10	10.92	7	50	1	0.92	0.07	
② 29.0-33.0	4.0	0.3	6.25	1	1.66	10	4	0.1	0.60	–	
	"	"	"	3	3.66	10	10	0.25	0.68	–	
	"	"	"	5	5.66	10	11	0.28	0.49	–	
	"	"	"	7	7.66	10	11	0.28	0.37	–	
	"	"	"	10	10.66	10	7	0.18	0.17	–	
	"	"	"	7	7.66	10	1	0.03	0.04	–	
	"	"	"	5	5.66	10	1	0.03	0.05	–	
	"	"	"	3	3.65	10	20	0.5	1.37	0.01	
	"	"	"	1	1.65	10	50	1.25	7.58	0.08	





① : Pump
② : Flow meter
③ : Pressure gauge
④ : Ground surface
⑤ : Drill hole
⑥ : Injection pipe
⑦ : Packer
⑧ : Water table
⑨ : Hydrostatic head
⑩ : Length of test section
⑪ : Diamater of hole

H_3 : Friction loss of water pressure
P_o : Gauge pressure
H_1 : Height of Pressure gauge
H_2 : Depth of Ground water
P : Effective pressure
$P = P_o + H/10$, $H = H_1 + H_2 - H_3$
t : Injected time
Q_t : Water volume during time in "t"
Q_o : Water volume per one min.
: Lugeon value in l/min/m/10 kg/cm²
L_u : Coefficient of permeability K

ELECTRIC POWER DEVELOPMENT CO. LTD. TOKYO JAPAN

PERMEABILITY TEST IN DRILL HOLE (SHEET 1 OF 2)

KASSEB PROJECT Upper reservoir damsite HOLE No. SB 1

LOCATION ____ DEPTH OF HOLE 35 m TEST DATE ____

ELEVATION ____ m DIAMETER OF HOLE NX cm TESTED BY ____

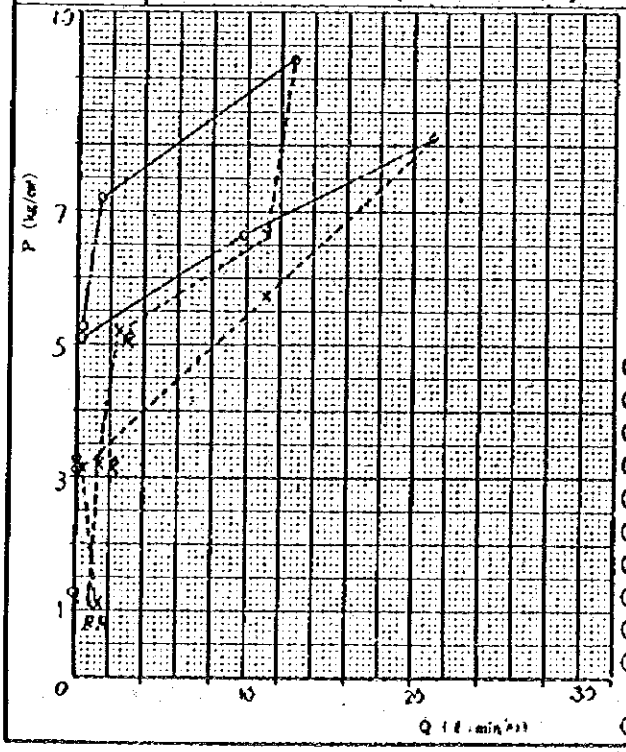
COORDINATE X 92,673.10 Y 92,973.81 DRILLED DEPTH ____ m DRILLED BY ____

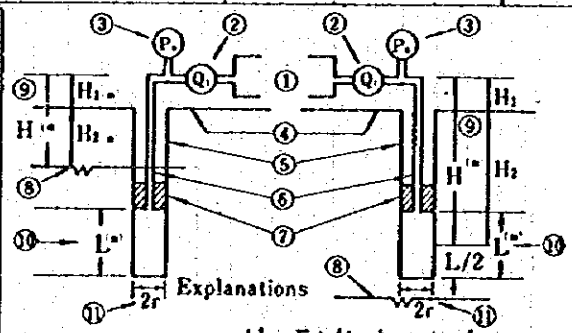
ANGLE FROM HORIZONTAL 90° LEVEL OF WATER TABLE CHECKED BY ____

BEARING OF ANGLE HOLE ____ BEFORE T. ① 1.6 m AFTER T. 1.5 2.4 m

Test section (m) From	To	L (m)	H_1 (m)	H_2 (m)	P_o (kg/cm²)	P (kg/cm²)	t (min)	Q_t (ℓ)	Q_o (ℓ/min/m)	L_u (Lugeon)	H_3 (m)	Remarks
① 15.0	20.0	5.0	0.3	3.75	1	1.11	10	1	0.02	0.18	–	
		〃	〃	〃	3	3.11	〃	1	0.02	0.06	–	
		〃	〃	〃	5	5.11	〃	3	0.06	0.12	–	
		〃	〃	〃	7	6.67	〃	495	9.9	14.84	4.34	
		〃	〃	〃	10	8.11	〃	1,060	21.2	28.14	20.03	
		〃	〃	〃	7	5.73	〃	880	17.6	30.72	13.73	
		〃	〃	〃	5	4.55	〃	560	11.2	24.62	5.53	
		〃	〃	〃	3	3.11	〃	10.	0.2	0.66	–	R
		〃	〃	〃	1	1.10	〃	70.	1.4.	12.73	0.09	R
② 20.0	25.0	5.0	0.3	2.0	1	1.23	10	0	0	0	–	
		〃	〃	〃	3	3.23	〃	1	0.02	0.06	–	
		〃	〃	〃	5	5.23	〃	15	0.3	0.57	0.01	
		〃	〃	〃	7	7.22	〃	77	1.54	2.13	0.14	
		〃	〃	〃	10	9.30	〃	640	12.8	13.76	9.34	
		〃	〃	〃	7	6.71	〃	480	9.6	14.31	5.25	
		〃	〃	〃	5	5.19	〃	130	2.6	5.01	0.39	R
		〃	〃	〃	3	3.22	〃	73	1.46	4.53	0.12	R
		〃	〃	〃	1	1.22	〃	52.	1.04	8.52	0.06	R

Remarks. R ; Pumped-in water flew out from top of hole.





① : Pump
② : Flow meter
③ : Pressure gauge
④ : Ground surface
⑤ : Drill hole
⑥ : Injection pipe
⑦ : Packer
⑧ : Water table
⑨ : Hydrostatic head
⑩ : Length of test section
⑪ : Diamater of hole

H_3 : Friction loss of water pressure.
P_o : Gauge pressure
H_1 : Height of Pressure gauge
H_2 : Depth of Ground water
P : Effective pressure
$P = P_o + H'' / 10$, $H = H_1 + H_2 - H_3$
t : Injected time
Q_t : Water volume during time in "t"
Q_o : Water volume per one min.
: Lugeon value in ℓ/min/m/10 kg/cm²
L_u : Coefficient of permeability
K

ELECTRIC POWER DEVELOPMENT CO., LTD. TOKYO JAPAN

PERMEABILITY TEST IN DRILL HOLE (SHEET 2 OF 2)

