社会開発調査部報告書

JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

LOCAL WATER UTILITIES ADMINISTRATION
REPUBLIC OF THE PHILIPPINES

CAVITE WATER SUPPLY DEVELOPMENT STUDY
IN
THE REPUBLIC OF THE PHILIPPINES

VOLUME 3

SUPPORTING REPORT

MAY 1995

KOKUSAI KOGYO CO., LTD.
NIPPON JOGESUIDO SEKKEI CO., LTD.

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1. TEST DRILLING, PUMPING TEST AND ELECTRIC LOGGING

1. TEST DRILLING, PUMPING TEST AND ELECTRIC LOGGING

1.1 STUDY METHOD AND WORK AMOUNTS

The sites where test wells were drilled in the Study are shown in **Fig.s 1-1** to **1-4** and the work amount for these wells is shown in **Table 1-1.** Daily activity records of drilling work are presented in **Tables 1-2** to **1-5**.

Main equipments and materials used in test drilling, pumping test and electric logging are as follows:

(1) Lotary Drilling Machine

LONGYEA-38	:	Spindle-type (for G.M.A and Naic)
LONGYEA-44	:	Spindle-type (for Mendez)
TOHO-HD6	:	Spindle-type (for Tanza)

(2) Instrument for Well Logging

GEOLOGGER (Model 3434)	:	Electric logging for G.M.A
MAC-OHM (Model 2115)	:	Electric logging for Tanza, Naic, and Mendez

Gamma-ray logging was carried out by GEOLOGGER for G.M.A., Tanza, Naic, and Mendez.

(3) Compressor for Well Development

KOMATSU Engine drive rotary type compressor
(7-8 kg/cm^2, 7 m^3/min)

Riser Pipe	:	ϕ 100 mm x 6 m (49 pcs)
Air Pipe	:	ϕ 25 mm x 6 m (25 pcs)
Air Hose	:	ϕ 25 mm x 20 m (1 pc)

(4) Submersible Pump for Pumping Test

Grund Jose	: 2" diameter x 22 stage 10 Hp x 220 V (for G.M.A.)
Pleuger	: 4" diameter x 6 stage x 70 Hp x 440 V (for Tanza)
Pleuger	: 4" diameter x 6 stage x 70 Hp x 440 V (for Naic)
Grund Jose	: 3" diameter x 20 stages x 30 Hp x 440 V (for Mendez)

(5) Casing Pipe (Standard Pipe)

ϕ 150 mm steel pipe	:	6 m x 12 = 72 m
ϕ 200 mm steel pipe	:	6 m x 64 = 384 m +lm x 2
ϕ 250 mm steel pipe	:	6 m x 20 = 120 m +lm x 2
		Total: 580 m

(6) Screen Pipe

MK Continuous V-shaped slot wedge stainless wire wound screen AISI Type 304

ϕ 150 mm Slot # 60	:	78 m
ϕ 200 mm Slot # 60	:	96 m
Total	:	174 m

(7) Gravel for Packing

# 10	:	30,800 kg
# 5	:	2,100 kg
Total	:	32,900 kg

1.2 HYDROGEOLOGICAL CHARACTERISTICS OF MAIN AQUIFERS

Well structure and geologic columnar section of tanza, Naic and Mendez test wells are presented in **Tables 1-6** to **1-8**.

Electric logging data are presented in **Fig.s 1-5** to **1-8**.

Fig.s 1-9 to **1-12** show the pumping test results of each test well.

Table 1-9 shows the hydrological constants obtained from electric logging and pumping test for the four test wells.

According to the results of the four test wells, three aquifers, shown in **Table 1-10,** were distinguished.

Middle Aquifer is the best aquifer among the three judging from its large specific capacity (Sc) and transmissivity (T), it was deposited at the end of Cavite Slope as alluvial fan conglomerate.

From the fact that conductivity is low in Upper Aquifer and Middle Aquifer but high in Lower Aquifer, groundwater stored in the former two is free and the latter is confined since the pressure holds the dissolved mineral in solution which gave high conductivity values.

Fig.s 1-13 to **1-16** show the relationship between pumping discharge and drawdown obtained from the step-drawdown pumping test for each test well.

Table 1-1 WORK AMOUNT FOR TEST WELL

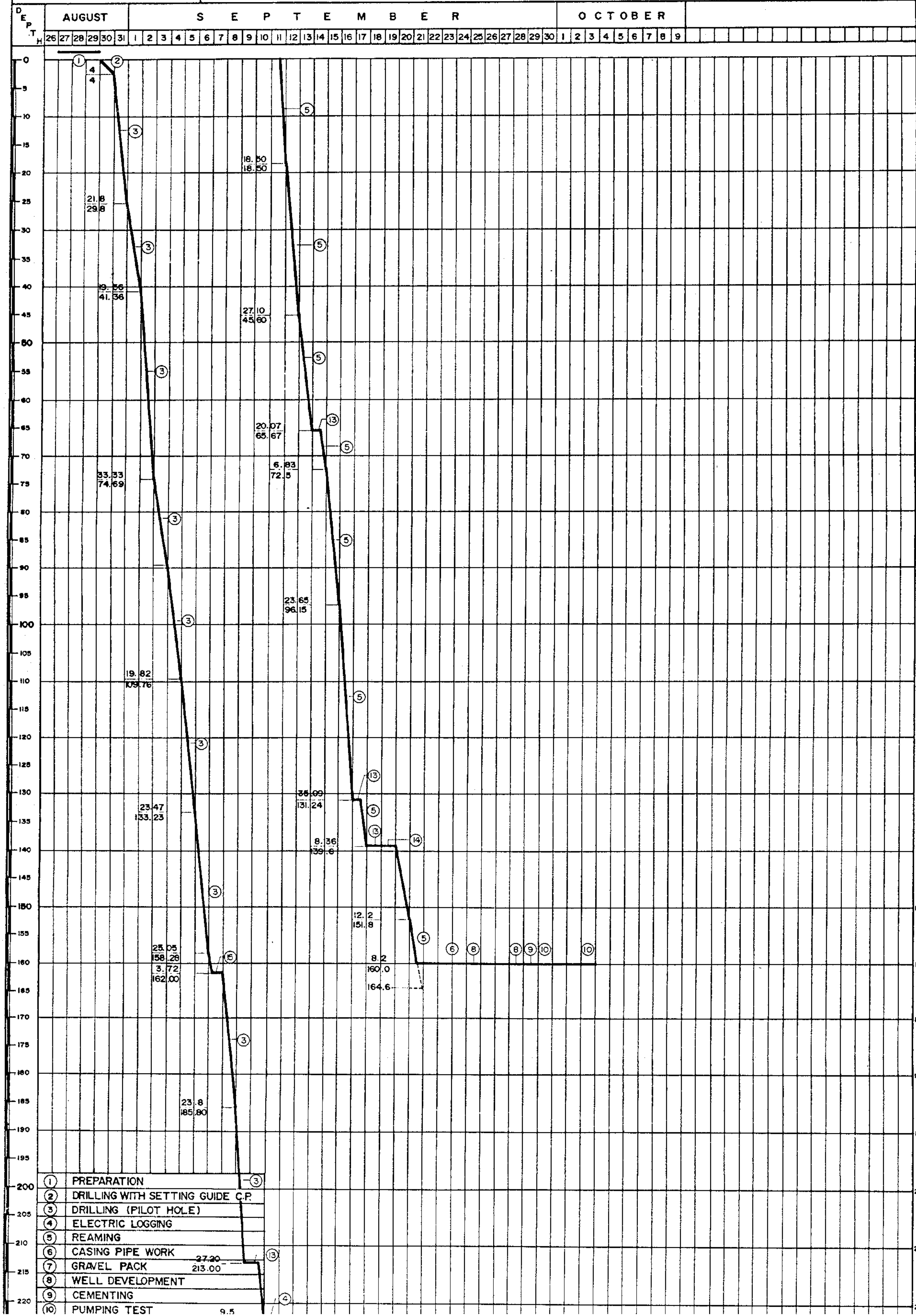
TEST WELL	Length of Borehole (m)					Length of Casing (m)				Length of Electric Logging			PUMPING TEST			REMARKS
	φ 400	φ 370	φ 350	φ 320	Total	φ 250	φ 200	φ 150	Total	SP	Normal	Gamma	STEP	CONT	REC	
A. G.M.A *1	-	-	100	60	160	-	100	60 (48)	160	220	220	220	4	1	1	Well site is in a lot for No. 4 well of G.M.A Water District
B. TANZA	60	90	-	-	150	60	90 (48)	-	150	150	150	150	4	1	1	Well site is in a private land about 4.6 km south of a lot for the well of Tanza Water District.
C. NAIC	60	90	-	-	150	60	90 (48)	-	150	150	150	150	4	1	1	Well site is in a lot of the elementary school of Naic.
D. MENDEZ *2	-	-	200	90	290	-	200	90 (30)	290	290	290	260	4	1	1	Well site is in a private land about 600 m south of a lot for the well of Mendez Water District.
TOTAL	120	180	300	150	750	120	430 (96)	150 (78)	750 (174)	810	810	730	16	4	4	

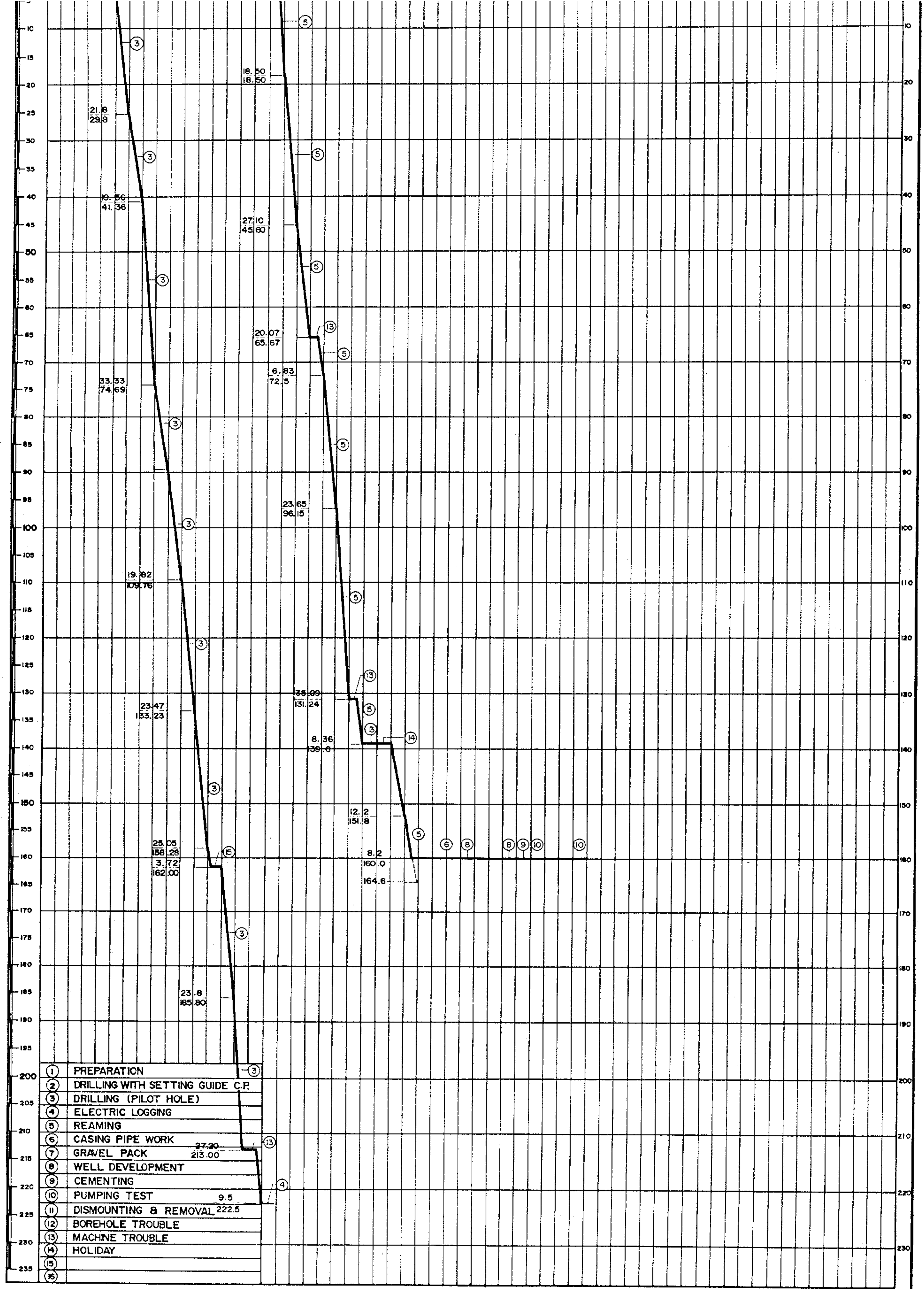
* Figure with parentheses means the total depth of screens.

*1 The length of the borehole of G.M.A. was designed as 220 m at first but it was changed to 160 m because permeability between 160 m and 220 below GL was estimated low.

*2 The length of the borehole of Mendez was designed as 230 m at first, but it was changed to 290 m because the groundwater level was estimated deeper than 100 m below GL.

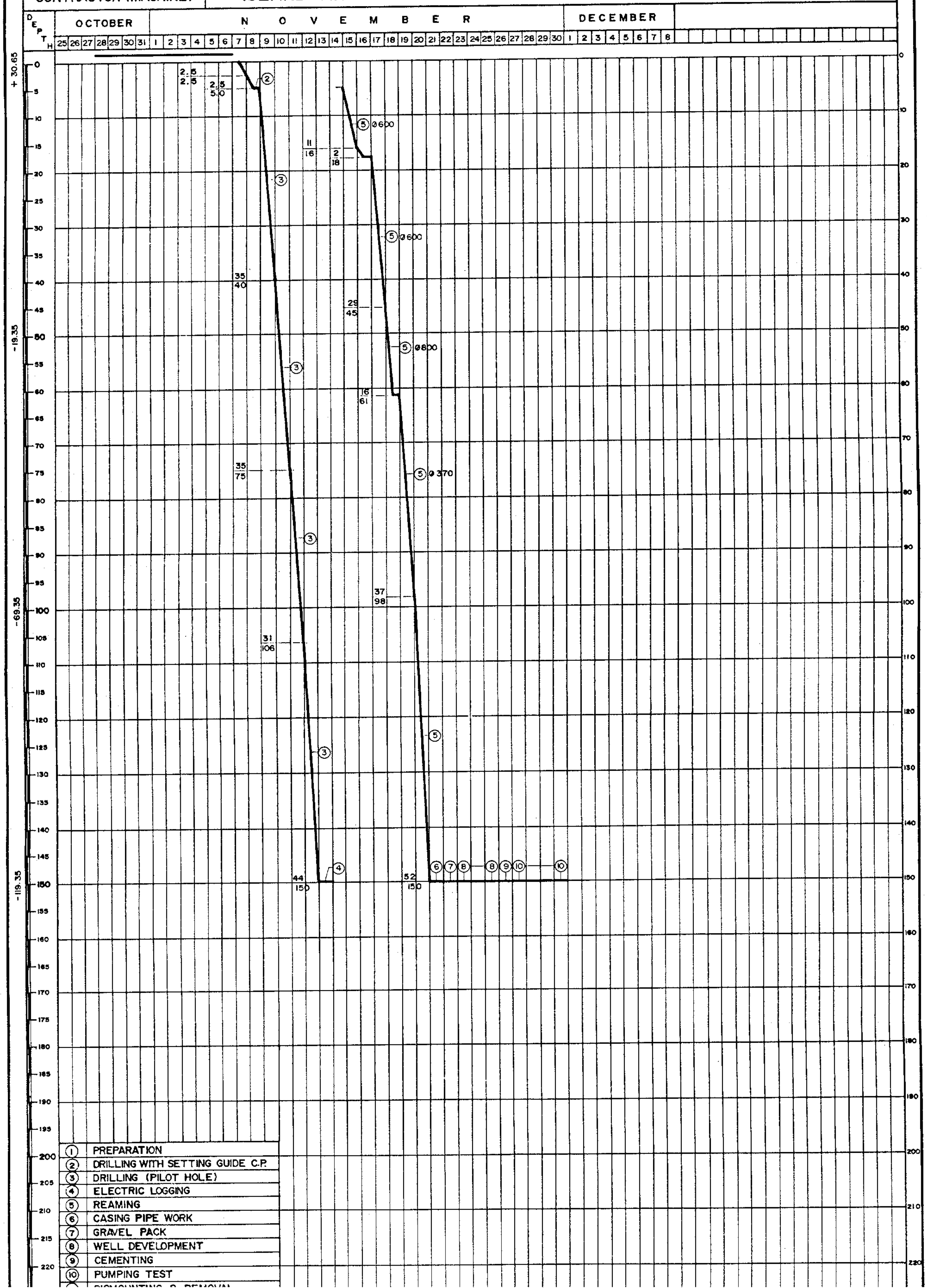
WELL NO.	LOCATION (G. EL.)	G.M.A., CAVITE WELL NO. A		(EL. 163.65 M.)
WELL CONSTRUCTION DATA	DEPTH : 220 (M.), HOLE DIAMETER :	350 mm.,		320 mm. 2 SHIFT / D = 24 H
CONTRACTOR (MACHINE)	ISLAND ARC DRILLING CORPORATION			(SPINDLE TYPE ROTARY DRILLING MACHINES)

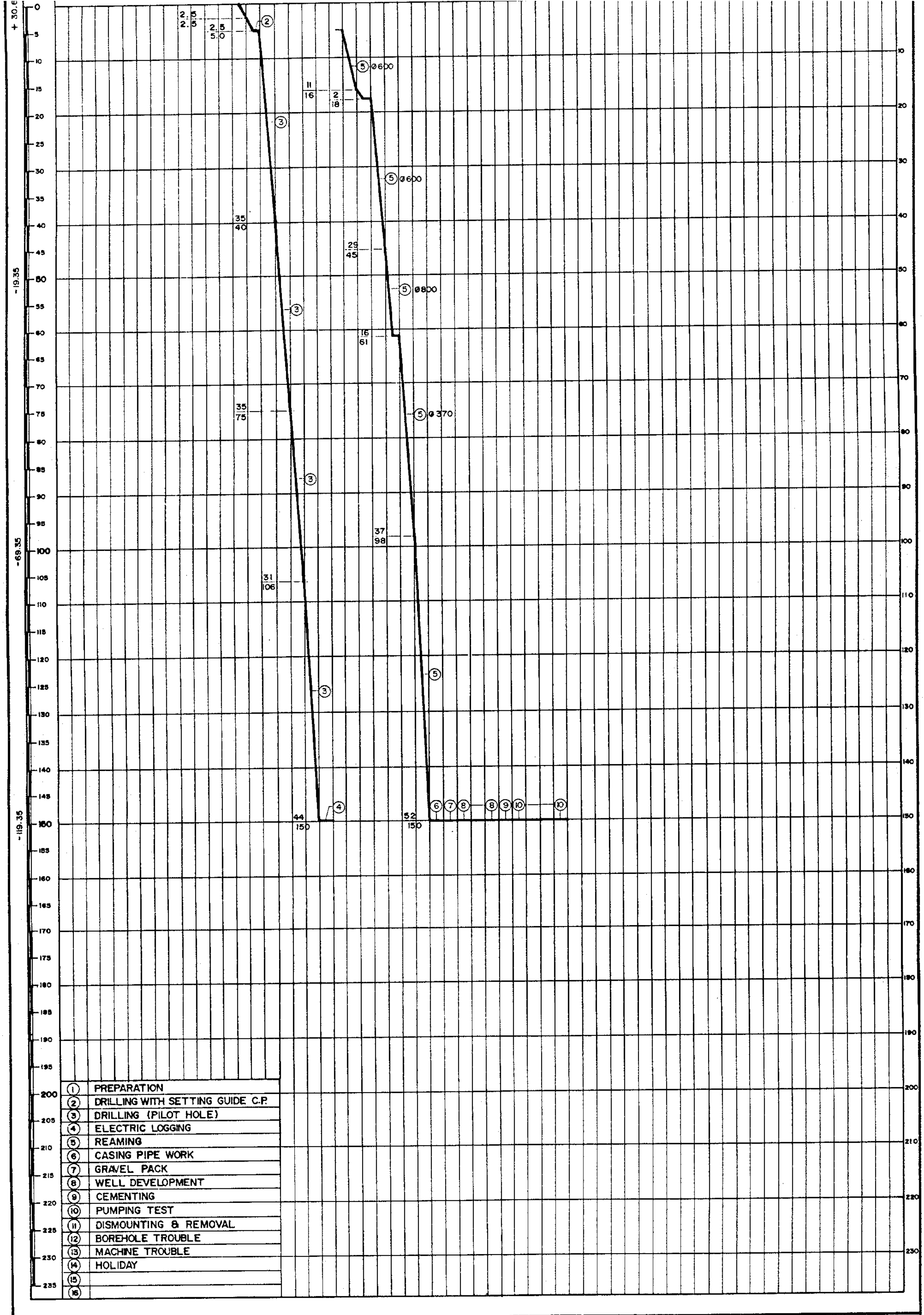




CAVITE WATER SUPPLY DEVELOPMENT STUDY	Table 1-2 DAILY ACTIVITY RECORD OF DRILLING WORK (A) G. M. A
JAPAN INTERNATIONAL COOPERATION AGENCY	

WELL NO.	LOCATION (G. EL.)	TANZA, CAVITE WELL NO. B	(EL. 30.65 M.)
WELL CONSTRUCTION DATA		DEPTH : 150 (M.), HOLE DIAMETER : 400 mm. , 370 mm.	
CONTRACTOR (MACHINE)		ISLAND ARC DRILLING CORPORATION	(SPINDLE TYPE ROTARY DRILLING MACHINES)