KASSEB PROJECT Upper reservoir dam site HOLE No. SB 14

LOCATION _____ DEPTH OF HOLE 35 m TEST DATE _____

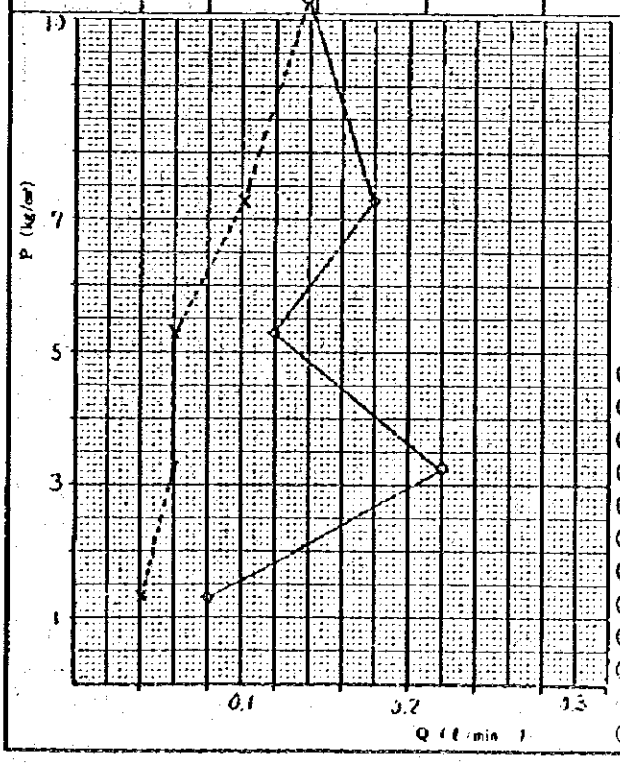
ELEVATION _____ m DIAMETER OF HOLE NX cm TESTED BY _____

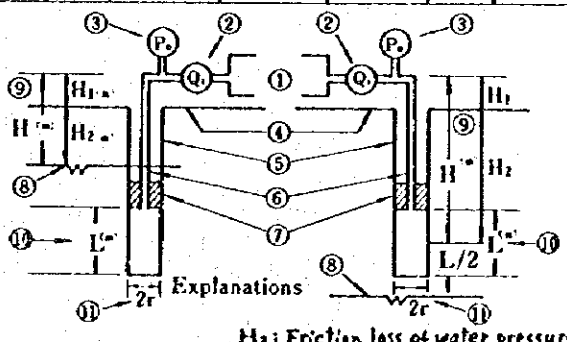
COORDINATE _____ DRILLED DEPTH _____ m DRILLED BY _____

ANGLE FROM HORIZONTAL _____ ° LEVEL OF WATER TABLE CHECKED BY M. Suetomi

BEARING OF ANGLE HOLE _____ BEFORE T. ① 1.8 m ③ AFTER T. 3.2 m

Test section (m) From	To	L (m)	H_1 (m)	H_2 (m)	P_o (kg/cm²)	P (kg/cm²)	t (min)	Q_t (ℓ)	Q_o (ℓ/min/m)	L_u (Lugeon)	H_3 (m)	Remarks
③ 25.0	30.0	5.0	0.3	2.5	1	1.28	10	4	0.08	0.63	–	
		〃	〃	〃	3	3.28	〃	11	0.22	0.67	–	
		〃	〃	〃	5	5.28	〃	5	0.1	0.19	–	
		〃	〃	〃	7	7.28	〃	8	0.16	0.22	–	
		〃	〃	〃	10	10.28	〃	7	0.14	0.14	–	
		〃	〃	〃	7	7.28	〃	5	0.1	1.37	–	
		〃	〃	〃	5	5.28	〃	3	0.06	0.11	–	
		〃	〃	〃	3	3.28	〃	3	0.06	0.18	–	
		〃	〃	〃	1	1.28	〃	2	0.04	0.31	–	
④ 30.0	35.0	5.0	0.3		1	1.2	10	1	0.02	0.17	–	
		〃	〃		3	3.2	〃	15	0.3	0.93	0.01	
		〃	〃		5	5.2	〃	4	0.08	0.15	–	
		〃	〃		7	7.2	〃	1	0.02	0.03	–	
		〃	〃		10	10.2	〃	8	0.16	0.16	–	
		〃	〃		7	7.2	〃	0	0	0	–	
		〃	〃		5	5.2	〃	1	0.02	0.04	–	R
		〃	〃		3	3.2	〃	2	0.04	0.13	–	R
		〃	〃		1	1.2	〃	3	0.06	0.5	–	R





H_3 : Friction loss of water pressure

① : Pump — P_o : Gauge pressure

② : Flow meter — H_1 : Height of Pressure gauge

③ : Pressure gauge — H_2 : Depth of Ground water

④ : Ground surface — P : Effective pressure

⑤ : Drill hole — $P = P_o + H'' / 10$, $H = H_1 + H_2 - H_3$

⑥ : Injection pipe — t : Injected time

⑦ : Packer — Q_t : Water volume during time in "t"

⑧ : Water table — Q_o : Water volume per one min.

⑨ : Hydrostatic head — : Lugeon value in ℓ/min/m/10 kg/cm²

⑩ : Length of test section — L_u : Coefficient of permeability

⑪ : Diamater of hole — K

PERMEABILITY TEST IN DRILL HOLE (SHEET 1 OF 6)

KASSEY PROJECT Intake site HOLE No. S1 2

LOCATION _____ DEPTH OF HOLE 150.0 m TEST DATE _____

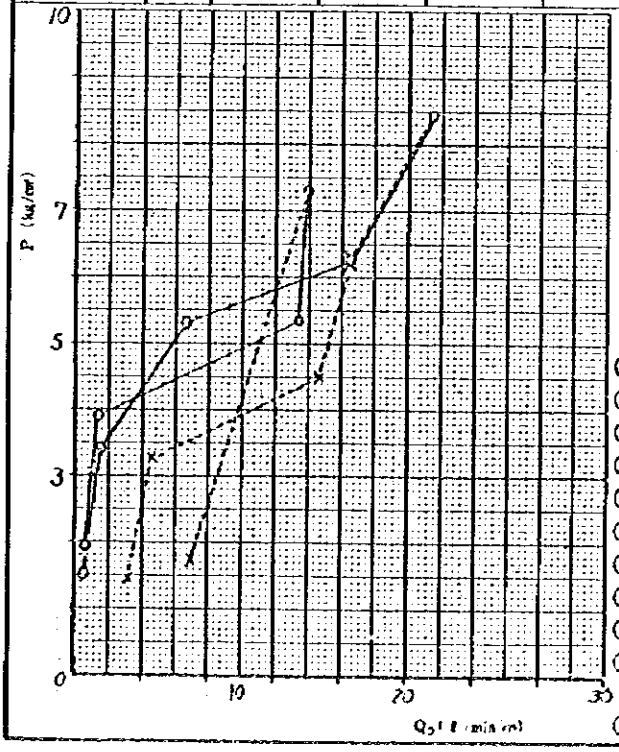
ELEVATION _____ m DIAMETER OF HOLE _____ cm TESTED BY _____

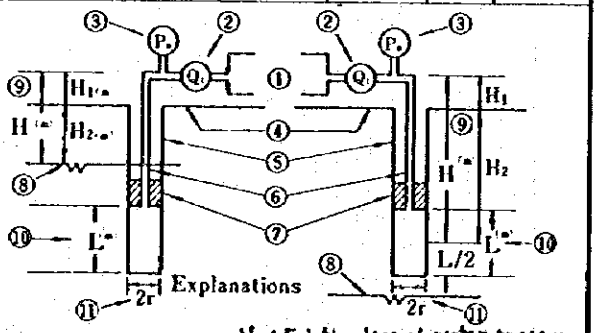
COORDINATE 181,932.91 / 123,453.58 DRILLED DEPTH _____ m DRILLED BY _____