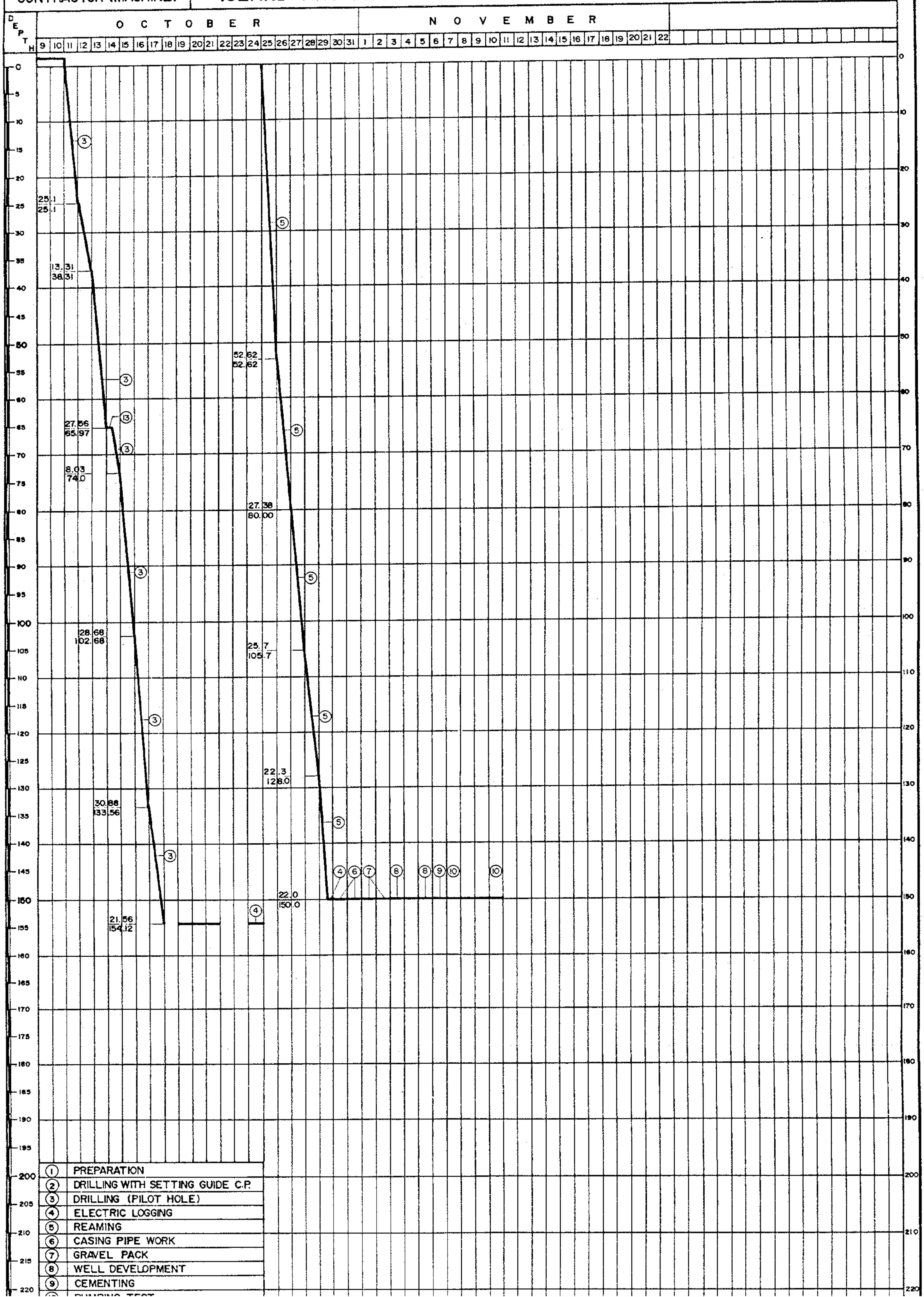


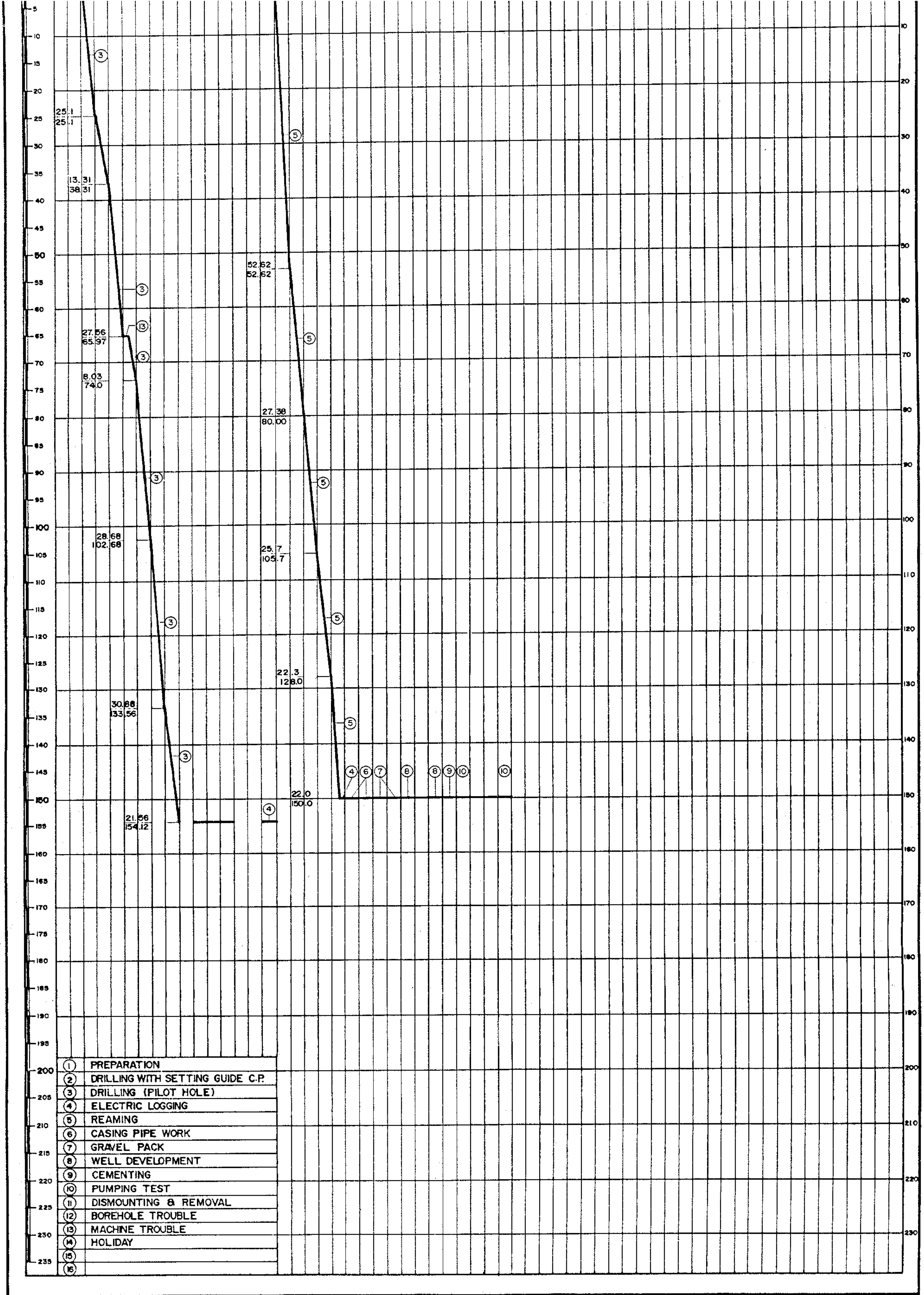
CAVITE WATER SUPPLY DEVELOPMENT STUDY

JAPAN INTERNATIONAL COOPERATION AGENCY

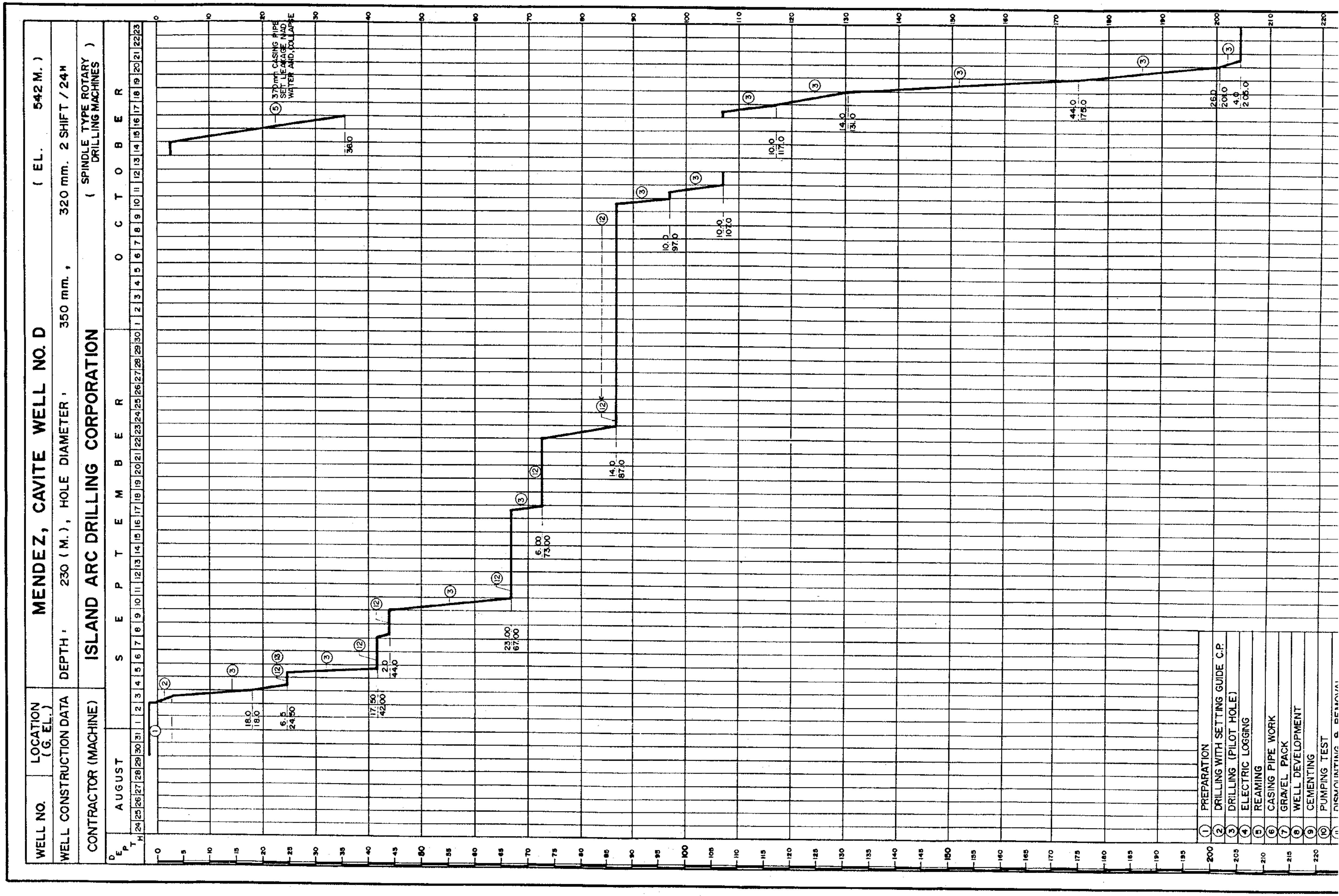
Table 1-3
DAILY ACTIVITY RECORD
OF DRILLING WORK (B) TANZA

WELL NO.	LOCATION (G. EL.)	NAIC, CAVITE WELL NO. C	(EL. 10.48 M.)
WELL CONSTRUCTION DATA		DEPTH : 150 (M.), HOLE DIAMETER : 400 mm., 370 mm.	
CONTRACTOR (MACHINE)		ISLAND ARC DRILLING CORPORATION	(SPINDLE TYPE ROTARY DRILLING MACHINES)

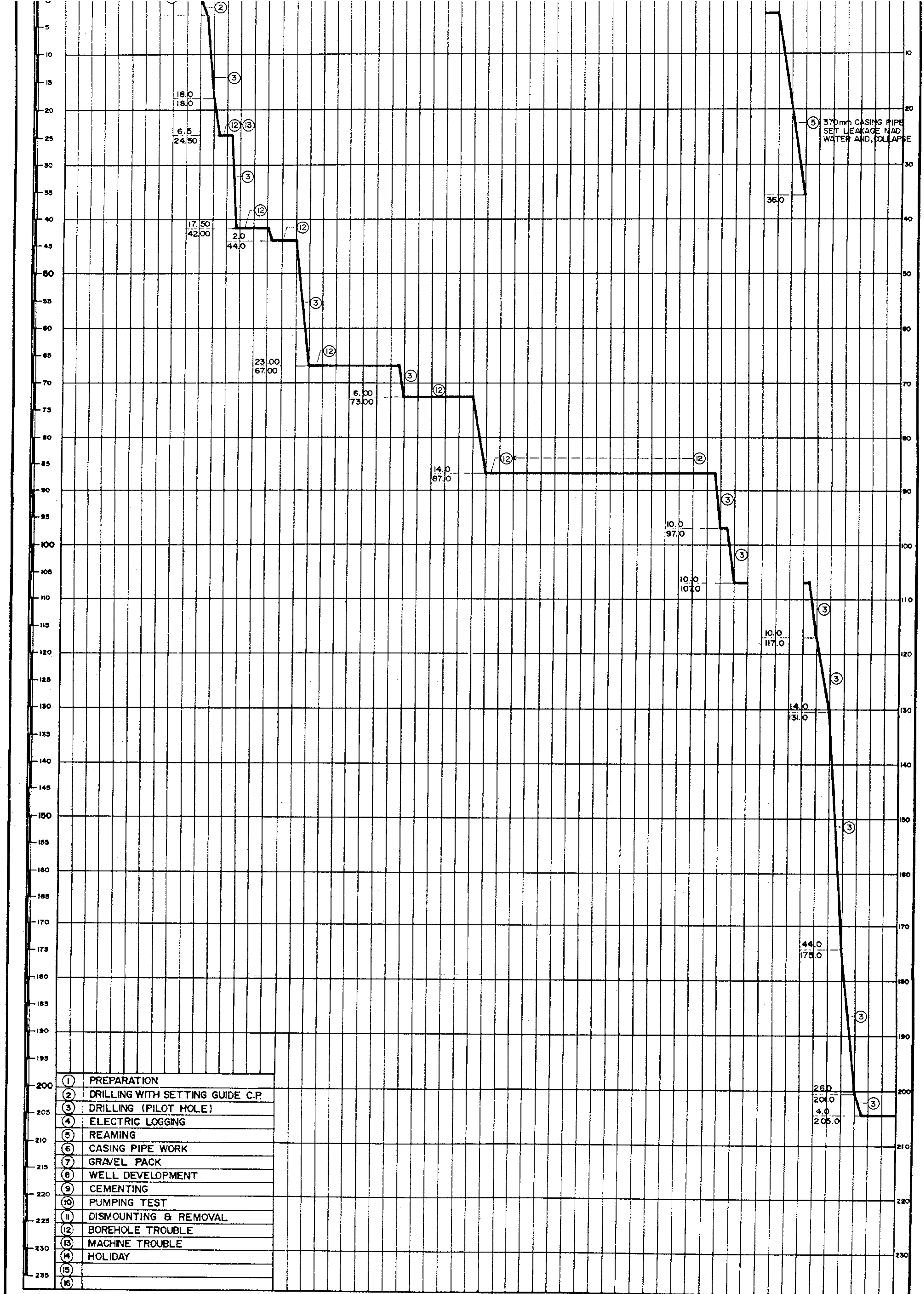




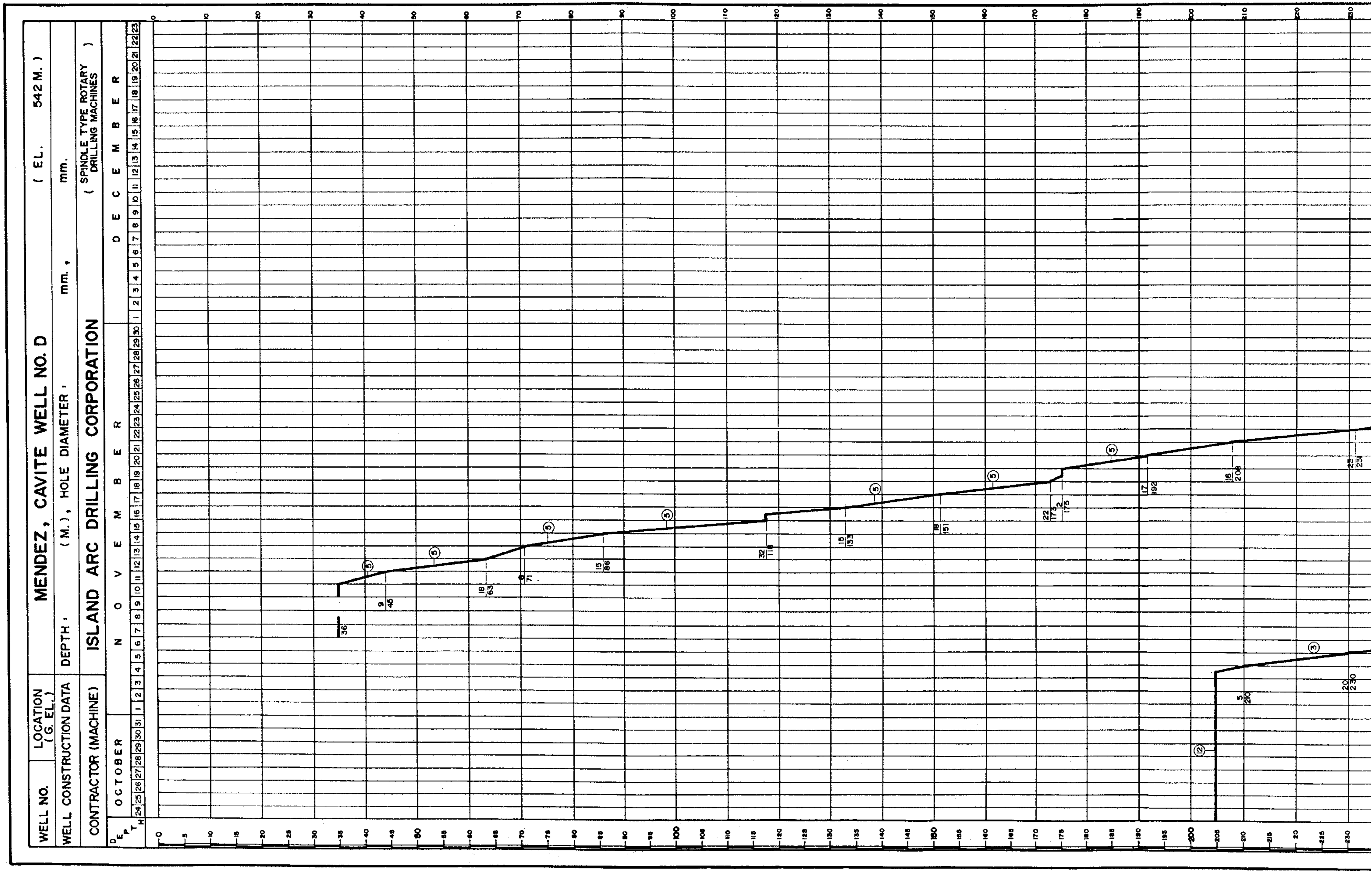
CAVITE WATER SUPPLY DEVELOPMENT STUDY	Table 1-4
JAPAN INTERNATIONAL COOPERATION AGENCY	DAILY ACTIVITY RECORD OF DRILLING WORK (C) NAIC

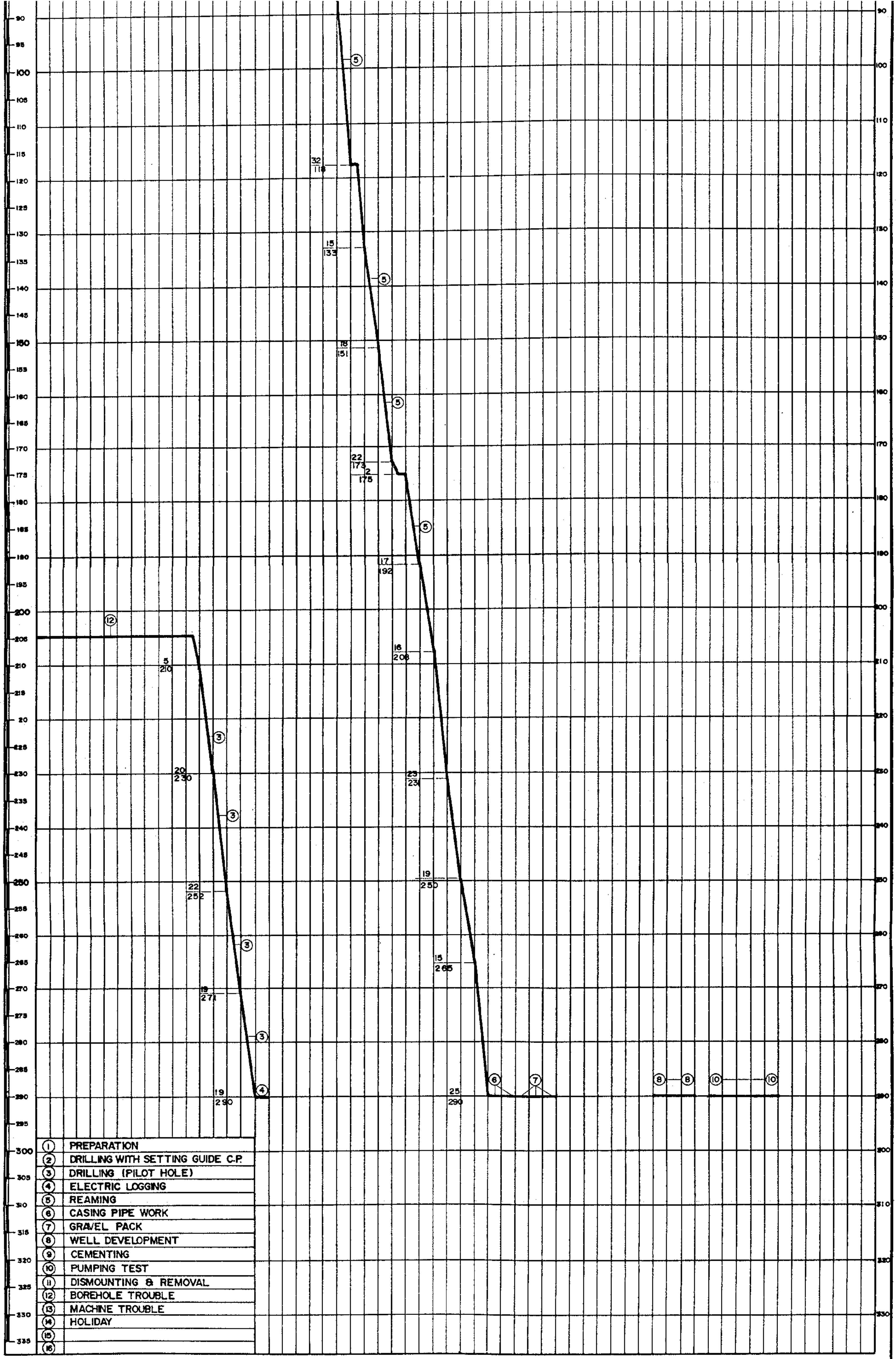


WELL NO.
LOCATION (G. EL.)
MENDEZ, CAVITE WELL NO. D
(EL. 542 M.)
WELL CONSTRUCTION DATA
DEPTH : 230 (M.), HOLE DIAMETER : 350 mm., 320 mm. 2 SHIFT / 24H
CONTRACTOR (MACHINE)
ISLAND ARC DRILLING CORPORATION
(SPINDLE TYPE ROTARY DRILLING MACHINES)
DEPTH
AUGUST
SEPTEMBER
OCTOBER
370mm CASING PIPE SET LEAKAGE NAD WATER AND COLLAPSE
1 PREPARATION
2 DRILLING WITH SETTING GUIDE C.P.
3 DRILLING (PILOT HOLE)
4 ELECTRIC LOGGING
5 REAMING
6 CASING PIPE WORK
7 GRAVEL PACK
8 WELL DEVELOPMENT
9 CEMENTING
10 PUMPING TEST



CAVITE WATER SUPPLY DEVELOPMENT STUDY	Table 1-5(a) DAILY ACTIVITY RECORD OF DRILLING WORK (D) MENDEZ (V2)
JAPAN INTERNATIONAL COOPERATION AGENCY	


WELL NO.
MENDEZ, CAVITE WELL NO. D
LOCATION (G. EL.)
(EL. 542 M.)
WELL CONSTRUCTION DATA
DEPTH : (M.), HOLE DIAMETER : mm. , mm.
CONTRACTOR (MACHINE)
ISLAND ARC DRILLING CORPORATION
(SPINDLE TYPE ROTARY DRILLING MACHINES)
OCTOBER
NOVEMBER
DECEMBER
DEPTH



CAVITE WATER SUPPLY DEVELOPMENT STUDY	Table 1-5 (b) DAILY ACTIVITY RECORD OF DRILLING WORK (D) MENDEZ (2/2)
JAPAN INTERNATIONAL COOPERATION AGENCY	

Table 1-6(1/2)

WELL STRUCTURE AND GEOLOGIC COLUMNAR SECTION OF TANZA TEST WELL

LOCATION: TANZA, CAVITE	WELL NO. B					EL=30.65mL	DEPTH = 150 m				
DEPTH	SP	Short a = 0.4 m		Long a=1.6m		DEPTH	SP	Short a=0.4m		Long a=1.6m	
	MV	R	4π aR	R	4π aR		MV	R	4π aR	R	4π aR
						53	- 210	4.297	21.60	0.865	17.39
6						54	- 197	1.611	8.10	0.735	14.78
7	- 13.8					55	- 194	2.832	14.24	0.840	16.89
8	- 163					56	- 194	4.742	23.84	0.756	15.20
9	- 413					57	- 198	4.262	21.42	0.964	19.38
10	- 202	2.519	12.66	0.971	19.52	58	- 215	4.338	21.81	1.155	23.22
11	- 182	2.548	12.80	0.971	19.52	59	- 209	3.763	18.91	0.996	20.03
12	- 188	4.091	20.56	1.075	21.61	60	- 20	3.608	18.14	1.057	21.25
13	- 198	7.878	35.60	1.170	23.52	61	- 193	4.465	22.44	0.938	18.86
14	- 195	6.910	34.73	1.415	28.45	62	- 197	1.465	7.36	0.440	8.85
15	- 218	7.004	35.21	1.692	34.02	63	- 200	1.049	5.27	0.487	9.79
16	- 193	6.060	30.46	1.459	29.33	64	- 212	1.054	5.30	0.462	9.29
17	- 192	2.874	14.45	0.978	19.66	65	- 192	1.060	5.33	0.429	8.63
18	- 187	2.149	10.80	1.009	20.29	66	- 198	2.438	12.25	0.465	9.35
19	- 188	2.667	13.41	1.038	20.87	67	- 194	2.434	12.23	0.465	9.35
20	- 188	3.862	19.41	0.775	15.58	68	- 195	3.981	20.01	0.50	10.07
21	- 190	2.101	10.56	0.886	17.81	69	- 200	2.390	12.01	0.692	14.06
22	- 214	2.716	13.65	1.015	20.41	70	- 203	2.350	11.81	0.666	13.39
23	+ 193	3.742	18.81	0.906	18.22	71	- 200	1.639	8.24	0.549	11.04
24	- 197	2.503	12.58	0.931	18.72	72	- 203	1.723	8.66	0.521	10.48
25	- 186	2.655	13.35	1.146	23.04	73	- 221	1.297	6.52	0.498	10.01
26	- 187	4.904	24.65	1.044	20.99	74	- 205	1.786	8.97	0.547	11.00
27	- 193	5.064	25.45	1.241	24.95	75	- 201	3.542	17.80	0.301	6.05
28	- 184	7.658	38.49	1.551	31.18	76	- 206	0.947	4.76	0.292	5.87
29	- 192	10.330	51.92	1.870	37.60	77	- 207	0.699	3.51	0.347	6.98
30	- 191	11.29	56.75	2.513	50.53	78	- 193	0.666	3.35	0.297	5.97
31	- 191	11.00	55.29	2.811	56.52	79	- 197	0.475	2.39	0.293	5.89
32	- 188	10.86	54.59	2.820	56.70	80	- 198	0.801	4.03	0.270	5.43
33	- 195	9.770	49.11	2.627	52.82	81	- 197	0.857	4.31	0.291	5.85
34	- 192	6.042	30.37	2.239	45.02	82	- 199	0.858	4.31	0.301	6.05
35	- 186	8.022	40.32	2.573	51.73	83	- 107	0.854	4.29	0.258	5.19
36	- 190	10.86	54.59	2.379	47.83	84	- 99	0.810	4.07	0.270	5.43
37	- 190	13.19	66.30	2.858	57.46	85	- 203	0.578	2.91	0.289	5.81
38	- 195	13.15	66.10	2.845	57.20	86	- 215	0.967	4.86	0.316	6.35
39	- 202	12.20	61.32	2.539	51.05	87	- 201	1.287	6.47	0.313	6.29
40	- 193	3.361	16.89	1.327	26.68	88	- 204	0.627	3.15	0.311	6.25
41	- 207	6.055	30.44	1.563	31.42	89	- 114	1.065	5.35	0.345	6.94
42	- 203	10.210	51.32	1.303	26.20	90	- 208	1.220	6.13	0.325	6.53
43	- 193	10.820	54.39	1.639	32.95	91	- 100	1.087	5.46	0.341	6.86
44	- 199	2.413	12.13	0.846	17.01	92	- 207	1.272	6.39	0.367	7.38
45	- 193	1.896	9.53	0.890	17.89	93	- 219	0.757	3.81	0.359	7.22
46	- 190	2.510	12.62	0.844	16.97	94	- 122	1.325	6.60	0.421	8.46
47	- 192	2.209	11.10	0.630	12.67	95	- 212	1.579	7.94	0.430	8.65
48	- 196	2.016	10.13	0.781	15.70	96	- 209	2.395	12.04	0.433	8.71
49	- 192	2.597	13.05	0.767	15.42	97	- 209	1.578	7.93	0.613	12.33
50	- 200	3.947	19.84	0.906	18.22	98	- 138	1.723	8.66	0.691	13.89
51	- 207	6.137	30.85	0.983	19.76	99	- 206	3.234	16.26	0.617	12.41
52	- 204	6.694	33.65	1.213	24.39	100	- 207	1.089	5.47	0.298	5.99

Table 1-6(2/2)

WELL STRUCTURE AND GEOLOGIC COLUMNAR SECTION OF TANZA TEST WELL

LOCATION: TANZA, CAVITE WELL NO. B EL 30.65 m DEPTH = 150 m

DEPTH	SP MV	Short a=0.4m R	Short a=0.4m 4π aR	Long a=1.6m R	Long a=1.6m 4π aR	DEPTH	SP MV	Short a=0.4m R	Short a=0.4m 4π aR	Long a=1.6m R	Long a=1.6m 4π aR
101	- 212	0.763	3.84	0.357	7.18	149	- 248	1.548	7.78	0.506	10.17
102	- 223	0.807	4.06	0.303	6.09	150	286	0.811	4.08	0.507	10.19
103	- 210	0.489	2.46	0.281	5.65						
104	- 204	0.555	2.79	0.292	5.87						
105	- 209	0.717	3.60	0.284	5.71						
106	- 112	0.760	3.82	0.300	6.03						
107	- 204	0.567	2.85	0.321	6.45						
108	- 207	1.713	8.61	0.391	7.86						
109	- 206	4.349	21.86	0.447	8.99						
110	- 102	7.889	39.65	0.746	15.00						
111	- 217	6.208	31.20	0.878	17.65						
112	- 216	1.891	9.50	1.018	20.47						
113	- 208	4.027	20.24	1.061	21.33						
114	- 219	5.847	29.39	0.890	17.89						
115	- 222	4.217	21.20	1.046	21.03						
116	- 226	5.541	27.85	1.265	25.43						
117	- 213	5.640	28.35	0.788	15.84						
118	- 214	1.962	9.86	0.503	10.11						
119	- 117	1.338	6.73	0.382	7.68						
120	- 214	0.926	4.65	0.383	7.70						
121	- 217	0.620	3.12	0.370	7.44						
122	- 224	1.103	5.54	0.351	7.06						
123	- 220	1.470	7.39	0.376	7.52						
124	- 229	1.600	8.04	0.370	7.44						
125	- 228	1.469	7.38	0.415	8.34						
126	- 230	0.939	4.72	0.469	9.43						
127	- 227	1.041	5.23	0.539	10.84						
128	- 223	3.436	17.27	0.522	10.50						
129	- 213	3.142	15.79	0.772	15.52						
130	- 203	4.749	23.87	0.835	16.79						
131	- 126	4.449	22.36	0.860	17.29						
132	- 213	1.480	7.44	0.617	12.40						
133	- 121	2.341	11.77	0.656	13.19						
134	- 131	1.731	8.70	0.529	10.64						
135	- 218	1.741	8.75	0.534	10.74						
136	- 212	1.737	8.73	0.517	10.79						
137	- 210	1.736	8.73	0.513	10.31						
138	- 212	1.734	8.72	0.506	10.17						
139	- 217	1.432	7.20	0.503	10.11						
140	- 212	1.448	7.28	0.500	10.05						
141	- 219	1.465	7.36	0.506	10.17						
142	- 122	1.471	7.39	0.504	10.13						
143	- 222	1.033	5.19	0.505	10.15						
144	- 25	1.679	8.44	1.494	30.04						
145	- 216	0.520	2.61	1.548	31.12						
146	- 214	1.512	7.60	0.509	10.23						
147	- 225	1.520	7.64	0.506	10.17						
148	- 227	0.504	2.53	1.533	30.82						

Table 1-7(1/2)

WELL STRUCTURE AND GEOLOGIC COLUMNAR SECTION OF NAIC TEST WELL

LOCATION: NAIC, CAVITE			WELL NO. C EL 10.48 m					DEPTH = 150 m			
DEPTH	SP MV	Short a=0.26 m		Long a=1.2m		DEPTH	SP MV	Short a=0.26m		Long a=1.02m	
		R	4πaR	R	4πaR			R	4πaR	R	4πaR
4	- 240	1.30	4.25	0.75	9.61	52	- 195	1.38	4.51	1.06	13.59
5	- 45	9.64	31.50	3.28	42.04	53	- 205	1.29	4.21	0.99	12.69
6	- 140	1.96	6.40	1.00	12.82	54	- 203	1.28	4.18	0.99	12.69
7	- 180	1.23	4.02	0.76	9.74	55	- 194	1.29	4.21	1.00	12.82
8	- 220	1.35	4.41	0.83	10.64	56	- 187	1.24	4.05	1.03	13.20
9	- 183	1.38	4.51	0.87	11.15	57	- 191	1.13	3.69	1.00	12.82
10	- 205	1.36	4.44	0.89	11.41	58	- 204	1.26	4.11	0.97	12.43
11	- 211	1.36	4.44	0.80	10.25	59	- 204	1.18	3.86	0.96	12.30
12	- 198	0.93	3.04	0.63	8.08	60	- 198	0.93	3.04	0.93	11.92
13	- 197	0.63	2.06	0.51	6.54	61	- 182	1.03	3.37	0.96	12.30
14	- 154	0.93	3.04	0.69	8.84	62	- 181	1.03	3.37	1.00	12.82
15	- 201	1.31	4.28	1.02	13.07	63	- 181	1.10	3.59	1.06	13.59
16	- 203	0.99	3.28	0.63	8.08	64	- 183	1.06	3.46	1.02	13.07
17	- 217	0.82	2.69	0.55	7.50	65	- 183	0.98	3.20	0.90	11.54
18	- 200	0.76	2.48	0.54	6.92	66	- 186	0.91	2.97	0.84	10.77
19	- 202	1.29	4.21	0.82	10.51	67	- 193	0.86	2.81	0.76	9.74
20	- 165	2.69	8.79	1.52	19.48	68	- 198	0.84	2.74	0.78	10.00
21	+ 203	7.39	24.15	2.42	31.02	69	- 205	0.61	1.99	0.69	8.84
22	- 202	8.36	27.31	2.84	36.40	70	- 218	0.35	1.14	0.51	6.54
23	- 220	1.28	4.17	0.73	9.36	71	- 200	0.31	1.01	0.46	5.90
24	- 198	1.28	4.18	0.75	9.61	72	- 200	0.30	0.98	0.35	4.49
25	- 203	1.33	4.35	0.80	10.25	73	- 196	0.30	0.98	0.34	4.36
26	- 202	1.47	4.80	0.97	12.43	74	- 184	0.27	0.88	0.31	3.97
27	- 202	1.47	4.80	1.00	12.82	75	- 213	0.27	0.88	0.31	3.97
28	- 204	1.32	4.31	0.83	10.64	76	- 218	0.38	1.24	0.34	4.36
29	- 200	0.93	3.04	0.50	6.41	77	- 221	0.27	0.88	0.31	3.97
30	- 201	1.09	3.56	0.56	7.18	78	- 219	0.26	0.85	0.31	3.97
31	- 197	1.09	3.56	0.56	7.18	79	- 232	0.17	0.56	0.37	4.74
32	- 186	1.12	3.66	0.71	9.10	80	- 223	1.10	3.59	0.56	7.18
33	- 163	1.25	4.02	0.80	10.25	81	- 200	1.15	3.76	0.77	9.87
34	- 157	1.12	3.60	0.71	9.10	82	- 157	1.70	5.55	1.02	13.70
35	- 104	1.29	4.21	0.85	10.90	83	- 220	0.87	2.84	0.60	7.69
36	- 156	1.34	4.38	0.89	11.41	84	- 238	0.73	2.39	0.54	6.92
37	- 155	1.55	5.06	1.28	16.41	85	- 237	0.69	2.25	0.46	5.90
38	- 158	1.57	5.13	1.28	16.41	86	- 232	0.87	2.84	0.49	6.28
39	- 163	1.52	4.90	1.24	15.89	87	- 236	0.73	2.39	0.56	7.18
40	- 172	1.15	3.76	0.88	11.28	88	- 235	0.74	2.42	0.68	8.72
41	- 154	1.29	4.21	0.99	12.69	89	- 203	0.94	3.07	0.74	9.49
42	- 123	1.23	4.20	0.95	12.18	90	- 220	0.95	3.10	0.78	10.00
43	- 159	1.50	4.90	1.15	14.74	91	- 222	0.96	3.14	0.82	10.51
44	- 178	1.00	3.27	0.77	9.87	92	- 224	0.98	3.20	0.85	10.90
45	- 186	0.91	2.97	0.74	9.49	93	- 216	1.25	4.08	1.00	12.82
46	- 186	1.46	4.77	1.06	13.59	94	- 201	1.25	4.08	0.99	12.69
47	- 164	1.86	6.08	1.42	18.20	95	- 162	1.44	4.70	1.04	13.33
48	- 95	1.81	5.91	1.38	17.69	96	- 179	1.36	4.44	0.99	12.69
49	- 157	1.69	5.52	1.29	16.53	97	- 203	0.64	2.09	0.65	8.33
50	- 172	1.57	5.13	1.20	15.38	98	- 216	0.87	2.84	0.49	6.28
51	188	1.56	5.10	1.21	15.51	99	218	0.30	0.98	0.45	5.77

Table 1-7(2/2)

WELL STRUCTURE AND GEOLOGIC COLUMNAR SECTION OF NAIC TEST WELL

LOCATION: NAIC		WELL NO. C EL 10.48 m						DEPTH = 150 m			
DEPTH	SP MV	Short a=0.26m		Long a=1.02m		DEPTH	SP MV	Short a=.26m		Long a=1.02m	
		R	4πaR	R	4πaR			R	4πaR	R	4πaR
100	-207	0.53	1.73	0.41	5.26	148	-303	0.42	1.37	0.32	4.10
101	-206	0.53	1.73	0.41	5.26	149	-316	0.42	1.37	0.32	4.10
102	-205	0.59	1.92	0.45	5.77	150	-320	0.40	0.31	0.31	3.97
103	-207	0.88	2.88	0.64	8.20						
104	-206	0.92	3.00	0.71	9.10						
105	-198	1.23	4.02	0.91	11.66						
106	-184	1.19	3.89	0.88	11.28						
107	-64	1.23	4.02	0.91	11.66						
108	-119	1.41	4.61	1.06	12.59						
109	-161	2.39	7.81	1.62	20.76						
110	-202	4.73	15.45	2.04	16.15						
111	-198	5.53	18.07	2.37	30.38						
112	-216	1.34	4.38	1.10	14.10						
113	-213	1.26	4.12	0.97	12.43						
114	-207	1.15	3.76	0.93	11.92						
115	-216	1.40	4.57	0.99	12.69						
116	-215	1.35	4.41	0.94	12.05						
117	-230	1.33	4.35	0.93	11.92						
118	-234	0.80	2.88	0.66	8.46						
119	-233	0.59	1.93	0.52	6.67						
120	-238	0.75	2.45	0.56	7.18						
121	-237	0.86	2.81	0.64	8.20						
122	-237	1.29	4.21	0.96	12.30						
123	-235	2.01	6.57	1.49	19.10						
124	-195	3.20	98.70	2.33	29.87						
125	-143	6.50	21.34	3.39	43.45						
126	-62	8.27	27.02	4.01	51.40						
127	-154	8.36	27.31	4.07	52.17						
128	-210	7.20	23.57	3.64	46.66						
129	-225	4.83	15.78	2.76	35.38						
130	-237	1.39	4.54	0.86	11.02						
131	-235	1.22	3.99	0.75	9.61						
132	-214	1.12	3.66	0.69	8.84						
133	-240	1.53	5.00	1.11	14.23						
134	-241	1.29	4.21	0.94	12.05						
135	-243	1.22	3.99	0.86	11.02						
136	-240	0.92	3.01	0.79	10.13						
137	-257	1.17	3.87	0.82	10.51						
138	-234	1.12	3.66	0.81	10.38						
139	-256	0.52	1.70	0.40	5.13						
140	-261	0.48	1.57	0.37	4.74						
141	-274	0.44	1.44	0.34	4.36						
142	-279	0.47	1.34	0.36	4.61						
143	-280	0.54	1.76	0.39	5.00						
144	-300	0.49	1.60	0.38	4.87						
145	-296	0.44	1.44	0.34	4.36						
146	-302	0.43	1.41	0.33	4.23						
147	-302	0.50	1.63	0.35	4.49						

Table 1-8(1/3)

WELL STRUCTURE AND GEOLOGIC COLUMNAR SECTION OF MENDEZ TEST WELL

LOCATION: MENDEZ			WELL NO. D		EL. 542 ml m			DEPTH = 290 m			
	SP	Short a=0.26m		Long a=1.02m			SP	Short a=0.26m		Long a=1.02m	
DEPTH	MV	R	4πaR	R	4πaR	DEPTH	MV	R	4πaR	R	4πaR
Temporary Guide Casing Pipe GL-36 m						80.5	- 8.1	4.12	13.46	2.33	29.87
33.5						81.5	- 4.8	3.74	12.22	2.22	28.46
34.5						82.5	- 2.5	3.04	9.93	1.76	22.56
35.5						83.5	- 1.9	2.67	8.72	1.80	23.07
36.5	- 3.8	4.25	13.89	1.90	24.35	84.5	- 2.1	3.80	11.11	1.88	24.10
37.5	- 3.3	4.93	16.10	2.52	32.30	85.5	- 2.2	4.46	14.57	2.35	30.12
38.5	- 3.0	4.86	14.57	2.58	33.07	86.5	- 2.8	5.70	18.62	2.98	38.19
39.5	- 5.5	4.16	13.59	2.37	30.38	87.5	- 2.9	6.75	22.05	3.42	43.84
40.5	- 4.0	3.82	12.48	2.27	29.10	88.5	- 4.6	6.88	22.48	4.08	52.30
41.5	- 3.8	3.79	12.38	2.23	28.58	89.5	- 7.5	8.79	28.72	4.67	59.86
42.5	- 3.5	4.20	13.72	2.22	28.46	90.5	- 15.6	9.75	31.86	5.63	72.16
43.5	- 3.2	3.70	12.09	1.83	23.46	91.5	- 6.1	10.16	33.20	6.04	77.42
44.5	- 3.0	1.88	6.14	1.35	17.30	92.5	- 4.0	10.38	33.91	4.10	52.55
45.5	- 8.4	1.79	5.85	1.22	15.64	93.5	- 9.9	9.98	32.61	5.71	73.19
46.5	- 5.1	2.80	9.15	1.45	18.59	94.5	- 4.2	8.81	28.78	5.08	65.11
47.5	- 3.3	4.95	16.17	2.55	32.69	95.5	- 1.7	8.63	28.19	4.14	53.07
48.5	- 4.9	5.89	19.24	3.20	41.01	96.5	- 3.2	4.14	13.53	2.65	33.97
49.5	- 7.2	6.40	20.91	3.69	47.30	97.5	- 3.6	3.16	10.32	2.10	26.92
50.5	- 8.0	5.45	21.07	4.00	51.27	98.5	- 3.7	2.79	9.12	1.90	24.35
51.5	- 10.6	6.70	21.89	4.10	52.55	99.5	- 3.9	3.63	11.86	2.10	26.92
52.5	- 13.2	7.02	22.94	4.22	54.09	100.5	- 5.1	5.79	18.92	2.84	36.80
53.5	- 14.1	7.41	24.21	4.24	54.35	101.5	- 5.3	10.88	35.55	4.65	59.60
54.5	- 6.4	6.63	21.66	3.62	46.40	102.5	- 9.8	8.96	29.27	4.82	61.78
55.5	- 5.5	3.21	10.49	2.16	27.69	103.5	- 4.0	8.33	20.68	3.94	50.50
56.5	- 7.8	2.88	9.41	1.84	23.58	104.5	- 5.2	5.84	19.08	3.58	49.35
57.5	- 7.3	2.95	9.68	1.79	23.94	105.5	- 2.3	6.33	20.68	3.35	42.94
58.5	- 4.7	2.49	8.14	1.47	18.84	106.5	- 2.0	4.10	13.40	2.72	34.86
59.5	- 4.8	1.95	6.37	1.37	17.56	107.5	- 3.2	4.19	13.69	2.98	38.20
60.5	- 4.6	2.84	9.28	1.57	20.13	108.5	- 12.3	7.40	24.18	3.29	42.17
61.5	- 5.8	5.25	7.15	2.53	32.43	109.5	- 14.3	8.68	28.36	4.63	59.34
62.5	- 11.7	6.88	22.48	4.00	51.27	110.5	- 12.1	9.60	31.37	5.10	65.37
63.5	- 12.0	6.33	20.68	4.04	51.78	111.5	- 4.3	10.39	33.95	5.71	73.19
64.5	- 8.0	5.56	18.17	3.71	47.55	112.5	- 4.3	9.53	31.14	5.23	67.04
65.5	- 8.3	5.86	19.15	3.80	48.71	113.5	- 7.4	8.17	26.69	4.83	61.91
66.5	- 7.6	6.18	20.19	4.00	51.27	114.5	- 4.5	7.47	24.41	5.35	68.57
67.5	- 2.9	5.11	16.70	3.35	42.94	115.5	- 1.8	3.44	11.24	2.13	27.30
68.5	- 3.4	4.31	14.08	3.06	39.22	116.5	- 2.0	3.41	11.14	1.36	17.43
69.5	- 2.1	4.41	9.51	2.67	34.22	117.5	- 4.2	3.58	11.70	1.83	23.46
70.5	- 2.7	3.82	12.48	2.16	27.68	118.5	- 2.6	2.38	7.78	1.83	23.46
71.5	- 1.8	2.05	6.70	1.43	18.33	119.5	- 2.8	2.90	9.48	1.85	23.71
72.5	- 2.2	1.95	6.37	1.31	16.79	120.5	- 5.7	4.79	15.63	2.25	28.84
73.5	- 2.2	1.85	6.04	1.22	15.64	121.5	- 2.5	5.45	17.81	2.98	38.20
74.5	- 2.6	1.96	6.40	1.24	15.89	122.5	- 8.1	7.53	24.60	3.15	40.38
75.5	- 2.4	1.74	5.69	1.22	15.64	123.5	- 16.3	6.83	22.32	3.79	48.58
76.5	- 2.3	1.70	5.55	1.16	14.87	124.5	- 10.0	7.78	25.42	3.98	51.01
77.5	- 2.0	2.26	7.38	1.39	17.82	125.5	- 5.9	6.61	21.60	3.68	47.14
78.5	- 2.0	4.12	13.46	1.67	21.41	126.5	- 7.8	6.12	20.00	4.68	59.99
79.5	- 1.9	4.40	14.38	2.53	32.43	127.5	- 8.0	6.83	22.32	3.34	42.81

Table 1-8(2/3)