ANGLE FROM HORIZONTAL 90° LEVEL OF WATER TABLE CHECKED BY _____

BEARING OF ANGLE HOLE _____ BEFORE T. ⌀ 3.5 m AFTER T. 14.5 / 5.2 m

Test section (m) From	To	L (m)	H_1 (m)	H_2 (m)	P_o (kg/cm²)	P (kg/cm²)	t (min)	Q_t (ℓ)	Q_o (ℓ/min/m)	L_u (Lugeon)	H_3 (m)	Remarks
① 10.0	15.0	5.0	0.3	9.0	1	1.93	10	33	0.66	3.42	0.01	
		〃	〃	〃	3	3.72	〃	67	1.34	3.42	0.03	
		〃	〃	〃	5	5.34	〃	678	13.56	25.37	5.83	
		〃	〃	〃	7	7.30	〃	700	14.0	19.18	6.27	
		〃	〃	〃	1	1.77	〃	355	7.1	40.11	1.61	
② 15	20.0	5.0	0.3	4.7	1	1.5	10	14	0.28	1.87	—	
		〃	〃	〃	3	3.69	〃	85	1.7	4.87	0.13	
		〃	〃	〃	5	5.3	〃	335	6.7	12.64	2.03	
		〃	〃	〃	7	6.27	〃	830	16.6	26.48	12.26	
		〃	〃	〃	10	8.42	〃	1080	21.6	25.65	23.76	
		〃	〃	〃	7	6.27	〃	830	16.6	26.48	12.26	
		〃	〃	〃	5	4.54	〃	735	14.7	32.38	9.62	
		〃	〃	〃	3	3.40	〃	236	4.72	13.88	0.97	
		〃	〃	〃	1	1.45	〃	166	3.32	22.90	0.49	





① : Pump
② : Flow meter
③ : Pressure gauge
④ : Ground surface
⑤ : Drill hole
⑥ : Injection pipe
⑦ : Packer
⑧ : Water table
⑨ : Hydrostatic head
⑩ : Length of test section
⑪ : Diamater of hole

H_3 : Friction loss of water pressure.
P_o : Gauge pressure
H_1 : Height of Pressure gauge
H_2 : Depth of Ground water
P : Effective pressure
$P = P_o + H'/10$, $H = H_1 + H_2 - H_3$
t : Injected time
Q_t : Water volume during time in "t"
Q_o : Water volume per one min.
: Lugeon value in ℓ/min/m/10 kg/cm²
L_u : Coefficient of permeability
K

PERMEABILITY TEST IN DRILL HOLE (SHEET 2 OF 6)

KASHIBA PROJECT Iritono site HOLE No. S1 2

LOCATION ____ DEPTH OF HOLE 150.0 m TEST DATE ____

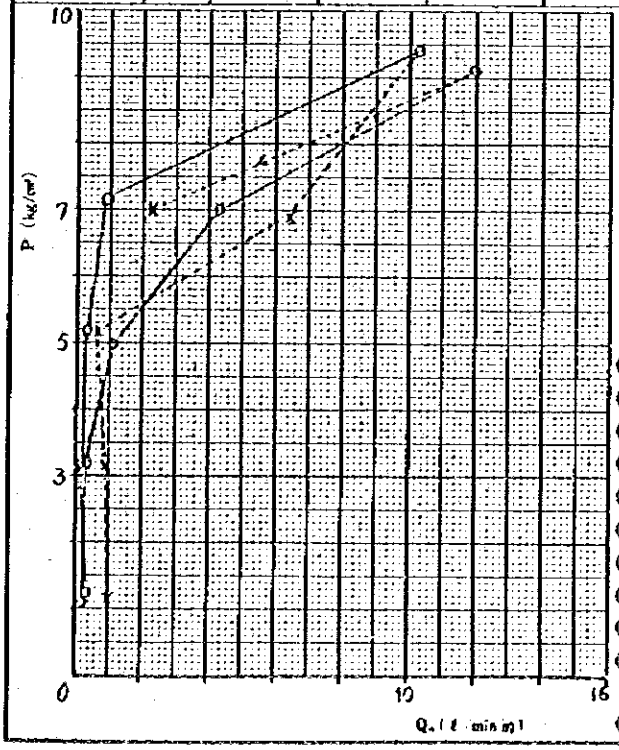
ELEVATION ____ m DIAMETER OF HOLE ____ cm TESTED BY ____

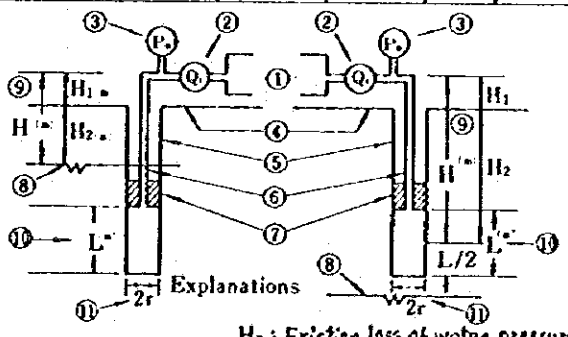
COORDINATE ____ DRILLED DEPTH ____ m DRILLED BY ____

ANGLE FROM HORIZONTAL 90° LEVEL OF WATER TABLE ③ 0.6 CHECKED BY ____

BEARING OF ANGLE HOLE ____ BEFORE T. ② 0 m AFTER T. 0.8 3.6 m

Test section (m) From	To	L (m)	H_1 (m)	H_2 (m)	P_o (kg/cm²)	P (kg/cm²)	t (min)	Q_t (ℓ)	Q_o (ℓ/min)	L_u (Lugeon)	H_3 (m)	Remarks
③20.0	25.0	5.0	0.3	0.7	1.	1.10	10	10	0.2	1.82	–	
		〃	〃	〃	3.	3.10	〃	14	0.28	0.90	–	
		〃	〃	〃	5	5.01	〃	58	1.16	2.32	0.03	
		〃	〃	〃	7	6.99	〃	219	4.38	6.27	1.09	
		〃	〃	〃	10	9.27	〃	602	12.04	12.99	8.26	
		〃	〃	〃	7	7.07	〃	112	2.24	3.17	0.29	
④25.0	30.0	5.0	0.3	1.5	1	1.18	10	16	0.32	2.71	–	
		〃	〃	〃	3	3.18	〃	9	0.18	0.57	–	
		〃	〃	〃	5	5.18	〃	15	0.3	0.58	–	
		〃	〃	〃	7	7.17	〃	47	0.94	1.03	0.06	
		〃	〃	〃	10	9.42	〃	524	10.48	11.13	7.63	
		〃	〃	〃	7	6.90	〃	320	6.4	9.28	2.85	
		〃	〃	〃	5	5.17	〃	66	1.32	2.55	0.12	
		〃	〃	〃	3	3.15	〃	98	1.96	6.22	0.27	
		〃	〃	〃	1	1.13	〃	104	2.08	18.09	0.33	





H_3 : *Friction loss of water pressure*

① : Pump
② : Flow meter
③ : Pressure gauge
④ : Ground surface
⑤ : Drill hole
⑥ : Injection pipe
⑦ : Packer
⑧ : Water table
⑨ : Hydrostatic head
⑩ : Length of test section
⑪ : Diamater of hole

P_o : Gauge pressure
H_1 : Height of Pressure gauge
H_2 : Depth of Ground water
P : Effective pressure
$P = P_o + H(m)/10$, $H = H_1 + H_2 - H_3$
t : Injected time
Q_t : Water volume during time in "t"
Q_o : Water volume per one min.
: Lugeon value in ℓ/min/m/10 kg/cm²
L_u : Coefficient of permeability
K

ELECTRIC POWER DEVELOPMENT CO., LTD. TOKYO JAPAN

PERMEABILITY TEST IN DRILL HOLE (SHEET 3 OF 6)