WELL STRUCTURE AND GEOLOGIC COLUMNAR SECTION OF MENDEZ TEST WELL

LOCATION: MENDEZ

DEPTH	SP MV	Short a=0.26m R	Short a=0.26m 4πaR	Long a=1.02m R	Long a=1.02m 4πaR	DEPTH	SP MV	Short a=0.26m R	Short a=0.26m 4πaR	Long a=1.02m R	Long a=1.02m 4πaR
128.5	-8.3	7.28	23.79	4.26	54.60	176.5	-11.0	12.19	39.83	6.51	83.44
129.5	-8.2	9.53	31.14	5.00	64.09	177.5	-9.8	10.31	33.69	7.00	89.72
130.5	-12.4	9.47	30.94	5.42	69.47	178.5	-8.7	9.81	32.05	5.23	67.04
131.5	-10.2	9.79	31.99	5.55	71.14	179.5	-10.5	9.41	30.74	6.50	83.32
132.5	-11.3	10.03	32.77	5.85	74.98	180.5	-1.8	2.39	7.81	1.49	19.10
133.5	-12.1	10.81	35.32	6.15	78.83	181.5	+2.5	1.60	5.23	1.35	17.30
134.5	-13.8	11.34	37.05	6.45	82.67	182.5	2.6	1.87	6.11	1.28	16.41
135.5	-16.2	11.79	38.52	6.81	87.29	183.5	2.5	5.15	16.83	1.67	21.41
136.5	-14.3	12.57	41.07	7.26	93.06	184.5	2.4	9.68	31.63	5.27	67.55
137.5	-12.4	13.57	44.34	7.77	99.59	185.5	2.0	12.85	41.98	6.62	84.85
138.5	-10.0	13.97	45.64	8.09	103.70	186.5	2.4	21.89	71.52	9.61	123.18
139.5	-10.0	14.56	47.57	8.53	109.33	187.5	2.4	22.02	71.94	12.65	162.14
140.5	-10.2	15.09	49.30	8.91	114.21	188.5	3.8	23.17	75.70	13.61	174.45
141.5	-10.7	15.69	51.26	9.32	119.46	189.5	4.3	25.68	83.90	14.31	183.42
142.5	-12.0	16.00	52.28	9.47	121.38	190.5	7.9	23.26	76.00	13.55	173.68
143.5	-11.1	15.71	51.33	9.33	119.59	191.5	2.2	18.22	59.53	10.44	133.82
144.5	-9.8	14.97	48.91	9.02	115.62	192.5	2.1	12.44	40.64	5.02	64.34
145.5	-10.4	14.72	48.09	8.78	112.54	193.5	2.5	5.90	19.28	2.96	37.94
146.5	-11.7	14.78	48.29	8.74	112.03	194.5	2.7	2.59	8.46	1.86	23.84
147.5	-12.0	15.24	49.79	9.02	115.62	195.5	2.1	2.75	8.98	1.63	20.89
148.5	-10.0	15.14	49.47	9.08	116.38	196.5	2.0	2.72	8.89	1.74	22.30
149.5	-8.1	14.53	47.47	8.59	110.10	197.5	1.9	2.53	8.27	1.75	22.43
150.5	-8.8	13.46	43.98	7.89	101.13	198.5	2.0	2.72	8.89	1.84	23.58
151.5	-2.2	10.29	33.62	5.31	68.06	199.5	2.4	3.03	9.90	1.93	24.74
152.5	-9.9	5.93	19.37	4.13	52.94	200.5	3.0	3.15	10.29	2.02	25.89
153.5	-8.6	9.86	32.21	4.52	57.94	201.5	2.4	2.68	8.76	1.51	19.35
154.5	-9.2	11.34	37.05	6.04	77.42	202.5	3.1	1.75	5.72	1.53	19.61
155.5	-9.6	12.00	39.21	6.65	85.24	203.5	3.3	1.69	5.52	1.40	17.94
156.5	-10.0	12.14	39.66	6.83	87.54	204.5	2.7	3.25	7.35	1.63	20.89
157.5	-10.1	12.15	39.70	6.96	89.21	205.5	2.1	4.38	14.31	2.25	28.84
158.5	-7.6	12.41	40.55	7.11	91.13	206.5	1.9	5.95	19.44	3.18	40.76
159.5	-7.4	12.26	40.06	7.11	91.13	207.5	2.0	8.83	28.85	4.00	51.27
160.5	-7.0	11.41	37.28	6.60	84.60	208.5	2.1	8.83	27.38	4.66	59.73
161.5	-7.2	11.12	36.33	6.42	82.29	209.5	2.5	10.75	35.12	5.86	75.11
162.5	-9.0	11.42	37.31	6.45	82.67	210.5	4.2	8.02	26.20	6.64	85.11
163.5	-8.1	11.58	37.83	6.72	86.13	211.5	16.3	15.37	50.22	8.89	113.95
164.5	-8.3	11.98	39.14	6.81	87.29	212.5	4.4	14.97	48.91	8.35	107.03
165.5	-9.0	12.12	39.60	6.96	89.21	213.5	2.8	6.95	22.71	4.54	58.19
166.5	-9.8	12.64	41.30	7.17	91.90	214.5	1.9	4.90	16.01	3.88	49.73
167.5	-9.5	13.31	43.49	7.52	96.39	215.5	2.0	6.27	20.49	4.15	53.19
168.5	-7.7	12.58	41.10	7.00	89.72	216.5	2.6	10.19	33.29	5.85	74.98
169.5	-5.2	9.29	30.35	6.20	79.47	217.5	2.9	14.57	47.60	8.27	106.00
170.5	-8.6	10.63	34.73	5.96	76.39	218.5	3.4	19.53	63.81	11.19	143.43
171.5	-5.7	12.78	41.76	7.20	92.29	219.5	8.5	18.72	61.16	11.15	142.92
172.5	-10.1	13.64	44.57	7.74	99.21	220.5	19.7	6.55	21.40	4.16	53.32
173.5	-13.8	13.50	44.11	7.65	98.06	221.5	4.3	2.97	9.70	2.98	38.20
174.5	-13.9	13.12	42.87	7.70	98.70	222.5	3.8	6.22	20.32	2.98	38.20
175.5	-12.7	13.72	44.83	7.54	96.65	223.5	3.7	4.01	13.10	3.02	38.70

Table 1-8(3/3)

WELL STRUCTURE AND GEOLOGIC COLUMNAR SECTION OF MENDEZ TEST WELL

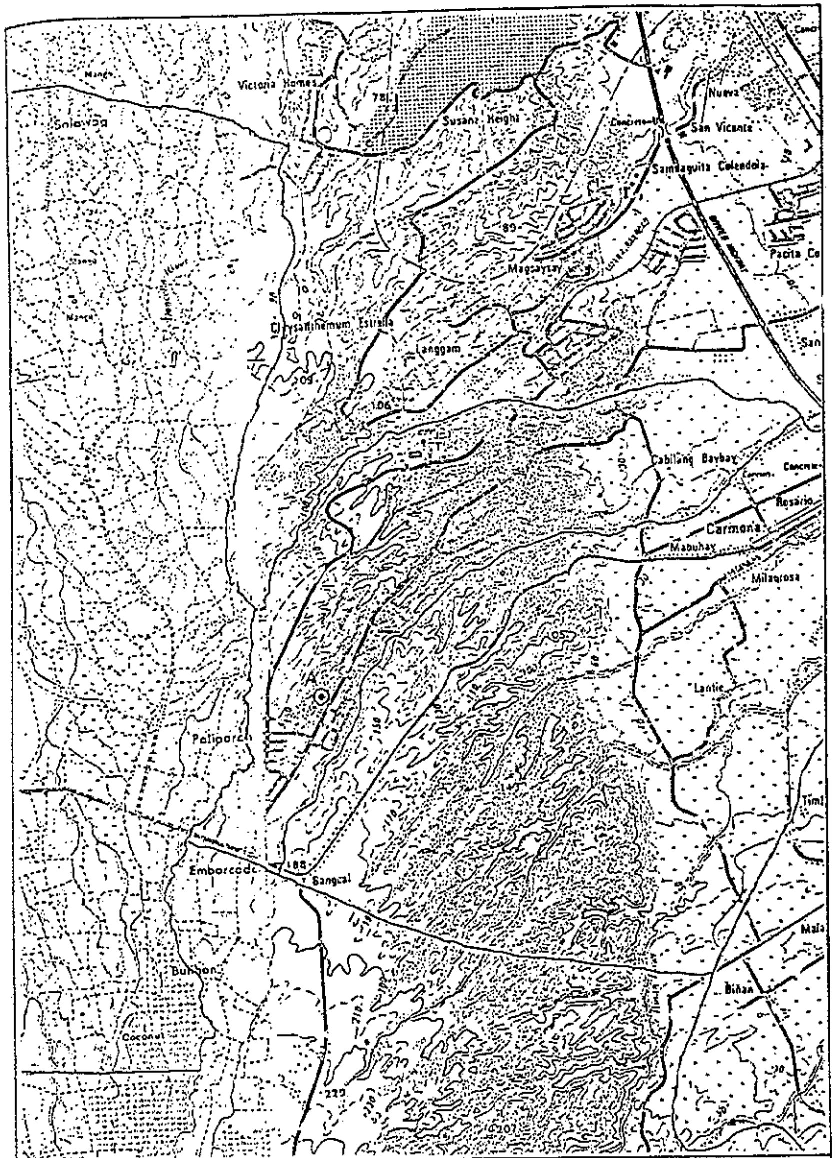
LOCATION: MENDEZ											
	SP	Short a=0.26m		Long a=1.02m			SP	Short a=0.26m		Long a=1.02m	
DEPTH	MV	R	4πaR	R	4πaR	DEPTH	MV	R	4πaR	R	4πaR
224.5	3.5	3.98	13.00	3.13	40.12	4.0	9.9	7.59	24.80	5.60	76.91
225.5	3.2	4.29	14.02	3.39	43.45	6.2	6.3	7.16	23.39	4.54	58.19
226.5	3.8	7.28	23.79	4.27	54.73	5.5	5.0	7.36	24.05	4.96	63.58
227.5	3.9	12.68	41.43	6.67	85.49	4.8	5.3	9.75	31.85	5.86	75.11
228.5	3.9	14.23	46.49	8.56	109.72	5.7	8.3	11.69	38.19	7.88	101.00
229.5	7.8	15.83	51.72	9.65	122.54	5.1	22.5	11.70	38.23	8.80	112.80
230.5	9.9	15.88	51.88	10.13	129.84	5.4	24.1	12.25	40.02	8.88	113.82
231.5	6.5	16.66	54.43	10.51	134.71	10.2	14.2	12.41	40.55	8.81	112.92
232.5	7.0	18.12	59.20	11.29	144.71	6.6	10.1	12.18	39.80	8.63	110.62
233.5	6.5	21.05	68.75	11.93	152.91	1.5	6.1	9.49	31.01	5.36	68.70
234.5	19.8	14.03	45.84	9.27	118.82	1.0	6.3	4.96	16.21	4.22	54.09
235.5	5.7	12.86	48.02	7.69	98.57	1.1	3.7	4.38	14.31	3.53	45.25
236.5	2.1	3.95	12.91	3.17	40.63	0.8	4.1	4.87	15.91	3.66	46.91
237.5	- 1.2	1.84	6.01	2.14	27.43	1.5	4.3	4.43	14.47	3.86	49.48
238.5	- 2.2	1.90	6.20	1.92	24.61	2.3	4.2	3.64	11.89	3.78	48.45
239.5	- 2.3	1.90	6.20	2.18	27.94	2.7					
240.5	- 2.6	2.05	6.70	2.15	27.56	4.2					
241.5	- 2.3	2.19	7.16	1.84	23.58	5.2					
242.5	- 2.0	3.76	12.28	1.47	18.84	6.2					
243.5	- 1.8	1.63	5.33	1.40	17.94						
244.5	- 1.9	2.25	7.35	1.65	21.15						
245.5	- 1.9	6.59	21.53	2.70	34.61						
246.5	0.0	5.37	17.55	3.30	42.30						
247.5	+ 2.5	2.62	8.56	2.26	28.97						
248.5	+ 2.5	5.52	18.04	2.29	29.35						
249.5	3.6	7.48	24.44	4.45	57.04						
250.5	4.0	8.73	28.52	5.84	74.98						
251.5	4.8	10.62	34.70	7.15	91.64						
252.5	4.6	11.08	36.20	7.96	102.03						
253.5	4.9	11.63	38.00	8.50	108.95						
254.5	12.4	11.60	37.90	8.59	110.10						
255.5	10.0	11.48	37.51	8.67	111.13						
256.5	4.3	10.19	33.29	7.79	99.85						
257.5	4.0	9.22	30.12	6.66	85.36						
258.5	1.8	3.37	110.10	3.84	49.22						
259.5	0.7	2.88	9.41	2.77	35.51						
260.5	- 4.0	2.85	9.31	2.10	26.92						
261.5	- 4.0	3.94	12.87	2.05	26.28						
262.5	- 4.2	4.34	14.18	2.33	29.87						
263.5	- 2.1	5.31	17.35	2.82	36.15						
264.5	- 1.2	6.44	21.04	3.19	40.89						
265.5	+ 1.8	5.03	16.43	3.81	48.84						
266.5	3.0	5.02	16.40	3.33	42.68						
267.5	4.3	3.97	12.97	2.82	36.15						
268.5	4.3	3.95	12.91	2.60	33.33						
269.5	4.7	6.32	20.68	3.05	39.09						
270.5	4.4	9.35	30.55	4.00	51.27						
271.5	4.0	9.53	31.44	5.37	68.83						

Table 1-9 DETAILS OF TEST WELLS.

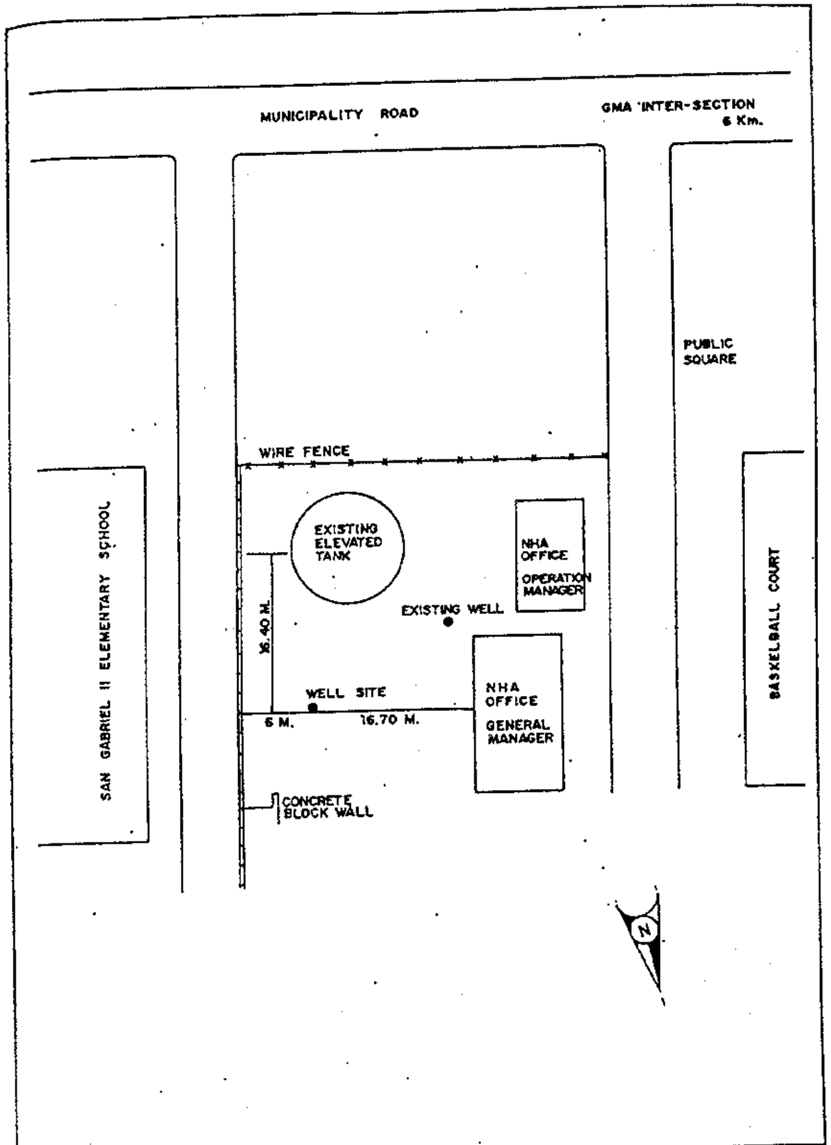
No.	LOCATION: Site	LOCATION: Ground Level (m)	WELL STRUCTURE: Borehole Depth (m)	Borehole φ (mm)	Casing Depth (m)	Casing φ (mm)	Screen φ (mm)	Screen TOP GL–m	Screen BOTTOM GL–m	SWL GL–m	PUMPING TEST DATA: STEP DRAWDOWN TEST Qmax (l/s)	Drawd. (m)	Sc (l/s/m)	CONSTANT DISCHARGE TEST Q (l/s)	Drawd. (m)	Sc (l/s/m)	(T) (cm²/s)	WELL LOGGING DATA: Temp (°C)	Cond. (S/cm)	Main Aquifer	Resistivity (ohm–m)	Stratigraphic Horizon
A	GMA	163.65	100	350	100	200	150	106	154	99.45	1.88	1.59	1.18	1.74	1.62	1.07	34.00	26.5	370	Scoria tuff ~C.S.S (Scoria rich)	30~50 / 20~30	Kaybubutong Formation (lower)
			220	320	160	150		(Total 48 m)														
B	TANZA	30.65	60	400	60	250	200	66	84	10.45	34.10	19.43	1.76	14.54	9.06	1.60	35.95	29.5	450	(Upper) Conglomerate ~Gravelly C.S.S	20~60	Kaybubutong Formation (lower)
							200	96	102													
							200	108	120													
							200	126	130											(Lower) Gravelly C.S.S ~Pumice tuff	20~40	Talisay Formation
							200	138	144													
			150	390	150	200		(Total 48 m)														
C	NAIC	5.40	60	400	60	250	200	66	72	6.26	36.00	33.20	1.08	38.08	36.38	1.05	22.20	30.2	510	MSS ~FSS (scoria rich)	30~50	Talisay Formation
							200	78	84													
							200	102	114													
							200	102	114													
							200	120	128													
			150	370	150	200		(Total 48 m)														
D	MENDEZ	542.00	200	350	200	200	150	206	212	112.19	8.24	12.60	0.65							Scoria tuff ~Volcanic conglomerate	100~180	Kaybubutong Formation (middle)
							150	218	221													
							150	251	257													
							150	251	257													
							150	275	284													
			290	320	270	150		(Total 30 m)														

Table 1-10 CLASSIFICATION OF AQUIFERS DISTINGUISHED IN THE STUDY AREA

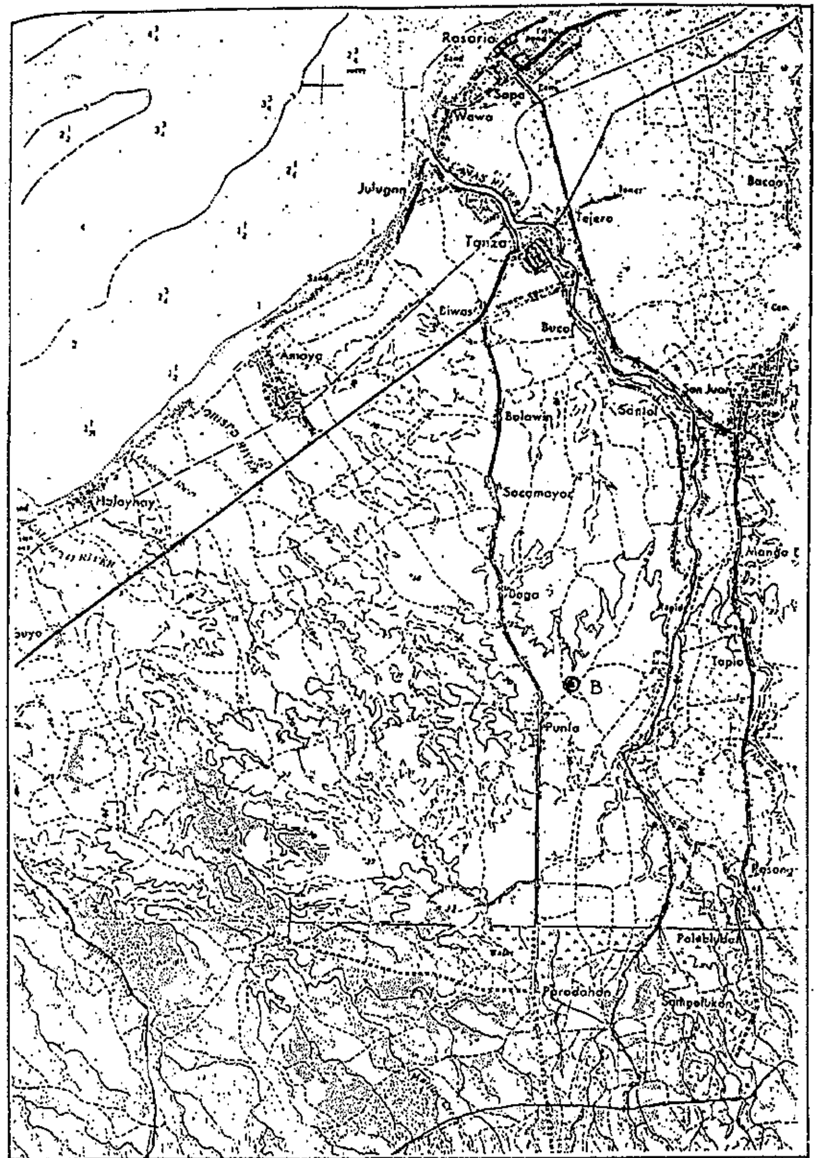
	Stratigraphic Horizon	Lithology	Sc (l/s/m)	T (cm^2/s)	Temperature (°C)	Conductivity (μs/cm)	Resistivity (ohm-m)	Test Well
Upper Aquifer	Middle horizon of Kaybubutong Formation	Scoria, Tuff, Volcanic Conglomerate Lava					100~180	Mendez
Middle Aquifer	Lower horizon of Kaybubutong Formation	Conglomerate ~Coarse sand	1.14~1.70	33.4~36.0	26.5~29.5	370~450	20~60	Tanza G.M.A
Lower Aquifer	Talisay Formation	Coarse sandstone with gravel ~Medium Sandstone	1.04~1.08	22.1	30.2	510	30~50	Naic



CAVITE WATER SUPPLY DEVELOPMENT STUDY	Fig. 1-1(a)
JAPAN INTERNATIONAL COOPERATION AGENCY	Test Drilling Site of G.M.A.



CAVITE WATER SUPPLY DEVELOPMENT STUDY	Fig. 1-1(b)
JAPAN INTERNATIONAL COOPERATION AGENCY	Sketch of the Drilling Site (G. M. A.)