KASSEB PROJECT Intake site HOLE No. S1 2

LOCATION _____ DEPTH OF HOLE 150.0 m TEST DATE _____

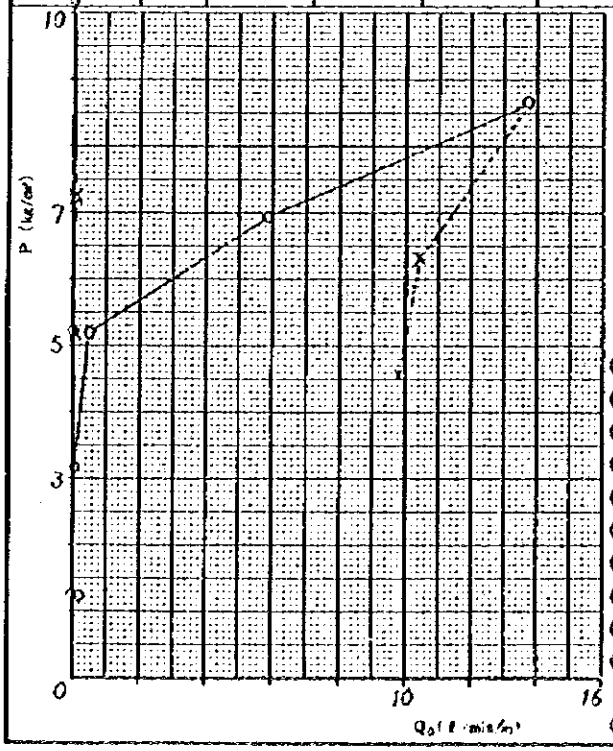
ELEVATION _____ m DIAMETER OF HOLE _____ cm TESTED BY _____

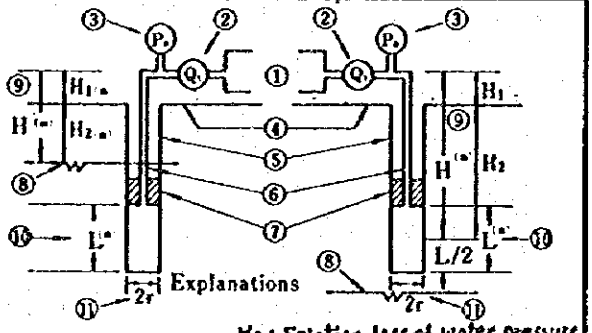
COORDINATE _____ DRILLED DEPTH _____ m DRILLED BY _____

ANGLE FROM HORIZONTAL 90° LEVEL OF WATER TABLE CHECKED BY _____

BEARING OF ANGLE HOLE _____ BEFORE T. ⑤ 1.5 / ⑧ 1.3 m AFTER T. 2.6 / 2.5 m

Test section (m) From	To	L (m)	H_1 (m)	H_2 (m)	P_0 (kg/cm²)	P (kg/cm²)	t (min)	Q_t (ℓ)	Q_0 (ℓ/min)	L_u (Lugeon)	H_3 (m)	Remarks
③30.0	35.0	5.0	0.3	2.05	1	1.24	10	0	0	0	0	
		〃	〃	〃	3	3.24	〃	2	0.36	0.12	–	
		〃	〃	〃	5	5.22	〃	24	0.48	0.92	0.19	
		〃	〃	〃	7	6.95	〃	295	5.92	8.52	2.87	
		〃	〃	〃	10	8.66	〃	673	13.55	16.00	15.75	
		〃	〃	〃	7	6.35	〃	519	10.38	16.35	8.84	
		〃	〃	〃	5	6.45	〃	489	9.78	21.98	7.84	
③35.0	40.0	5.0	0.3	1.75	1	1.21	10	1	0.02	0.17	–	
		〃	〃	〃	3	3.21	〃	0	0	0	0	
		〃	〃	〃	5	5.21	〃	0	0	0	0	
		〃	〃	〃	7	7.21	〃	0	0	0	0	
		〃	〃	〃	10	10.21	〃	0	0	0	0	
		〃	〃	〃	7	7.21	〃	2	0.04	0.06	–	
		〃	〃	〃	5	5.21	〃	4	0.08	0.15	–	





H_3 : Friction loss of water pressure

① : Pump
② : Flow meter
③ : Pressure gauge
④ : Ground surface
⑤ : Drill hole
⑥ : Injection pipe
⑦ : Packer
⑧ : Water table
⑨ : Hydrostatic head
⑩ : Length of test section
⑪ : Diamater of hole

P_0 : Gauge pressure
H_1 : Height of Pressure gauge
H_2 : Depth of Ground water
P : Effective pressure
$P = P_0 + H'/10$, $H = H_1 + H_2 - H_3$
t : Injected time
Q_t : Water volume during time in "t"
Q_0 : Water volume per one min.
: Lugeon value in ℓ/min/m/10 kg/cm²
L_u : Coefficient of permeability
K

PERMEABILITY TEST IN DRILL HOLE (SHEET 4 OF 6)

KASSEB PROJECT Intake site HOLE No. SI 2

LOCATION _____ DEPTH OF HOLE 150.0 m TEST DATE _____

ELEVATION _____ m DIAMETER OF HOLE _____ cm TESTED BY _____

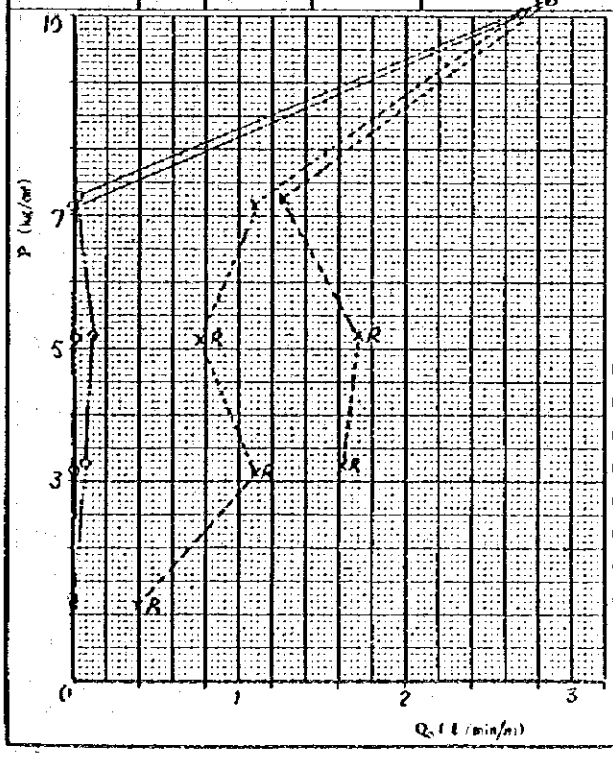
COORDINATE _____ DRILLED DEPTH _____ m DRILLED BY _____

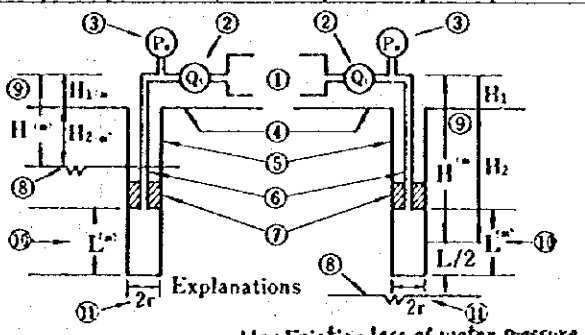
ANGLE FROM HORIZONTAL 90° LEVEL OF WATER TABLE CHECKED BY _____

BEARING OF ANGLE HOLE _____ BEFORE T. ② 1.5 ③ 0.3 m AFTER T. 2.6 1.5 m

Test section (m) From	To	L (m)	H_1 (m)	H_2 (m)	P_o (kg/cm²)	P (kg/cm²)	t (min)	Q_t (ℓ)	Q_o (ℓ/min)	L_u (Lugeon)	H_3 (m)	Remarks
⑦40.0	45.0	5.0	0.3	2.05	1	1.24	10	0	0	0	0	
		〃	〃	〃	3	3.23	〃	4	0.03	0.25	0.07	
		〃	〃	〃	5	5.22	〃	6	0.12	0.23	0.15	
		〃	〃	〃	7	7.24	〃	1	0.02	0.03	–	
		〃	〃	〃	10	10.24	〃	143	2.85	2.79	0.88	
		〃	〃	〃	7	7.23	〃	46	0.92	1.27	0.09	
		〃	〃	〃	5	5.23	〃	45	0.9	1.72	0.09	R
		〃	〃	〃	3	3.23	〃	26	0.52	1.61	0.03	R
⑨45.0	50.0	5.0	0.3	1.4	1	1.17	10	0	0	0	0	
		〃	〃	〃	3	3.17	〃	0	0	0	0	
		〃	〃	〃	5	5.17	〃	1	0.02	0.04	–	
		〃	〃	〃	7	7.17	〃	0	0	0	0	
		〃	〃	〃	10	10.08	〃	139	2.78	2.76	0.92	
		〃	〃	〃	7	7.16	〃	56	1.12	1.56	0.15	
		〃	〃	〃	5	5.16	〃	39	0.78	1.51	0.07	R
		〃	〃	〃	3	3.16	〃	55	1.12	3.54	0.15	R
		〃	〃	〃	1	1.17	〃	20	0.4	3.42	0.02	R

Remarks. R; Pumped-in water flew out from top of hole.





H_3: Friction loss of water pressure.

① : Pump
② : Flow meter
③ : Pressure gauge
④ : Ground surface
⑤ : Drill hole
⑥ : Injection pipe
⑦ : Packer
⑧ : Water table
⑨ : Hydrostatic head
⑩ : Length of test section
⑪ : Diamater of hole

P_o : Gauge pressure
H_1 : Height of Pressure gauge
H_2 : Depth of Ground water
P : Effective pressure
$P = P_o + H''/10$, $H = H_1 + H_2 - H_3$
t : Injected time
Q_t : Water volume during time in "t"
Q_o : Water volume per one min.
: Lugeon value in ℓ/min/m/10 kg/cm²
L_u : Coefficient of permeability
K

PERMEABILITY TEST IN DRILL HOLE (SHEET 5 OF 6)

KASSER PROJECT Intake site HOLE No. SI 2

LOCATION ____ DEPTH OF HOLE 150.0 m TEST DATE ____

ELEVATION ____ m DIAMETER OF HOLE NX cm TESTED BY ____

COORDINATE X 35 477.01 DRILLED DEPTH ____ m DRILLED BY ____

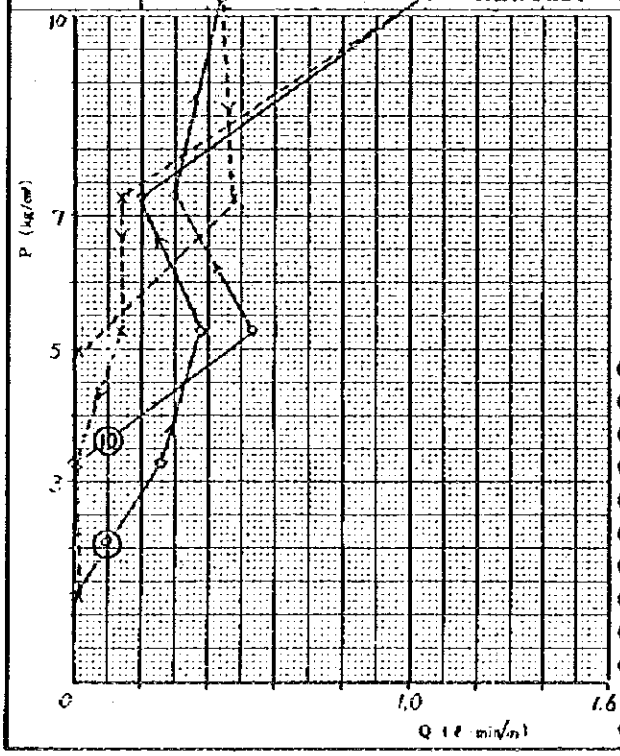
Y 23 216.32

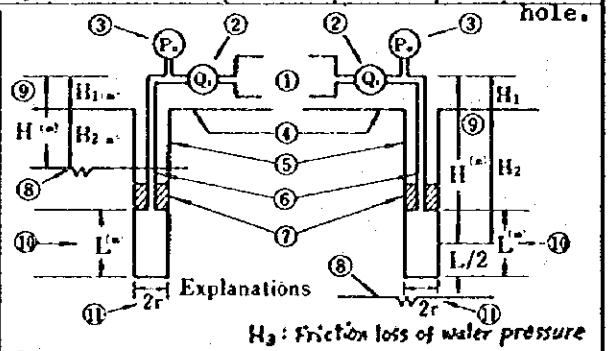
ANGLE FROM HORIZONTAL 90° LEVEL OF WATER TABLE CHECKED BY ____

BEARING OF ANGLE HOLE ____ BEFORE T. 1.5 / 2.0 m AFTER T. 3.4 / 3.0 m

Test section (m) From	To	L (m)	H_1 (m)	H_2 (m)	P_o (kg/cm²)	P (kg/cm²)	t (min)	Q_t (ℓ)	Q_o (ℓ/min/m)	L_u (Lugeon)	H_3 (m)	Remarks
⑦ 50.0	55.0	5.0	0.3	2.5	1	1.28	10	0	0	0	0	
		〃	〃	〃	3	3.28	〃	13	0.26	0.79	–	
		〃	〃	〃	5	5.28	〃	19	0.38	0.72	0.02	
		〃	〃	〃	7	7.28	〃	10	0.2	0.27	–	
		〃	〃	〃	10	10.27	〃	53	1.06	1.03	0.15	
		〃	〃	〃	7	7.28	〃	7	0.14	0.19	–	R
		〃	〃	〃	5	5.28	〃	7	0.14	0.27	–	R
		〃	〃	〃	3	3.28	〃	3	0.06	0.18	–	R
		〃	〃	〃	1	1.28	〃	4	0.08	0.63	–	R
⑧ 55.0	65.0	5.0	0.3	2.5	1	1.28	10	0	0	0	0	
		〃	〃	〃	3	3.28	〃	0	0	0	0	
		〃	〃	〃	5	5.28	〃	14	0.28	0.53	0.01	
		〃	〃	〃	7	7.28	〃	11	0.22	0.30	–	
		〃	〃	〃	10	10.28	〃	22	0.44	0.43	0.03	
		〃	〃	〃	7	7.28	〃	24	0.48	0.65	0.03	
		〃	〃	〃	5	5.28	〃	3	0.06	0.11	–	
		〃	〃	〃	3	3.28	〃	0	0	0	0	
		〃	〃	〃	1	1.23	〃	0	0	0	0	

Remarks. R; Pumped-in water flew out from top of hole.