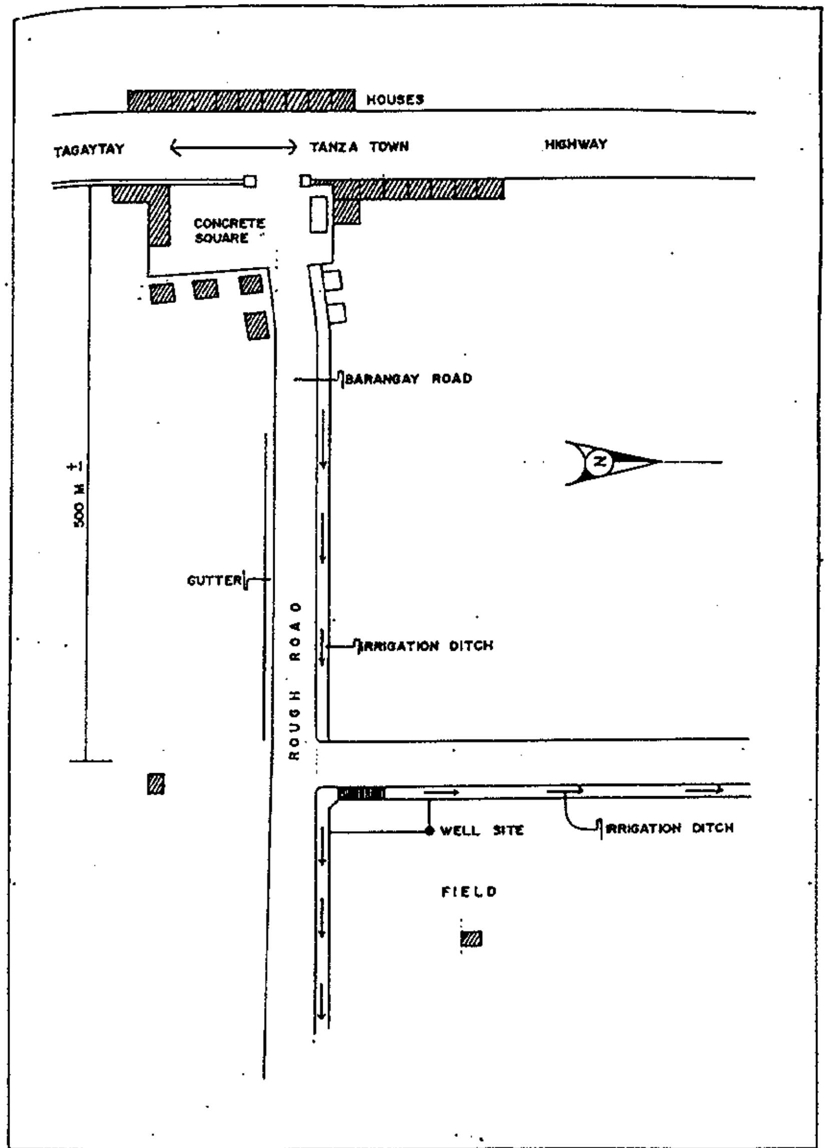


CAVITE WATER SUPPLY DEVELOPMENT STUDY

JAPAN INTERNATIONAL COOPERATION AGENCY

Fig. 1-2(a)

Test Drilling Site (Tanza)

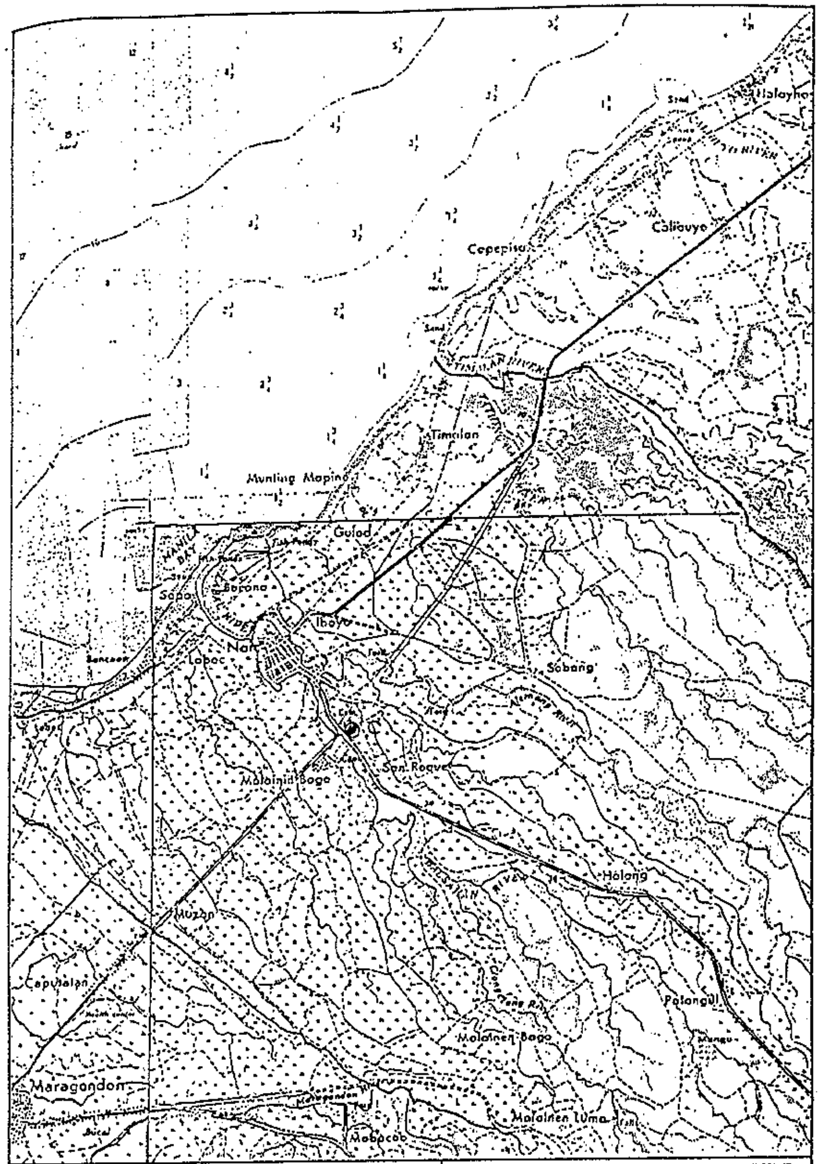


CAVITE WATER SUPPLY DEVELOPMENT STUDY

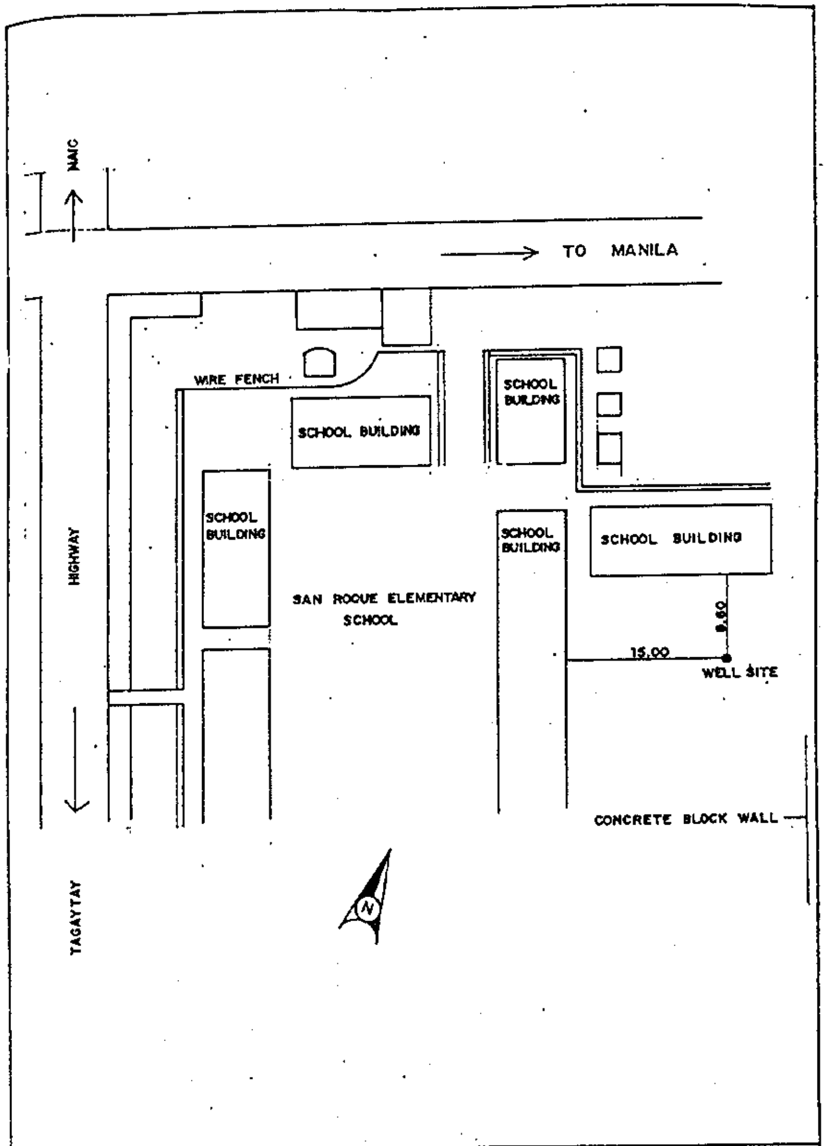
JAPAN INTERNATIONAL COOPERATION AGENCY

Fig. 1-2(b)

Sketch of the Drilling Site (Tanza)

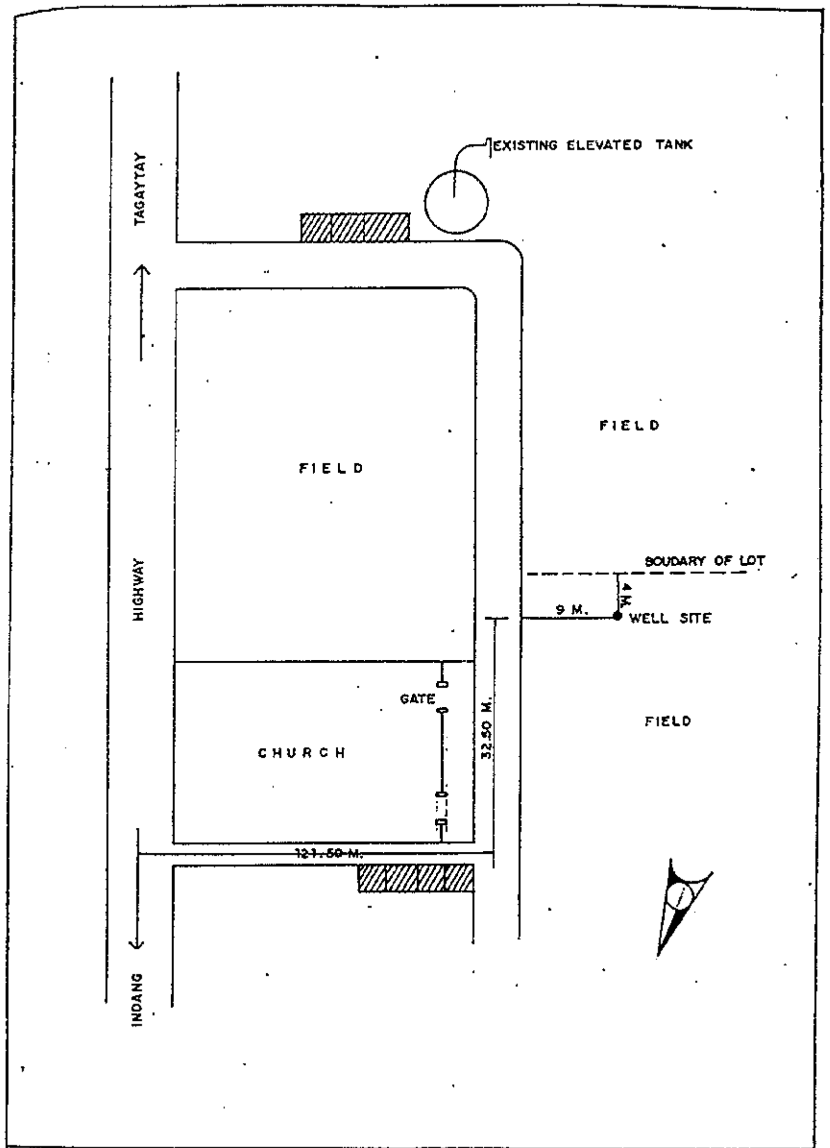


CAVITE WATER SUPPLY DEVELOPMENT STUDY	Fig. 1-3(a)
JAPAN INTERNATIONAL COOPERATION AGENCY	Test Drilling Site (Naic)



CAVITE WATER SUPPLY DEVELOPMENT STUDY	Fig. 1-3(b)
JAPAN INTERNATIONAL COOPERATION AGENCY	Sketch of the Drilling Site (Naic)

CAVITE WATER SUPPLY DEVELOPMENT STUDY	Fig. 1-4(a)
JAPAN INTERNATIONAL COOPERATION AGENCY	Test Drilling Site of Mendez



CAVITE WATER SUPPLY DEVELOPMENT STUDY	Fig. 1-4(b)
JAPAN INTERNATIONAL COOPERATION AGENCY	Sketch of the Drilling Site (Mendez)

WELL NO. A G.M.A.,CAVITE

WELL CONSTRUCTION DATA

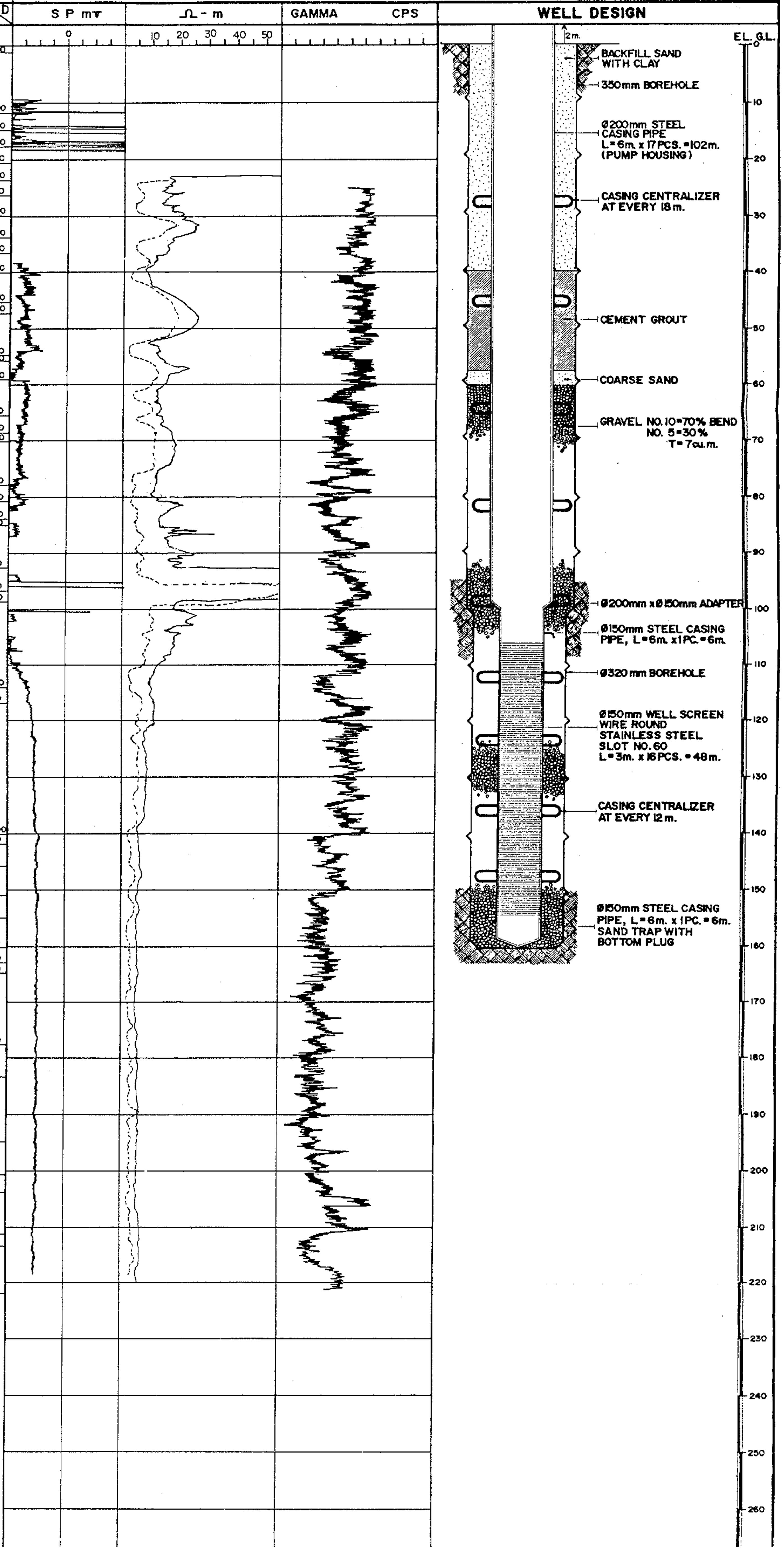
EL.= 163.65 m. NORMAL WATER LEVEL = G.L.- 99.45m.

DEPTH: 160 m.; CASING PIPE : STEEL Ø 200mm. 100m.; SCREEN : STAINLESS STEEL Ø150mm 48m.

SLOT NO. 60 (1,524 mm.); GRAVEL: # 10 # 5 BLEND (5mm.~ 10 mm., 2.5 m.~ 4 m.) 7 m³

DURATION : FROM : MONTH AUGUST DAY 27 YEAR '94 TO : MONTH OCTOBER DAY 03 YEAR '94 NUMBER OF DAYS : 38 DAYS

DEPTH	LITHOLOGY	COLOR	T
3.00	PYROCLASTIC FLOW PUMICE (10-18) MIX	BROWN	3.00
12.00	MEDIUM SAND PUMICE MIX 2%	DARK BROWNISH GRAY	9.00
15.00	COARSE SAND PUMICE MIX 5%	-DO-	3.00
18.00	PYROCLASTIC FLOW FINE SAND MIX	BROWN GRAY	3.00
21.00	MEDIUM SAND PUMICE MIX 10%	-DO-	3.00
24.00	MEDIUM SAND PUMICE MIX 20%	REDISH BROWN	3.00
27.00	MEDIUM SAND PUMICE MIX 5%	DARK BROWNISH GRAY	3.00
30.00	MEDIUM SAND PUMICE MIX 5%	-DO-	3.00
34.00	COARSE SAND PUMICE MIX 5%	-DO-	4.00
37.00	MEDIUM SAND	BLACK GRAY	3.00
41.00	COARSE SAND PUMICE RICH	BROWNISH GRAY	4.00
46.00	COARSE SAND SCORIA RICH	BLACK BROWN	5.00
47.50	PYROCLASTIC FLOW	YELLOW BROWN	1.50
55.00	COARSE SAND SCORIA RICH	BLACK BROWN	7.50
56.00	PYROCLASTIC FLOW	YELLOW BROWN	1.00
59.50	MEDIUM SAND SCORIA RICH	BLACK BROWN	3.50
65.50	MEDIUM SAND SCORIA RICH	BLACK BROWN	6.00
68.50	COARSE SAND SCORIA RICH	BLACK BROWN	3.00
70.00	FINE SAND SCORIA	-DO-	1.50
78.00	COARSE SAND SCORIA RICH	BLACK BROWN	8.00
81.00	COARSE SAND PUMICE RICH	BROWN	3.00
84.00	FINE SANDSTONE SCORIA RICH	BLACK BROWN	3.00
	MEDIUM SAND SCORIA RICH	DARK BROWN GRAY	1.00
93.00	FINE SAND PUMICE MIX CORAL FOSSIL MIX	BROWN	8.00
97.00	PYROCLASTIC FLOW SCORIA RICH PUMICE MIX	DARK BROWNISH GRAY	4.00
99.00	SCORIA PUMICE MIX	BLACK BROWN	2.00
114.00	COARSE SAND SCORIA MIX PUMICE MIX 2% LOOSE	BLACK GRAY	15.00
117.00	COARSE SAND PUMICE MIX 20%	BROWNISH GRAY	3.00
140.00	COARSE SAND SCORIA MIX LOOSE	DARK BROWNISH GRAY	23.00
142.00	GRAVEL AND SAND	-DO-	2.00
146.00	COARSE SAND SCORIA RICH	DARK BROWN	4.00
151.00	SCORIA COARSES GRANULE MIX	BLACK GRAY	5.00
155.00	PYROCLASTIC FLOW COARSE SAND MIX	DARK BROWNISH GRAY	4.00
160.00	CONGLOMERATE AND SHALL ALTERNATION	YELLOW BROWNISH GRAY	5.00
163.00	CONGLOMERATE	BROWNISH GRAY	3.00
165.00	CONGLOMERATE AND SHALL ALTERNATION	YELLOW MAIN	2.00
178.00	CONGLOMERATE SHALL MIX Ø MAX. = 10mm	BROWN	13.00
184.00	COARSE SANDSTONE GRANULE MIX	DARK BROWNISH GRAY	6.00
195.00	FINE SANDSTONE AND COARSE SANDSTONE SCORIA RICH PUMICE MIX	PALE BROWN ~ DARK BROW	11.00
201.00	FINE SANDSTONE AND COARSE SANDSTONE ALTERNATION	PALE BROWN DARK BROWN	6.00
204.00	-DO-	BROWN	3.00
212.00	FINE SANDSTONE AND MEDIUM SANDSTONE ALTERNATION	DARK BROWNISH GRAY	8.00
214.00	NO SAMPLE –	–	2.00
222.50	GRAVELLY COARSE SANDSTONE SCORIA RICH	BLACK BROWN	8.50