H_3 : Friction loss of water pressure

① : Pump
② : Flow meter
③ : Pressure gauge
④ : Ground surface
⑤ : Drill hole
⑥ : Injection pipe
⑦ : Packer
⑧ : Water table
⑨ : Hydrostatic head
⑩ : Length of test section
⑪ : Diamater of hole

P_o : Gauge pressure
H_1 : Height of Pressure gauge
H_2 : Depth of Ground water
P : Effective pressure
$P = P_o + H/10$, $H = H_1 + H_2 - H_3$
t : Injected time
Q_t : Water volume during time in "t"
Q_o : Water volume per one min.
: Lugeon value in ℓ/min/m/10^{-6}kg/cm²
L_u : Coefficient of permeability
K

PERMEABILITY TEST IN DRILL HOLE (SHEET 6 OF 6)

KASSEB PROJECT Intake site HOLE No. SI 2

LOCATION _____ DEPTH OF HOLE 150.0 m TEST DATE _____

ELEVATION _____ m DIAMETER OF HOLE EX cm TESTED BY _____

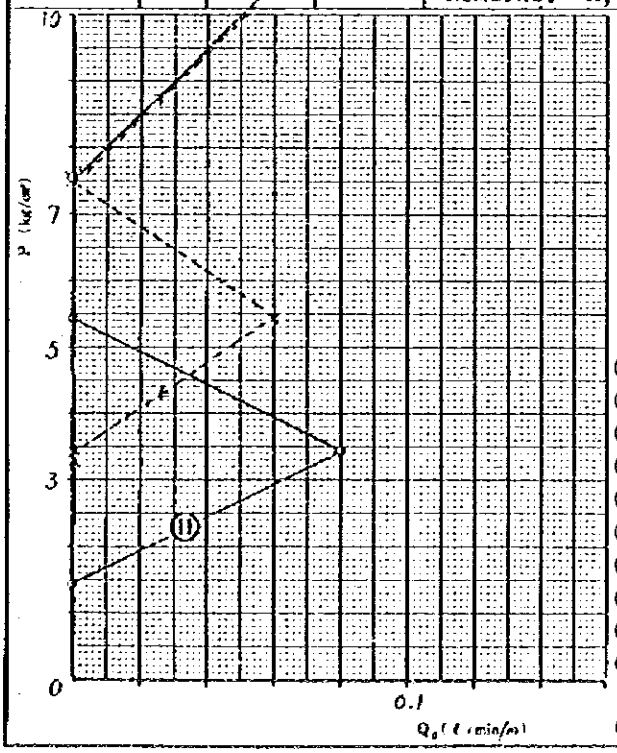
COORDINATE _____ DRILLED DEPTH _____ m DRILLED BY _____

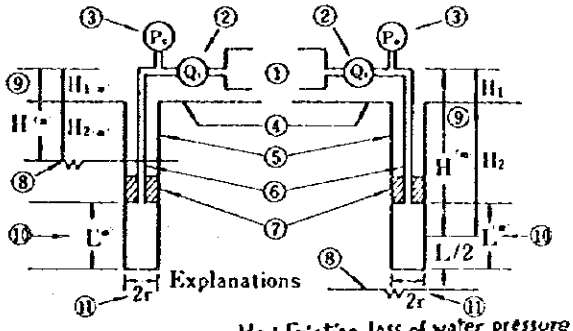
ANGLE FROM HORIZONTAL 90° LEVEL OF WATER TABLE CHECKED BY _____

BEARING OF ANGLE HOLE _____ BEFORE T. 2.8 m AFTER T. 5.6 m

Test section (m) From	To	L (m)	H_1 (m)	H_2 (m)	P_o (kg/cm²)	P (kg/cm²)	t (min)	Q_t (ℓ)	Q_o (ℓ/min)	L_u (Lugeon)	H_3 (m)	Remarks
⑪ 600	650	5	0.3	4.7	1	1.45	10	0	0	0	0	
		〃	〃	〃	3	3.45	〃	4	0.08	0.23	–	
		〃	〃	〃	5	5.45	〃	0	0	0	0	
		〃	〃	〃	7	7.45	〃	0	0	0	0	
		〃	〃	〃	10	10.45	〃	3	0.06	0.06	–	
		〃	〃	〃	7	7.45	〃	0	0	0	0	
		〃	〃	〃	5	5.45	〃	3	0.06	0.17	–	R
		〃	〃	〃	3	3.45	〃	0	0	0	0	
		〃	〃	〃	1	1.45	〃	0	0	0	0	

Remarks. R; Pumped-in water flew out from top of hole.





H_3 : Friction loss of water pressure

① : Pump
② : Flow meter
③ : Pressure gauge
④ : Ground surface
⑤ : Drill hole
⑥ : Injection pipe
⑦ : Packer
⑧ : Water table
⑨ : Hydrostatic head
⑩ : Length of test section
⑪ : Diamater of hole

P_o : Gauge pressure
H_1 : Height of Pressure gauge
H_2 : Depth of Ground water
P : Effective pressure
$P = P_o + H'/10$, $H = H_1 + H_2 - H_3$
t : Injected time
Q_t : Water volume during time in "t"
Q_o : Water volume per one min.
: Lugeon value in ℓ/min/m/10 kg/cm²
L_u : Coefficient of permeability
K

PERMEABILITY TEST IN DRILL HOLE (SHEET NO. 1 OF 3)

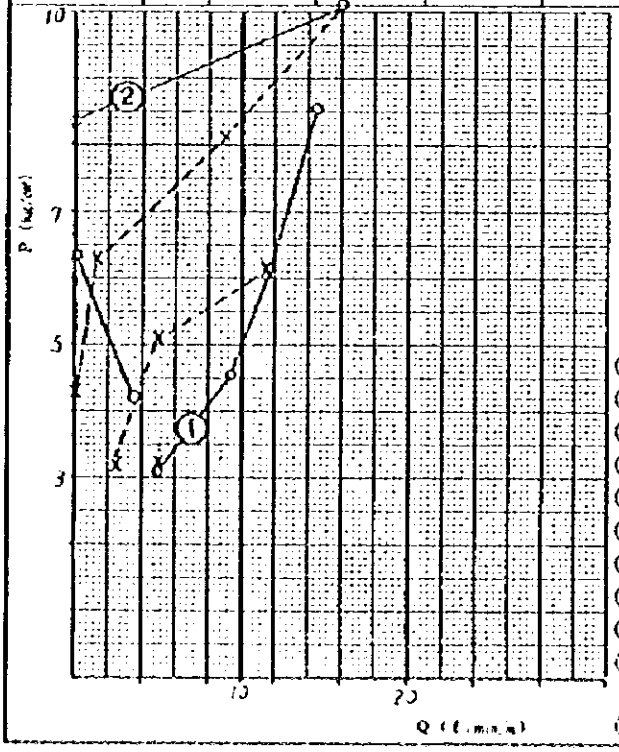
KASSEB PROJECT Outlet site HOLE No. SU 11

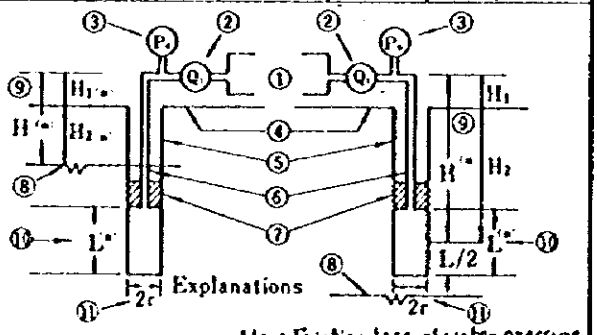
LOCATION
ELEVATION m
COORDINATE X 77.283 Y 91.383 (Planning)
ANGLE FROM HORIZONTAL 90°
BEARING OF ANGLE HOLE

DEPTH OF HOLE 70 m NX, 0-48 m
DIAMETER OF HOLE BX, 48- m
DRILLED DEPTH m
LEVEL OF WATER TABLE
BEFORE T. ① 2.5 ② 11.1 m AFTER T. 2.5 14.9 m