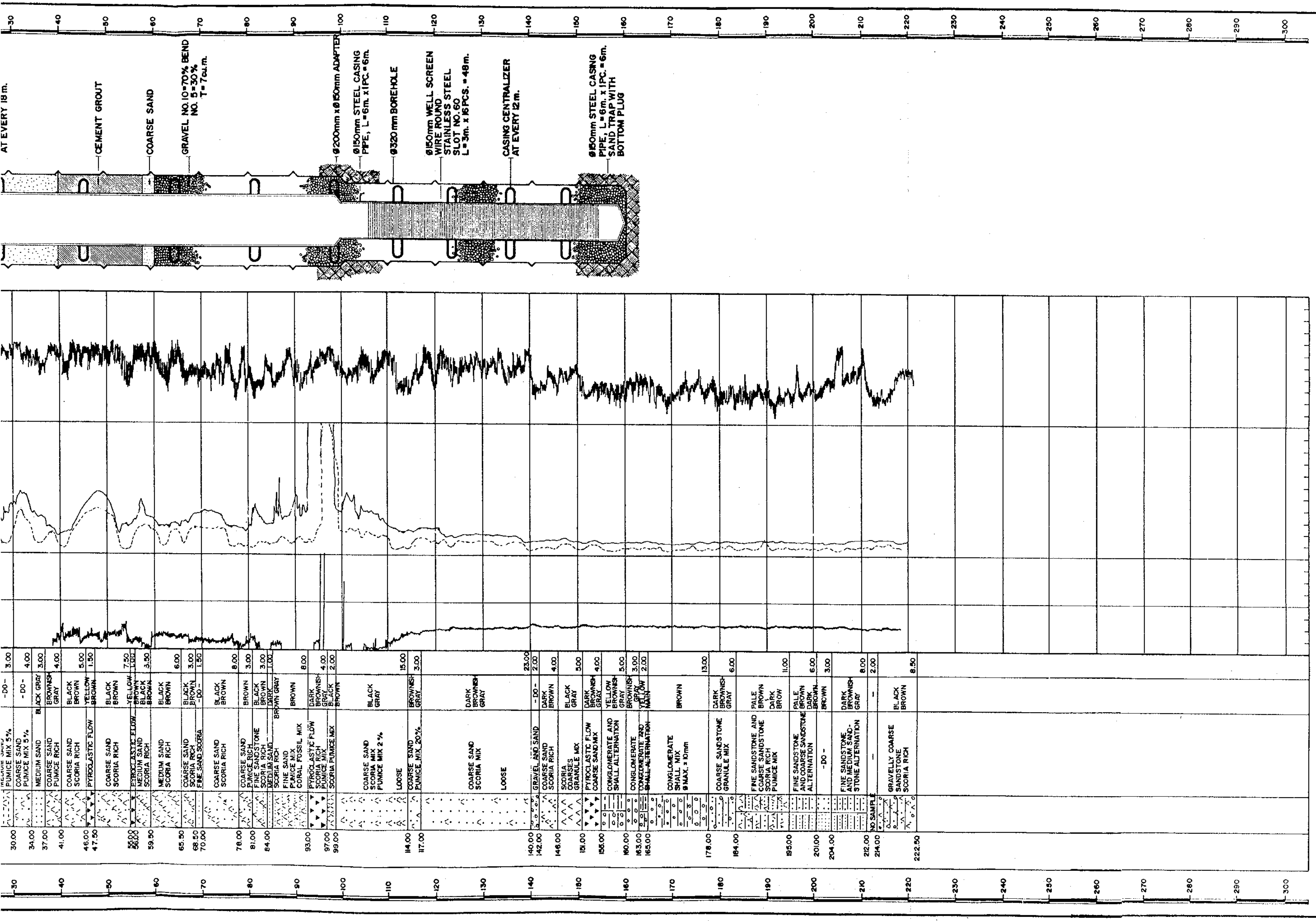


Fig. 1-5
WELL STRUCTURE AND GEOLOGIC COLUMNAR SECTION (A) G. M. A

CAVITE WATER SUPPLY DEVELOPMENT STUDY

JAPAN INTERNATIONAL COOPERATION AGENCY

WELL NO. B-TANZA, CAVITE

WELL CONSTRUCTION DATA

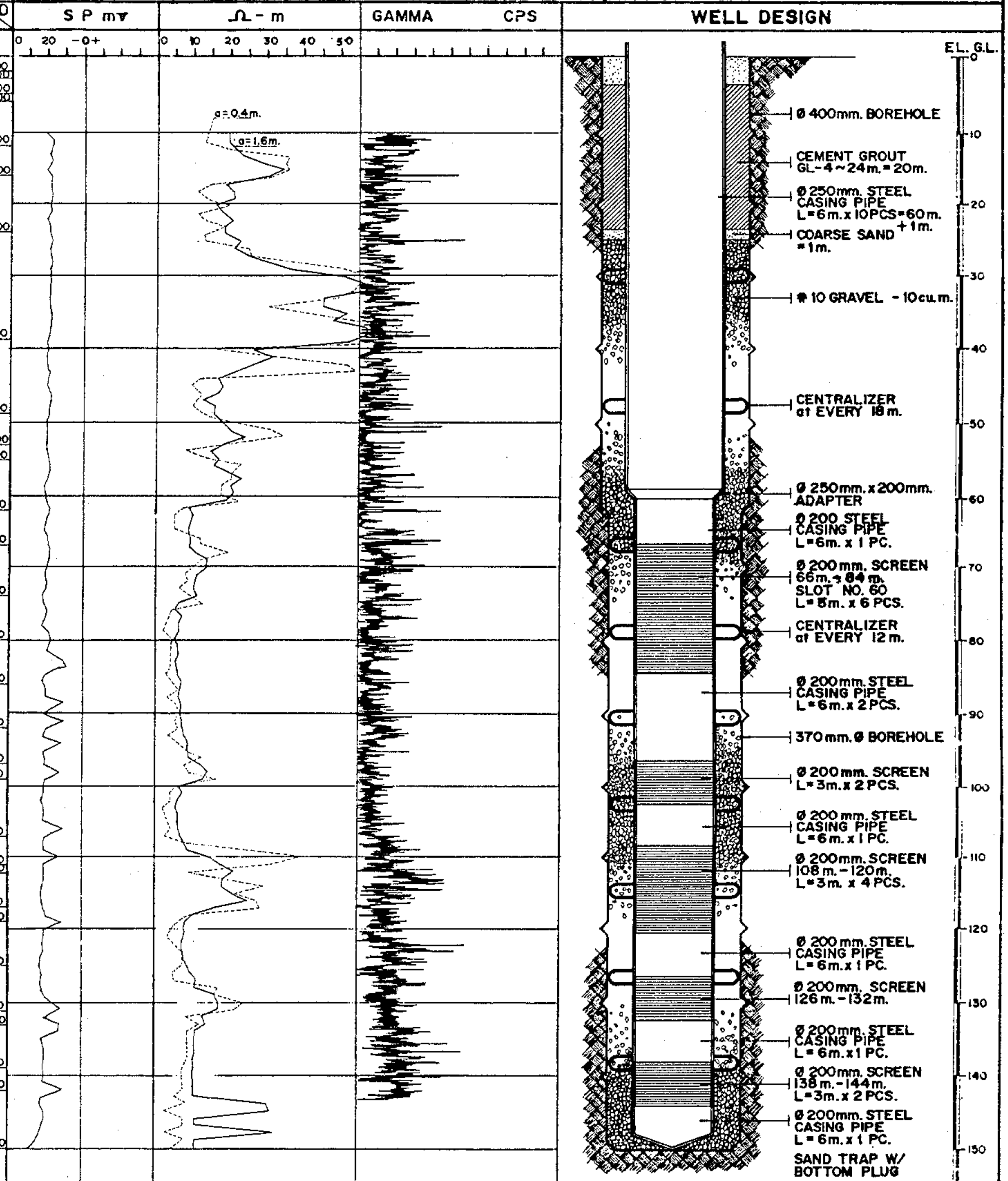
EL. = 30.65 m. NORMAL WATER LEVEL = G.L. - 10.45 m.

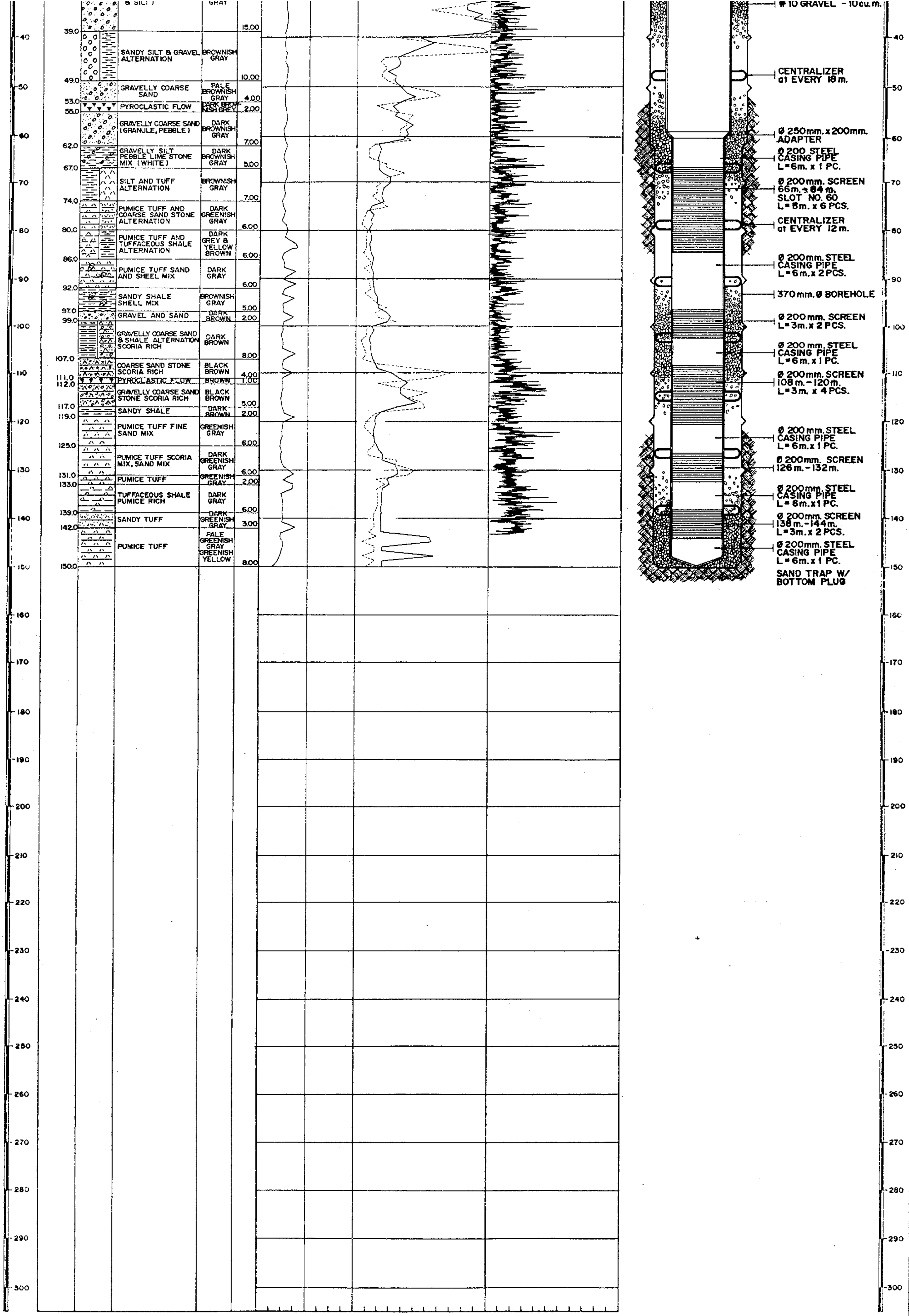
DEPTH: 150 m.; CASING PIPE: STEEL Ø 250 mm. 60 m.; SCREEN: STAINLESS STEEL 200mm. 48m.

SLOT NO. 60 (1.524 mm.); GRAVEL: # 10 # - BLEND (5 mm.~ 10 mm., - m.~ - m.) 10 m^3

DURATION: FROM: DATE: MONTH OCTOBER DAY 28, YEAR 1994 TO: DATE: MONTH NOVEMBER DAY 30, YEAR 1994 NUMBER OF DAYS: 34

DEPTH (m)	LITHOLOGY	COLOR	T (m)
2.0	N.S.		2.00
3.0	PYROCLASTIC FLOW	BROWNISH GRAY	1.00
5.0	N.S.		2.00
6.0	SILTY FINE SAND	BROWNISH GRAY	1.00
12.0	PYROCLASTIC FLOW PEBBLE PUMICE MIX	BROWNISH GRAY	6.00
16.0	GRAVELLY FINE SAND GRANULE	BROWNISH GRAY	4.00
24.0	PYROCLASTIC FLOW GRAVEL & COARSE SAND PUMICE RICH	YELLOW BROWN	8.00
39.0	GRAVEL & SAND (PEBBLE & SAND & SILT)	BLACK BROWNISH GRAY	15.00
49.0	SANDY SILT & GRAVEL ALTERNATION	BROWNISH GRAY	10.00
53.0	GRAVELLY COARSE SAND	PALE BROWNISH GRAY	4.00
55.0	PYROCLASTIC FLOW	DARK BROWNISH GRAY	2.00
62.0	GRAVELLY COARSE SAND (GRANULE, PEBBLE)	DARK BROWNISH GRAY	7.00
67.0	GRAVELLY SILT PEBBLE LIME STONE MIX (WHITE)	DARK BROWNISH GRAY	5.00
74.0	SILT AND TUFF ALTERNATION	BROWNISH GRAY	7.00
80.0	PUMICE TUFF AND COARSE SAND STONE ALTERNATION	DARK GREENISH GRAY	6.00
86.0	PUMICE TUFF AND TUFFACEOUS SHALE ALTERNATION	DARK GREY & YELLOW BROWN	6.00
92.0	PUMICE TUFF SAND AND SHEEL MIX	DARK GRAY	6.00
97.0	SANDY SHALE SHELL MIX	BROWNISH GRAY	5.00
99.0	GRAVEL AND SAND	DARK BROWN	2.00
107.0	GRAVELLY COARSE SAND & SHALE ALTERNATION SCORIA RICH	DARK BROWN	8.00
111.0	COARSE SAND STONE SCORIA RICH	BLACK BROWN	4.00
112.0	PYROCLASTIC FLOW	BROWN	1.00
117.0	GRAVELLY COARSE SAND STONE SCORIA RICH	BLACK BROWN	5.00
119.0	SANDY SHALE	DARK BROWN	2.00
125.0	PUMICE TUFF FINE SAND MIX	GREENISH GRAY	6.00
131.0	PUMICE TUFF SCORIA MIX, SAND MIX	DARK GREENISH GRAY	6.00
133.0	PUMICE TUFF	GREENISH GRAY	2.00
139.0	TUFFACEOUS SHALE PUMICE RICH	DARK GRAY	6.00
142.0	SANDY TUFF	DARK GREENISH GRAY	3.00
150.0	PUMICE TUFF	PALE GREENISH GRAY GREENISH YELLOW	8.00





CAVITE WATER SUPPLY DEVELOPMENT STUDY

JAPAN INTERNATIONAL COOPERATION AGENCY

Fig. 1-6
WELL STRUCTURE AND GEOLOGIC COLUMNAR SECTION (B) TANZA

WELL NO. C NAIC CAVITE

WELL CONSTRUCTION DATA

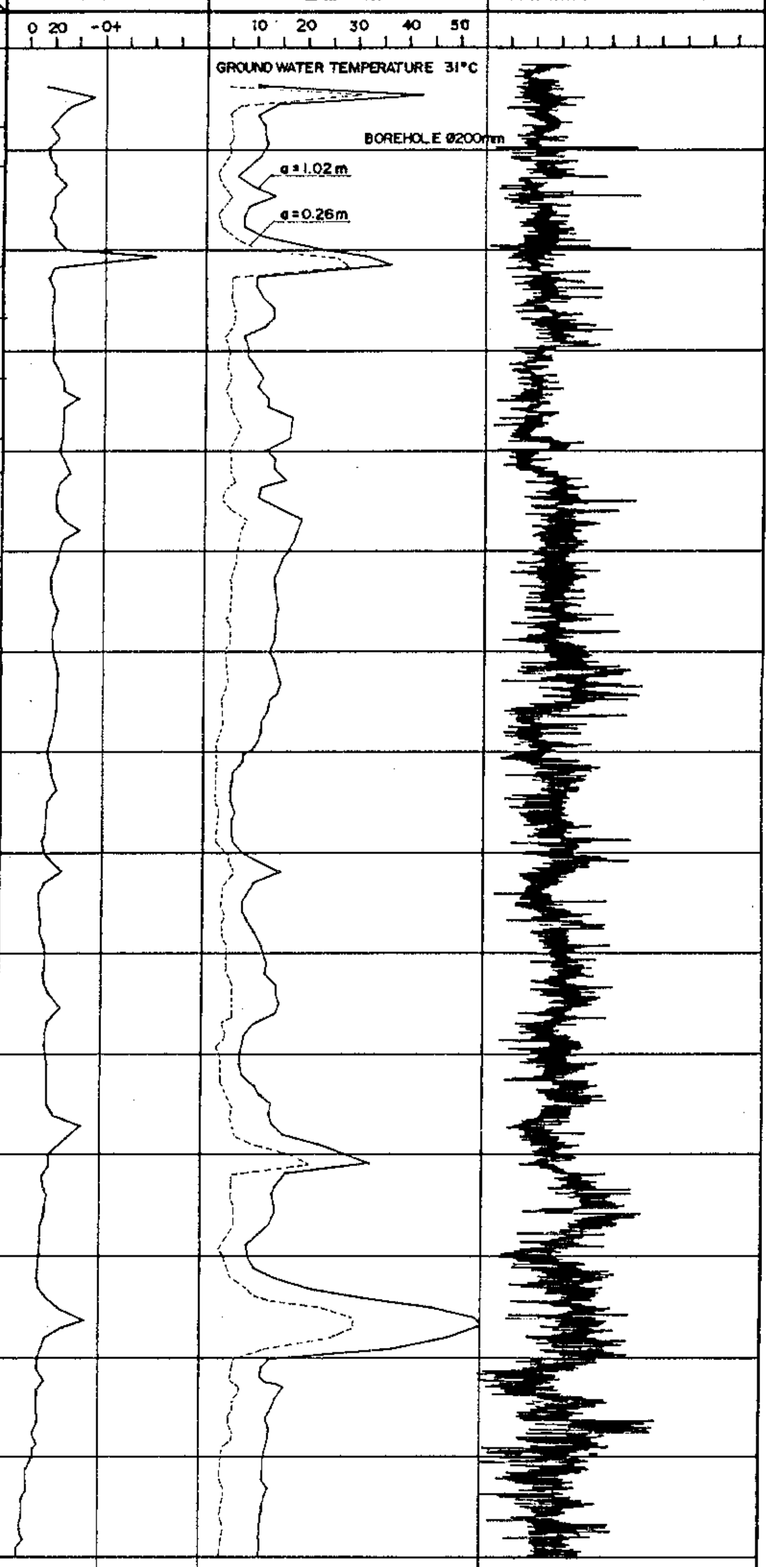
EL.= 10.48 m. NORMAL WATER LEVEL = G.L.- 6.28 m.

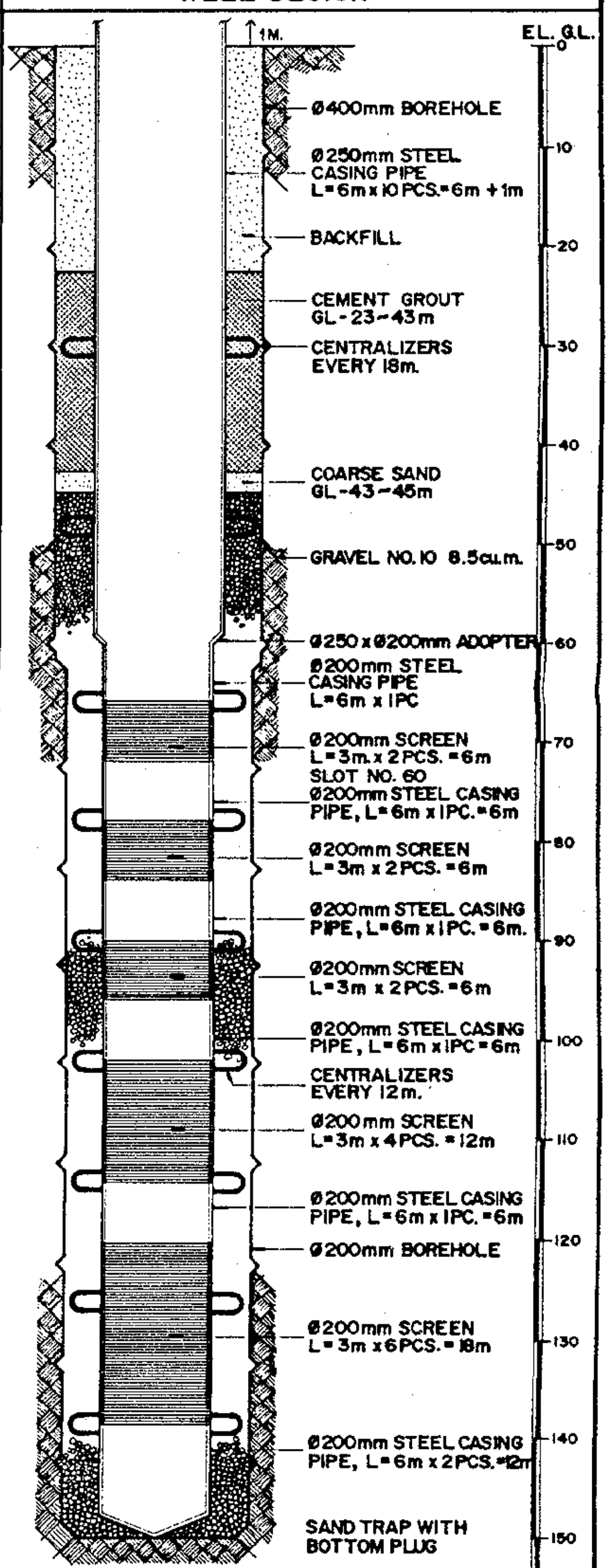
DEPTH: 150 m.; CASING PIPE: STEEL Ø 250 mm. 60 m.; SCREEN: STAINLESS STEEL 200mm 48m.

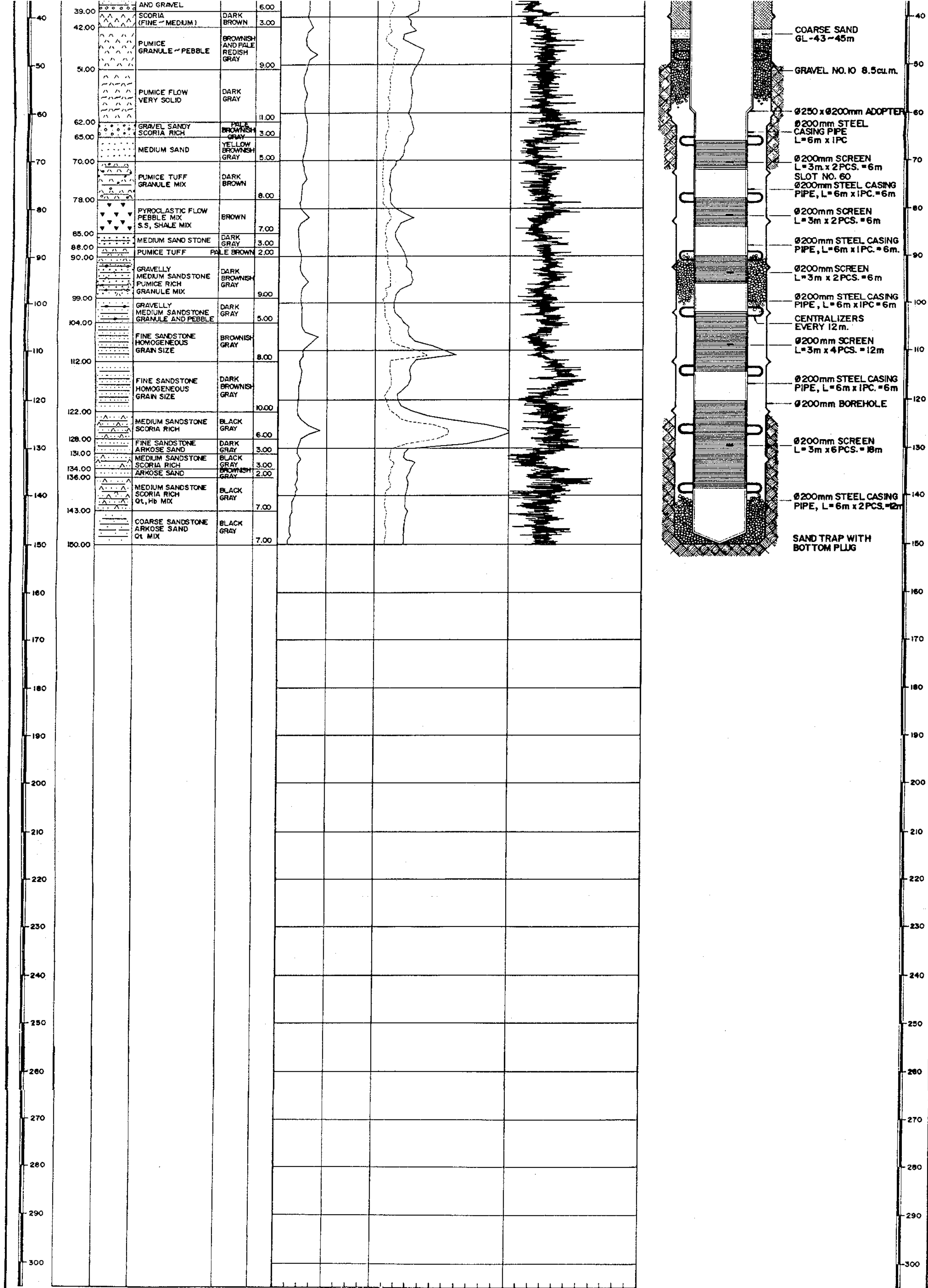
SLOT NO. 60 (1,524 mm.); GRAVEL: # 10 # / BLEND (5 mm.~ 10 mm., / m.~ / m.) 8.5 m³

DURATION: FROM: MONTH OCTOBER DAY 9 YEAR '94 TO: MONTH NOVEMBER DAY 10 YEAR '94 NUMBER OF DAYS: 33 / DAYS

DEPTH	LITHOLOGY	COLOR	T
8.00	GRAVELLY FINES AND GRANULE MIX 1~2%	BLACK BROWN	8.00
12.00	FINE SAND SCORIA RICH PUMICE MIX	DARK BROWNISH GRAY	4.00
22.00	GRAVELLY COARSE SAND GRANULE MIX SCORIA RICH PUMICE MIX	DARK BROWN	10.00
27.00	CONGLOMERATE GRANULE	BROWNISH GRAY	5.00
33.00	PYROCLASTIC FLOW GRAVELLY MEDIUM SAND, GRANULE	BROWNISH GRAY	6.00
39.00	ALTERNATION SAND AND SILT AND GRAVEL	BROWN	6.00
42.00	SCORIA (FINE~MEDIUM)	DARK BROWN	3.00
51.00	PUMICE GRANULE~PEBBLE	BROWNISH AND PALE REDISH GRAY	9.00
62.00	PUMICE FLOW VERY SOLID	DARK GRAY	11.00
65.00	GRAVEL SANDY SCORIA RICH	PALE BROWNISH GRAY	3.00
70.00	MEDIUM SAND	YELLOW BROWNISH GRAY	5.00
78.00	PUMICE TUFF GRANULE MIX	DARK BROWN	8.00
85.00	PYROCLASTIC FLOW PEBBLE MIX S.S, SHALE MIX	BROWN	7.00
88.00	MEDIUM SAND STONE	DARK GRAY	3.00
90.00	PUMICE TUFF	PALE BROWN	2.00
99.00	GRAVELLY MEDIUM SANDSTONE PUMICE RICH GRANULE MIX	DARK BROWNISH GRAY	9.00
104.00	GRAVELLY MEDIUM SANDSTONE GRANULE AND PEBBLE	DARK GRAY	5.00
112.00	FINE SANDSTONE HOMOGENEOUS GRAIN SIZE	BROWNISH GRAY	8.00
122.00	FINE SANDSTONE HOMOGENEOUS GRAIN SIZE	DARK BROWNISH GRAY	10.00
128.00	MEDIUM SANDSTONE SCORIA RICH	BLACK GRAY	6.00
131.00	FINE SANDSTONE ARKOSE SAND	DARK GRAY	3.00
134.00	MEDIUM SANDSTONE SCORIA RICH	BLACK GRAY	3.00
136.00	ARKOSE SAND	BROWNISH GRAY	2.00
143.00	MEDIUM SANDSTONE SCORIA RICH Qt, Hb MIX	BLACK GRAY	7.00
150.00	COARSE SANDSTONE ARKOSE SAND Qt MIX	BLACK GRAY	7.00







CAVITE WATER SUPPLY DEVELOPMENT STUDY

JAPAN INTERNATIONAL COOPERATION AGENCY

Fig. 1-7

WELL STRUCTURE AND GEOLOGIC COLUMNAR SECTION (C) NAIC

WELL NO. D-MENDEZ,CAVITE

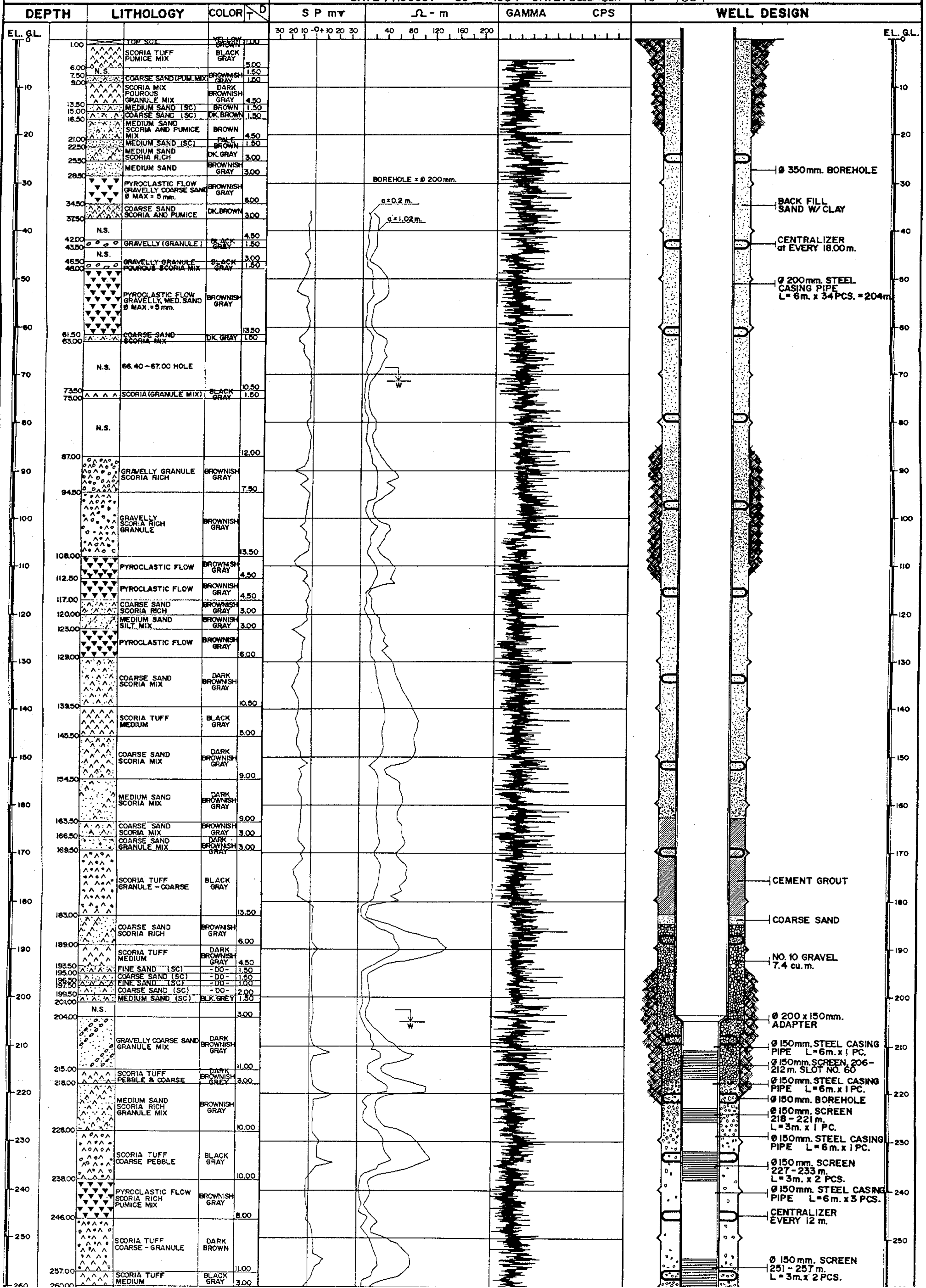
WELL CONSTRUCTION DATA

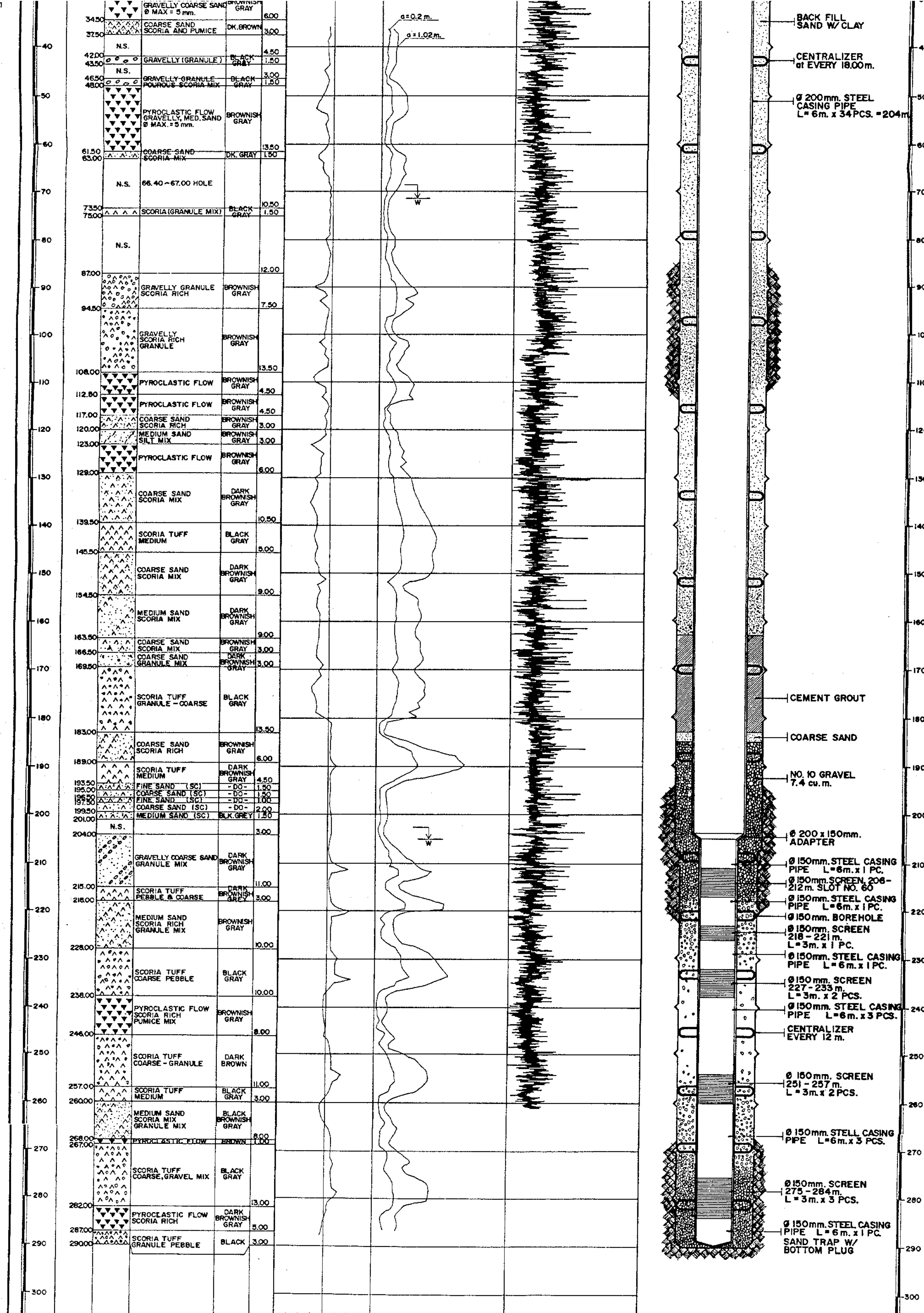
EL.= 542 m. NORMAL WATER LEVEL = G.L.- 112.19 m.

DEPTH: 290 m.; CASING PIPE: STEEL Ø 200 mm. 200 m.; SCREEN: STAINLESS STEEL 150 mm 30m.

SLOT NO.60 (1,524 mm.); GRAVEL: # 10 # BLEND (5 mm.~ 10 mm., m.~ m.) m³

DURATION: FROM: MONTH AUGUST DAY 30 YEAR 1994 TO: MONTH DECEMBER DAY 16 YEAR 1994 NUMBER OF DAYS: 109

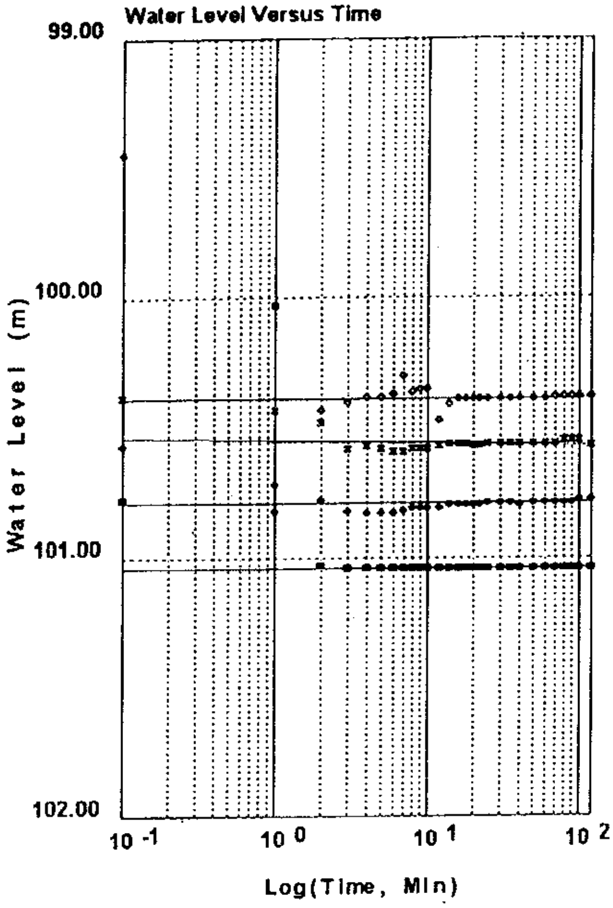


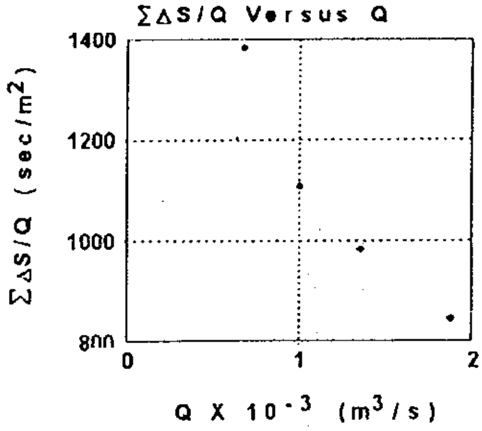


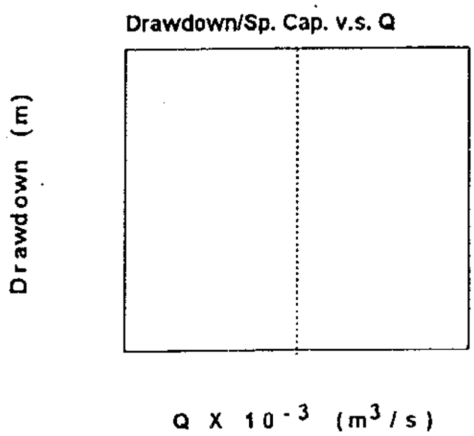
CAVITE WATER SUPPLY DEVELOPMENT STUDY

JAPAN INTERNATIONAL COOPERATION AGENCY

Fig. 1-8
WELL STRUCTURE AND GEOLOGIC COLUMNAR SECTION (D) MENDEZ







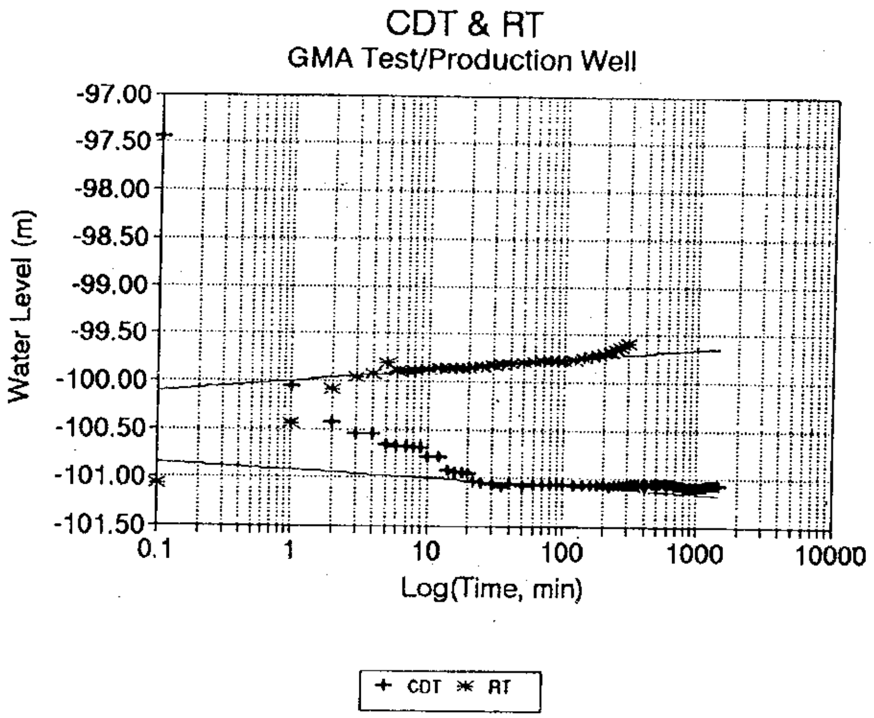
Step No.	ΔS (m)	ΣΔS (m)	$QX10^{-3}$ (m^3/s)	ΣΔS/Q (s/m^2)	Q/ΣΔS (Lps/m)	BQ (m)	CQ^2 (m)	Swc (m)	Well Loss (%)
1	0.94	0.94	0.68	1382	0.72				
2	0.18	1.12	1.01	1109	0.90				
3	0.22	1.34	1.36	985	1.01				
4	0.25	1.59	1.88	846	1.18				

Fig. 1-9(1/2)

Step Drawdown Test

GMA Test/Production Well

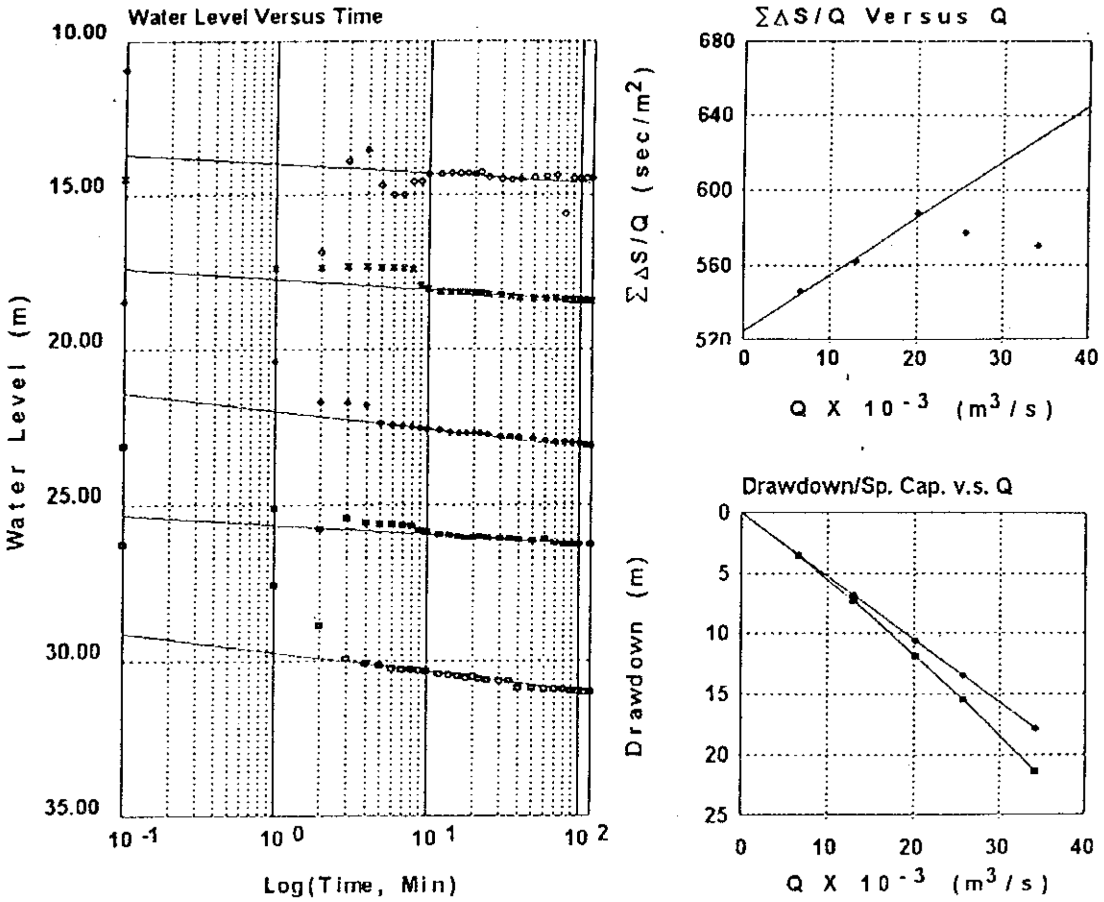
NHA Compound, GMA, Cavite



	CDT	RT
Delta S	0.08 m	0.11 m
Average Discharge	1.74 L/s	
Transmissivity	0.004 m^2/s	0.00289 m^2/s

Ave. Trans = 0.0034 m^2/s

Fig. 1-9(2/2) PUMPING TEST RESULTS OF GMA TEST WELL



Step No.	ΔS (m)	ΣΔS (m)	QX10^{-3} (m^3/s)	ΣΔS/Q (s/m^2)	Q/ΣΔS (Lps/m)	BQ (m)	CQ^2 (m)	Swc (m)	Well Loss (%)
1	3.63	3.63	6.65	546	1.83	3.49	0.13	3.62	4
2	3.69	7.32	13.02	562	1.78	6.84	0.51	7.35	7
3	4.61	11.93	20.33	587	1.70	10.67	1.24	11.91	10
4	2.92	14.85	25.75	577	1.73	13.52	1.99	15.51	13
5	4.58	19.43	34.10	570	1.76	17.90	3.50	21.40	16

Formation Loss Factor, (B) = 525 s/m^2

Well Loss Factor, (C) = 3007 s^2/m^5

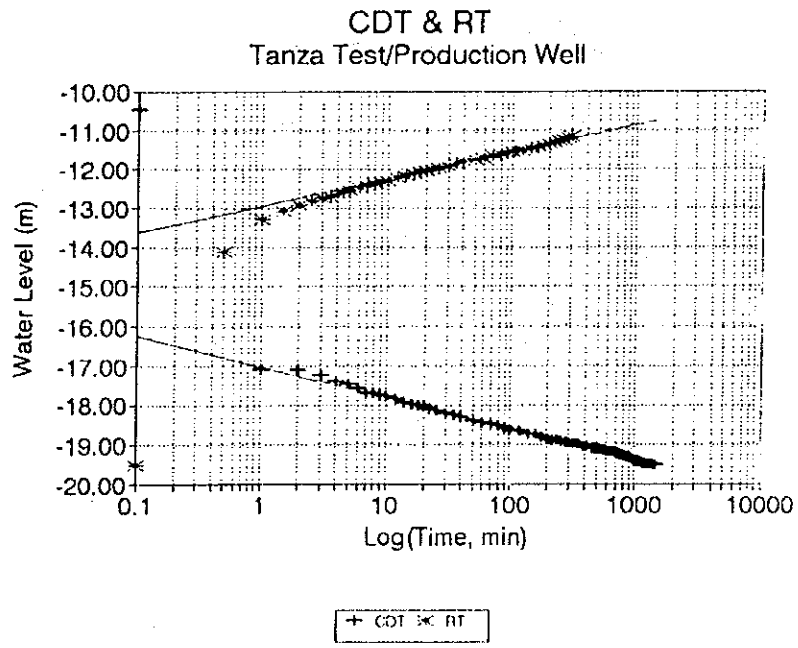
Transmissivity = 3.98 X 10^{-3} s^2/m^5

Fig. 1-10(1/2)