TEST DATE
TESTED BY
DRILLED BY
CHECKED BY HELLALI

Test section (m) From	To	L (m)	H_1 (m)	H_2 (m)	P_o (kg/cm²)	P (kg/cm²)	t (min)	Q_t (ℓ)	Q_o (ℓ/min/m)	L_u (Lugeon)	H_3 (m)	Remarks.
① 33.0	35.0	5.0	0.3	2.5	3	3.09	10	240	4.8	15.53	1.97	
		〃	〃	〃	5	4.56	〃	620	9.4	20.62	7.13	
		〃	〃	〃	7	6.15	〃	590	11.8	19.19	11.31	
		〃	〃	〃	10	8.55	〃	730	14.6	17.08	17.32	
		〃	〃	〃	7	6.21	〃	575	11.5	19.52	10.75	
		〃	〃	〃	5	5.09	〃	247	4.94	9.72	1.98	
		〃	〃	〃	3	3.23	〃	128	2.56	7.93	0.53	
② 35.5	63.0	3.5	0.3	13.0	3	4.27	10	126	3.6	8.43	0.61	
		〃	〃	〃	5	6.33	〃	0	0	0		
		〃	〃	〃	7	8.33	〃	0	0	0		
		〃	〃	〃	10	10.12	〃	564	16.1	15.91	12.15	
		〃	〃	〃	7	8.10	〃	245	7.0	8.64	2.27	
		〃	〃	〃	5	6.33	〃	3	0.86	0.14		
		〃	〃	〃	3	4.33	〃	0	0	0		





Explanations

① : Pump
② : Flow meter
③ : Pressure gauge
④ : Ground surface
⑤ : Drill hole
⑥ : Injection pipe
⑦ : Packer
⑧ : Water table
⑨ : Hydrostatic head
⑩ : Length of test section
⑪ : Diamater of hole

H_3 : Friction loss of water pressure.
P_o : Gauge pressure
H_1 : Height of Pressure gauge
H_2 : Depth of Ground water
P : Effective pressure
$P = P_o + H'/10$, $H = H_1 + H_2 - H_3$
t : Injected time
Q_t : Water volume during time in "t"
Q_o : Water volume per one min.
: Lugeon value in ℓ/min/m/10 kg/cm²
L_u : Coefficient of permeability
K

ELECTRIC POWER DEVELOPMENT CO. LTD TOKYO JAPAN

PERMEABILITY TEST IN DRILL HOLE (SHEET NO. 2 OF 3)

KASSEB PROJECT Outlet site HOLE No. SU 11

LOCATION _____ DEPTH OF HOLE 70 m TEST DATE _____

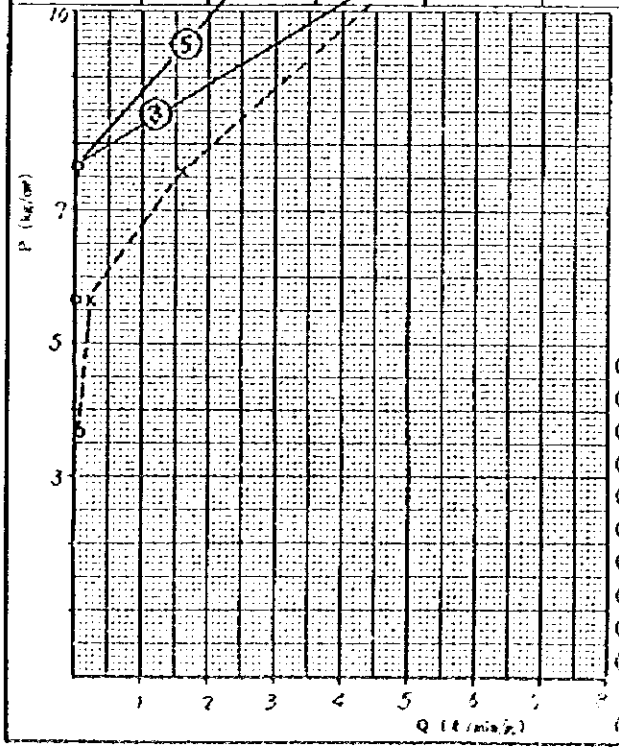
ELEVATION _____ m DIAMETER OF HOLE _____ cm TESTED BY _____

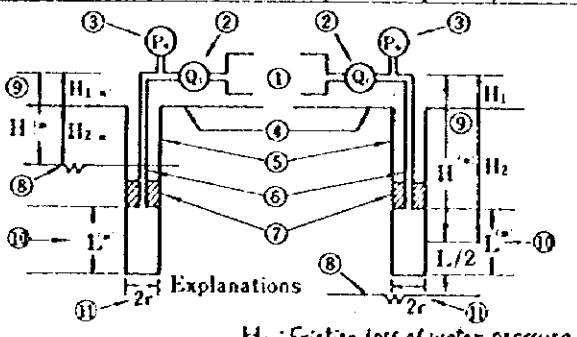
COORDINATE _____ DRILLED DEPTH _____ m DRILLED BY _____

ANGLE FROM HORIZONTAL 90° LEVEL OF WATER TABLE CHECKED BY HELIALI

BEARING OF ANGLE HOLE _____ BEFORE T. 11.1 m AFTER T. 14.9 m

Test section (m) From	To	L (m)	H_1 (m)	H_2 (m)	P_o (kg/cm²)	P (kg/cm²)	t (min)	Q_t (ℓ)	Q_o (ℓ/min/m)	L_u (Lugeon)	H_3 (m)	Remarks
③	40.0-45.0	5.0	0.3	13.0	3	4.33	10	7	0.04	0.07		
		〃	〃		5	6.33	〃	0	0	0		
		〃	〃		7	8.33	〃	0	0	0		
		〃	〃		10	11.02	〃	270	5.4	4.70	3.10	
		〃	〃		9	8.30	〃	33	1.6	1.93	0.27	
		〃	〃		5	6.32	〃	12	0.24	0.38	0.01	
		〃	〃		3	4.33	〃	0	0	0		
④	45.0-50.0	This section wasn't tested due to the collapse of hole.										
⑤	50.0-55.0	5.0	0.3	13.0	3	4.33	10	1	0.02	0.05	-	
		〃	〃	〃	5	6.33	〃	0	0	0	-	
		〃	〃	〃	7	8.33	〃	0	0	0	-	
		〃	〃	〃	10	11.31	〃	180	3.6	3.18	0.14	
		〃	〃	〃	7	8.33	〃	0	0	0	-	
		〃	〃	〃	5	6.33	〃	0	0	0	-	
		〃	〃	〃	3	4.33	〃	0	0	0	-	





① : Pump
② : Flow meter
③ : Pressure gauge
④ : Ground surface
⑤ : Drill hole
⑥ : Injection pipe
⑦ : Packer
⑧ : Water table
⑨ : Hydrostatic head
⑩ : Length of test section
⑪ : Diamater of hole

H_3 : Friction loss of water pressure.
P_o : Gauge pressure
H_1 : Height of Pressure gauge
H_2 : Depth of Ground water
P : Effective pressure
$P = P_o + H(m)/10$, $H = H_1 + H_2 - H_3$
t : Injected time
Q_t : Water volume during time in "t"
Q_o : Water volume per one min.
: Lugeon value in ℓ/min/m/10 kg/cm²
L_u : Coefficient of permeability
K

PERMEABILITY TEST IN DRILL HOLE (SHEET No.3 OF 3)

KASSEB PROJECT Outlet site HOLE No. SU 11

LOCATION _____ DEPTH OF HOLE 70.0 m TEST DATE _____

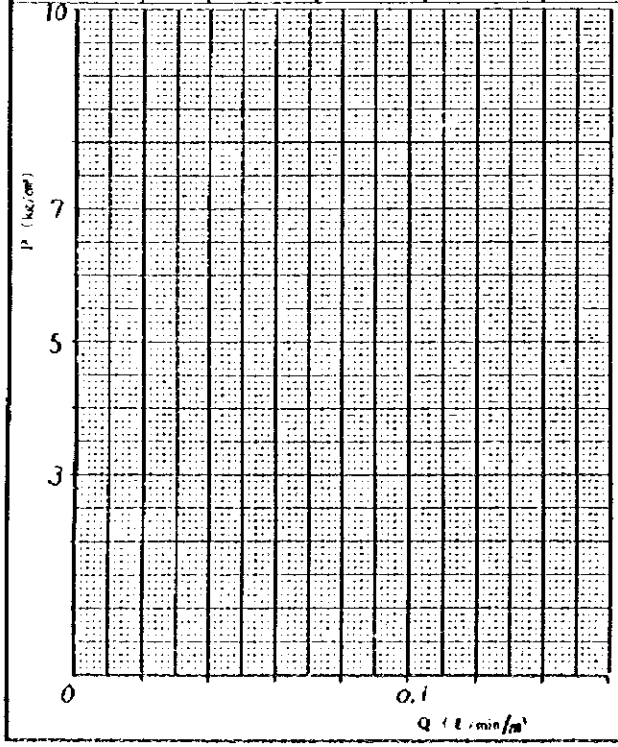
ELEVATION _____ m DIAMETER OF HOLE _____ cm TESTED BY _____

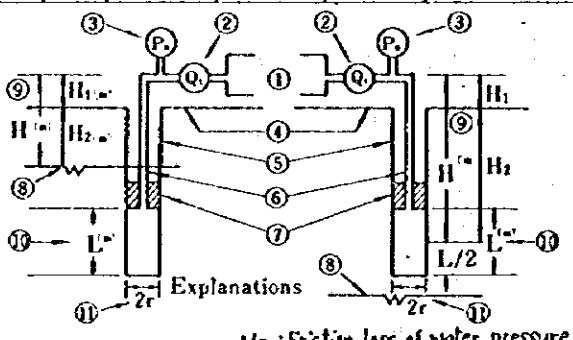
COORDINATE _____ DRILLED DEPTH _____ m DRILLED BY _____

ANGLE FROM HORIZONTAL 90° LEVEL OF WATER TABLE CHECKED BY HELLALI

BEARING OF ANGLE HOLE _____ BEFORE T. ⑤ 11.1 ⑥ 11.5 m AFTER T. 14.9 m

Test section (m) From	To	L (m)	H_1 (m)	H_2 (m)	P_o (kg/cm²)	P (kg/cm²)	t (min)	Q_t (ℓ)	Q_o (ℓ/min/m)	L_u (Lugeon)	H_3 (m)	Remarks
⑥55.0	65.0	5.0	0.3	13.0	3	4.33	10	0		0		
		"	"	"	5	6.33	"	0		0		
		"	"	"	7	8.33	"	0		0		
		"	"	"	10	11.33	"	4	0.08	0.07	-	
		"	"	"	7	8.33	"	0		0		
		"	"	"	5	6.33	"	0		0		
		"	"	"	3	4.33	"	0		0		
⑦60.0	65.0	5.0	0.3	13.0	3	4.33	10	0		0		
		"	"	"	5	6.33	"	0		0		
		"	"	"	7	8.33	"	0		0		
		"	"	"	10	11.33	"	2	0.04	0.04	-	
		"	"	"	7	8.33	"	0		0		
		"	"	"	5	6.33	"	0		0		
		"	"	"	3	4.33	"	0		0		
⑧65.0	70.0	This section wasn't tested due to the collapse of hole.										





① : Pump
② : Flow meter
③ : Pressure gauge
④ : Ground surface
⑤ : Drill hole
⑥ : Injection pipe
⑦ : Packer
⑧ : Water table
⑨ : Hydrostatic head
⑩ : Length of test section
⑪ : Diamater of hole

H_3 : Friction loss of water pressure.
P_o : Gauge pressure
H_1 : Height of Pressure gauge
H_2 : Depth of Ground water
P : Effective pressure
$P = P_o + H'/10$, $H = H_1 + H_2 - H_3$
t : Injected time
Q_t : Water volume during time in "t"
Q_o : Water volume per one min.
: Lugeon value in ℓ/min/m/10⁴g/cm²
L_u : Coefficient of permeability
K

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APPENDIX 3

CONTENTS

LOG OF TEST PIT OR AUGER HOLE

FEATURE Kasseb project LOCATION Damsite(Axis of dam) HOLE NO P 10
COORDINATE X= 87,070.21 Y= 78,641.75 METHOD OF EXCAVATION Hand
GROUND ELEVATION TOTAL DEPTH OF HOLE 3.5 m DIMENSIONS OF HOLE
DATE OF EXCAVATION HOLE LOGGED BY H.SUETOMI / HELLALI

DEPTH (m)	ELEVATION (m)	GRAPHIC	SOIL NAME AND CLASSIFICATION	DESCRIPTION	SAMPLING DEPTH (m)	WATER CONTENT (%)	GRADATION** (%)
1				Soil ; Brown, cohesive, With small debris and roots. 1.0			100 80 60 40 20 0
2				MARLSTONE; Dark brown, highly weathered, cracky and clayey. Foliated. 2.0			
3				MARLSTONE; Greyish brown, massive and compact. Upper portion is weathered and cracky but deeper portion changes to compact light grey.			
				Bottom of pit. 3.5 m			

NOTES
* GRAPHIC SYMBOLS ARE AS BELOW
ROCK FRAGMENT, GRAVEL, SAND, SILT, LOAM, CLAY, ORGANIC MATTER, G.W.L
** GRADATION
PERCENT PASSING NO 4 SIEVE
PERCENT PASSING NO 200 SIEVE

CHECKED
APPROVED
DATE

LOG OF TEST PIT OR AUGER HOLE

FEATURE Kaaseb project LOCATION Damsite(Axis of dam) HOLE NO P 11

COORDINATE X= 87,233.11 Y= 78,636.61 METHOD OF EXCAVATION Hand

GROUND ELEVATION _____ TOTAL DEPTH OF HOLE 6.0 m DIMENSIONS OF HOLE _____

DATE OF EXCAVATION _____ HOLE LOGGED BY STEO

DEPTH (m)	ELEVATION (m)	GRAPHIC	SOIL NAME AND CLASSIFICATION	DESCRIPTION	SAMPLING DEPTH (m)	WATER CONTENT (%)	GRADATION ** (%)
1				Clay; Silty, greyish yellow with rare rock-fragments.			100 80 60 40 20 0
2							
3				3.0 Clay; Silty, yellow. With concretions of CALCITE and small debris of MARLSTONE. 4.0			
4				MARLSTONE; Yellowish grey. Severely weathered. 4.2			
5				▽ 4.85 MARLSTONE; Grey. Highly cracked.			
6				Bottom of hole, 6.0m			

NOTES

* GRAPHIC SYMBOLS ARE AS BELOW

ROCK FRAGMENT | GRAVEL | SAND | SILT | LOAM | CLAY | ORGANIC MATTER | GWL

** GRADATION

PERCENT PASSING NO 4 SIEVE

PERCENT PASSING NO 200 SIEVE

DRAWN _____ CHECKED _____ SUBMITTED _____ RECOMMENDED _____ APPROVED _____ DATE _____