Step Drawdown Test

Tanza Test/Production Well

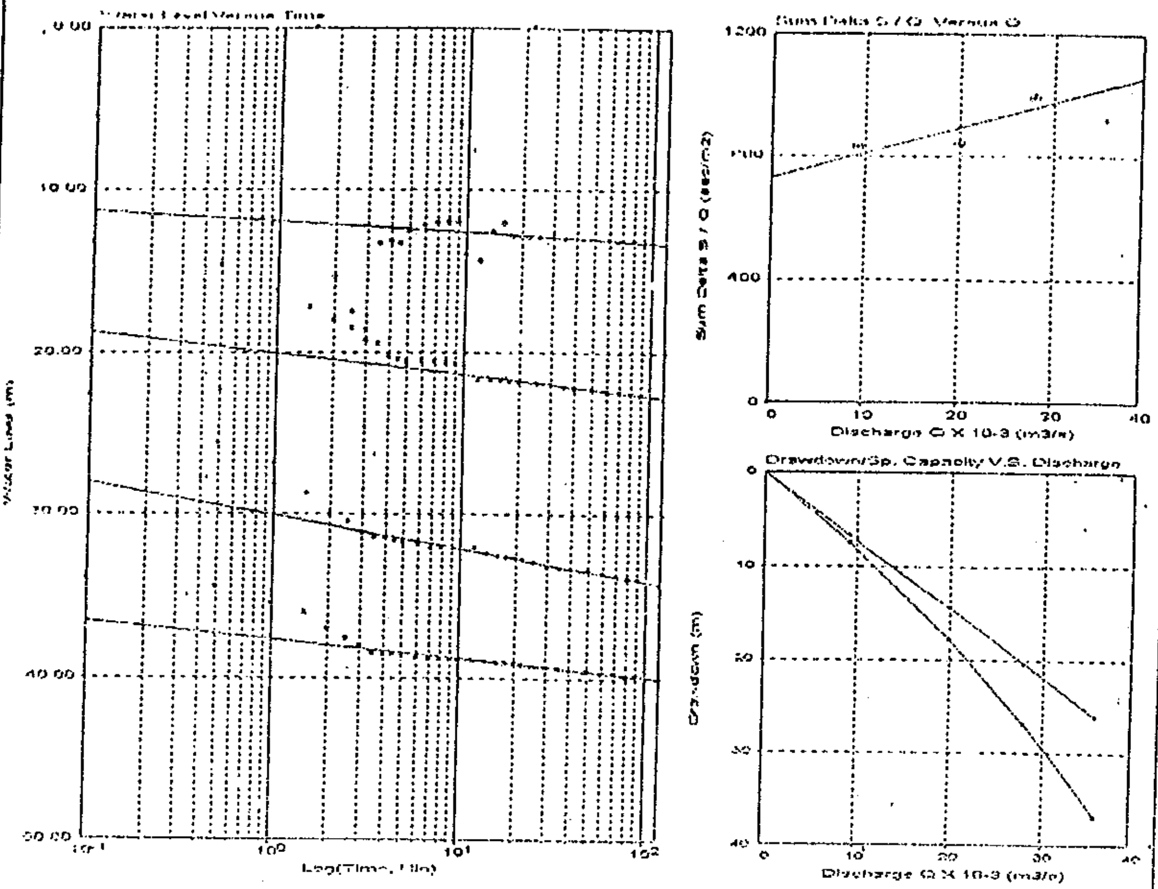
Bgy. Punta, Tanza, Cavite



	CDT	RT
Delta S	0.80 m	0.69 m
Ave. Discharge	14.54 L/s	
Transmissivity	0.00333 m^2/s	0.00386 m^2/s

Ave. Transmissivity 0.003595 m^2/s

Fig. 1-10(2/2) PUMPING TEST RESULTS OF TANZA TEST WELL



dS	SumdS	Q X 10^3	SumdS/Q	Q/SumdS	BQ	CQ^2	Sw	Well Loss
(m)	(m)	(m3/s)	(s/m2)	(l/s-m)	(m)	(m)	(m)	(%)
7.72	7.72	9.33	827	1.21	6.78	0.72	7.50	10
9.09	16.81	20.00	840	1.19	14.54	3.30	17.84	19
10.88	27.69	28.00	989	1.01	20.36	6.48	26.83	24
5.51	33.20	36.00	922	1.08	26.17	10.71	36.89	29

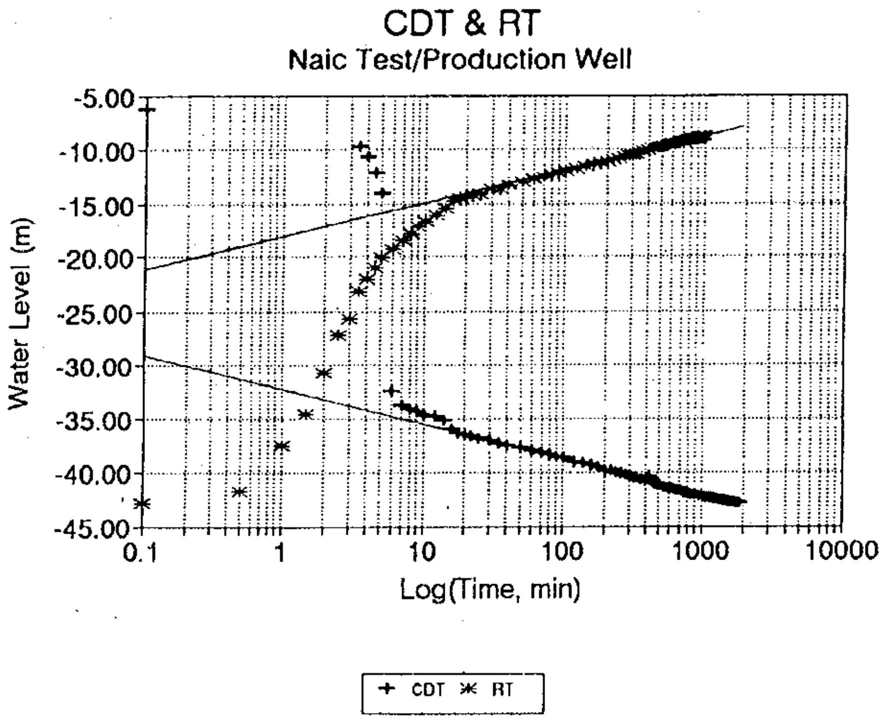
Formation Loss Factor (B) = 727 s/m^2

Well Loss Factor (C) = 8262 s^2/m^5

Fig. 1-11(1/2)

Step Drawdown Test

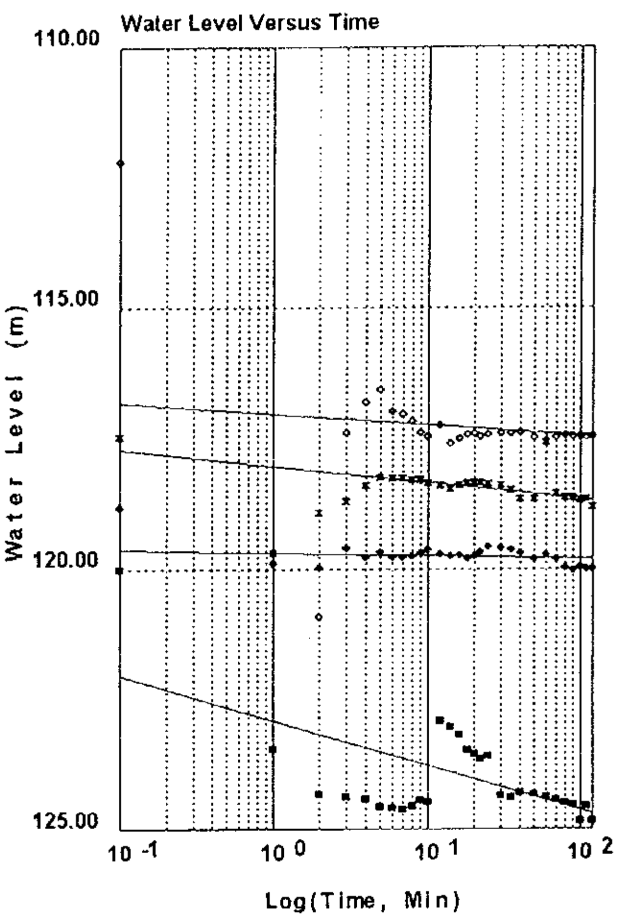
PUMPING TEST RESULTS OF NAIC TEST WELL

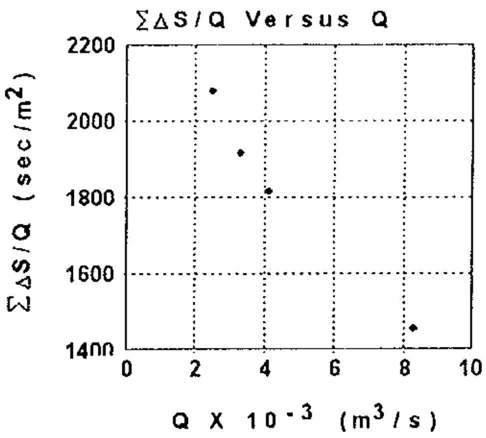


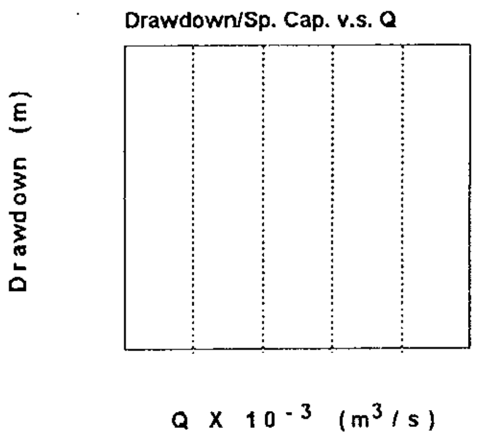
	CDT	RT
Delta S	3.23 m	3.07 m
Average Discharge	38.08 L/s	
Transmissivity	0.00216 m2/s	0.00227 m2/s

Ave. Trans 0.00222 m2/s

Fig. 1-11(2/2) PUMPING TEST RESULTS OF NAIC TEST WELL







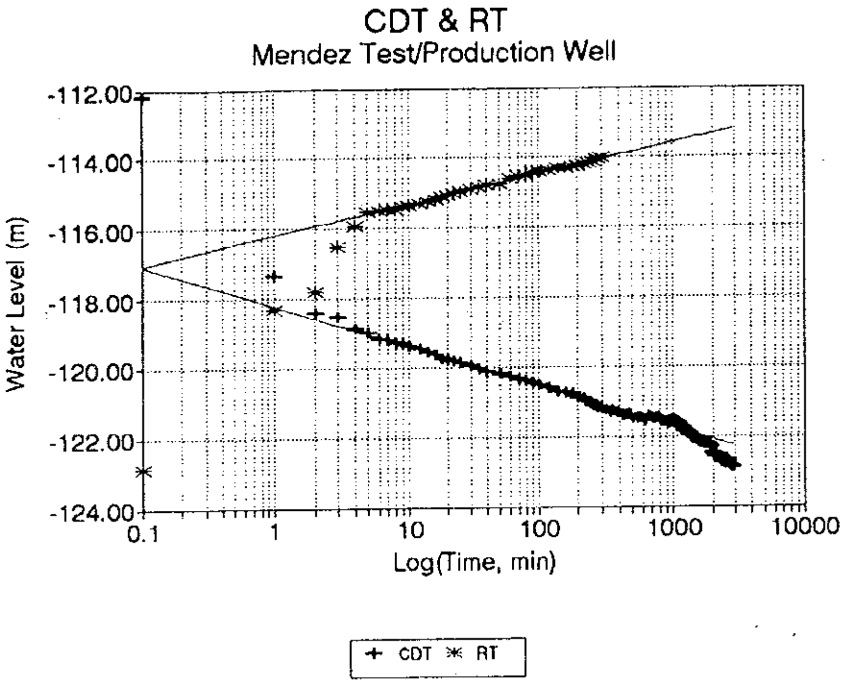
Step No.	ΔS (m)	$\Sigma\Delta S$ (m)	$QX10^{-3}$ (m^3/s)	$\Sigma\Delta S/Q$ (s/m^2)	$Q/\Sigma\Delta S$ (Lps/m)	BQ (m)	CQ^2 (m)	Swc (m)	Well Loss (%)
1	5.20	5.20	2.50	2080	0.48				
2	1.13	6.33	3.30	1918	0.52				
3	1.13	7.46	4.11	1815	0.55				
4	4.62	12.08	8.29	1457	0.69				

Fig. 1-12(1/2)

Step Drawdown Test

Mendez Test/Production Well

Bgy. Galicia, Mendez, Cavite



	CDT	RT
Delta S	1.16 m	0.86 m
Ave. Discharge	8.27 L/s	
Transmissivity	0.00130 m^2/s	0.00176 m^2/s

Ave. Trans = 0.00153 m^2/s

Fig. 1-12(2/2) PUMPING TEST RESULTS OF MENDEZ TEST WELL

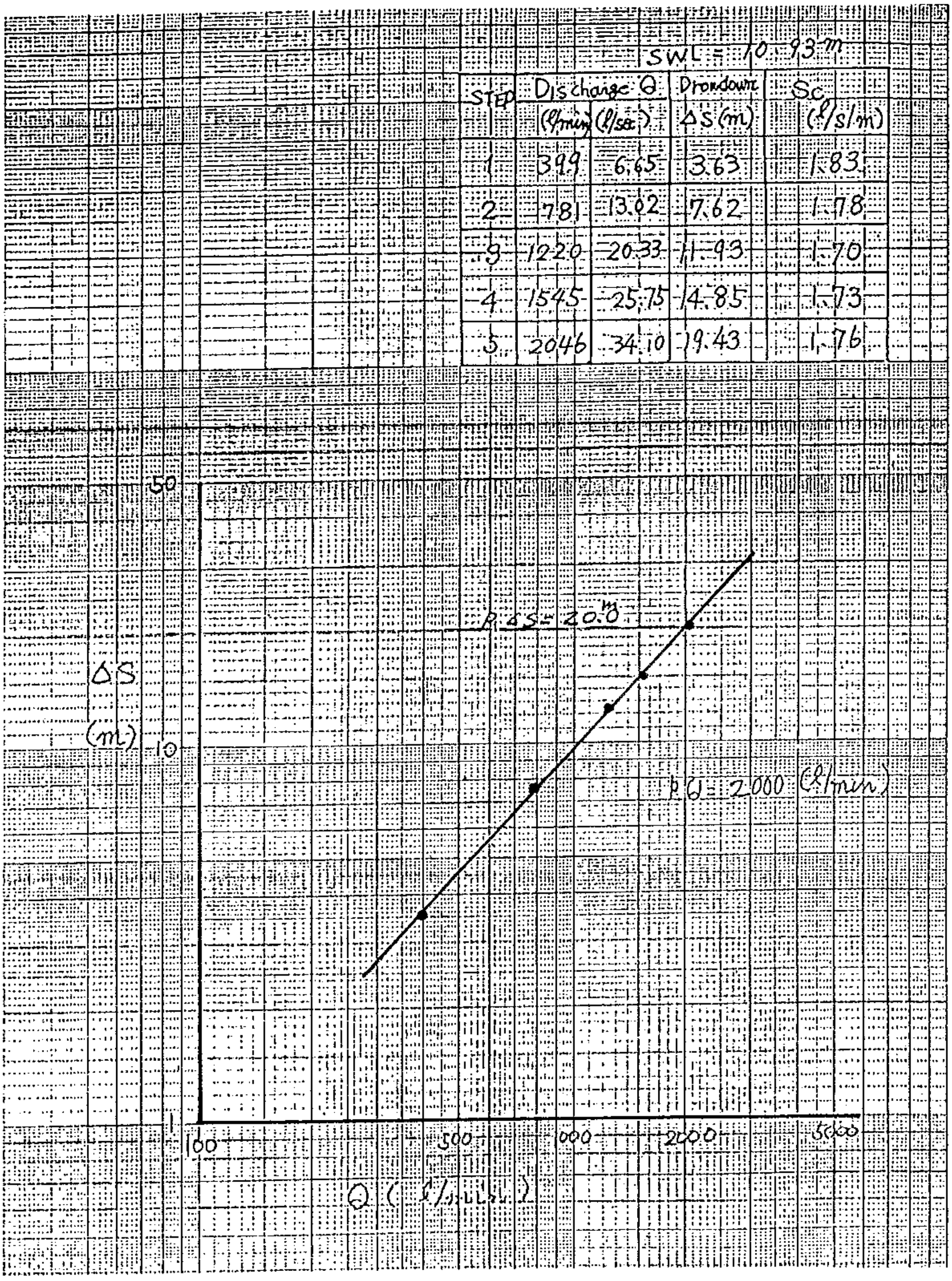
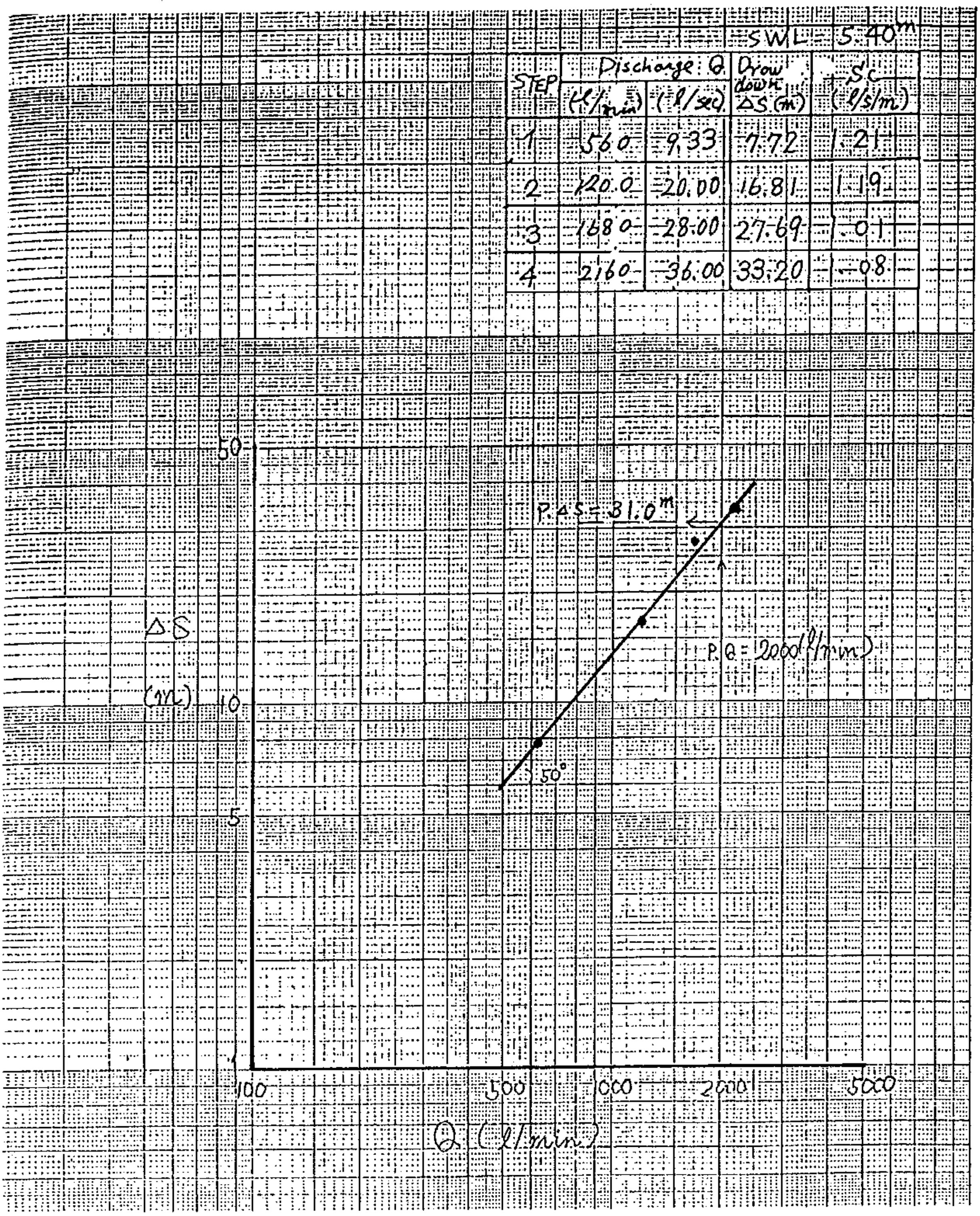


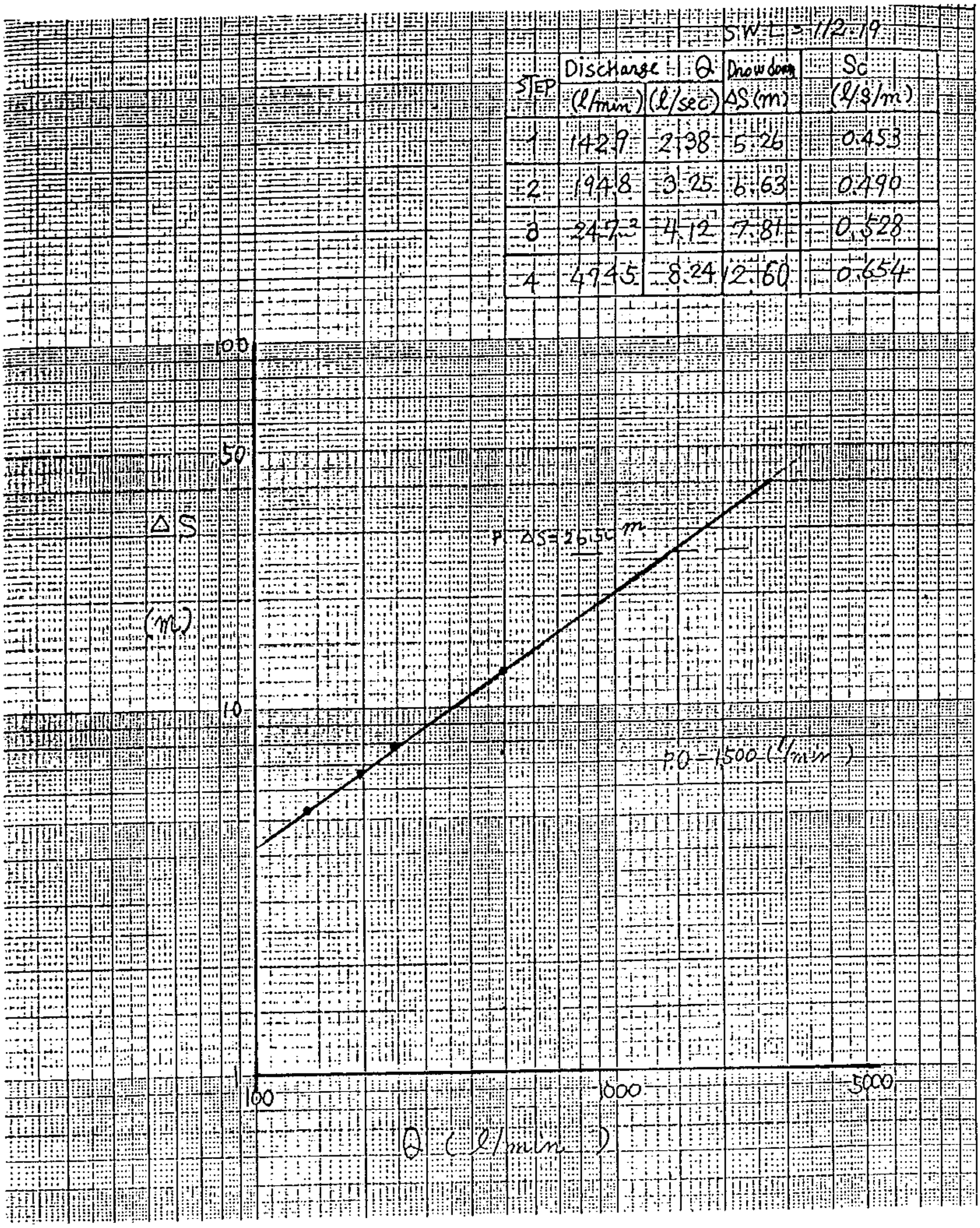
Fig. 1-13

RELATION BETWEEN PUMPING DISCHARGE AND DRAWDOWN OF TANZA TEST WELL



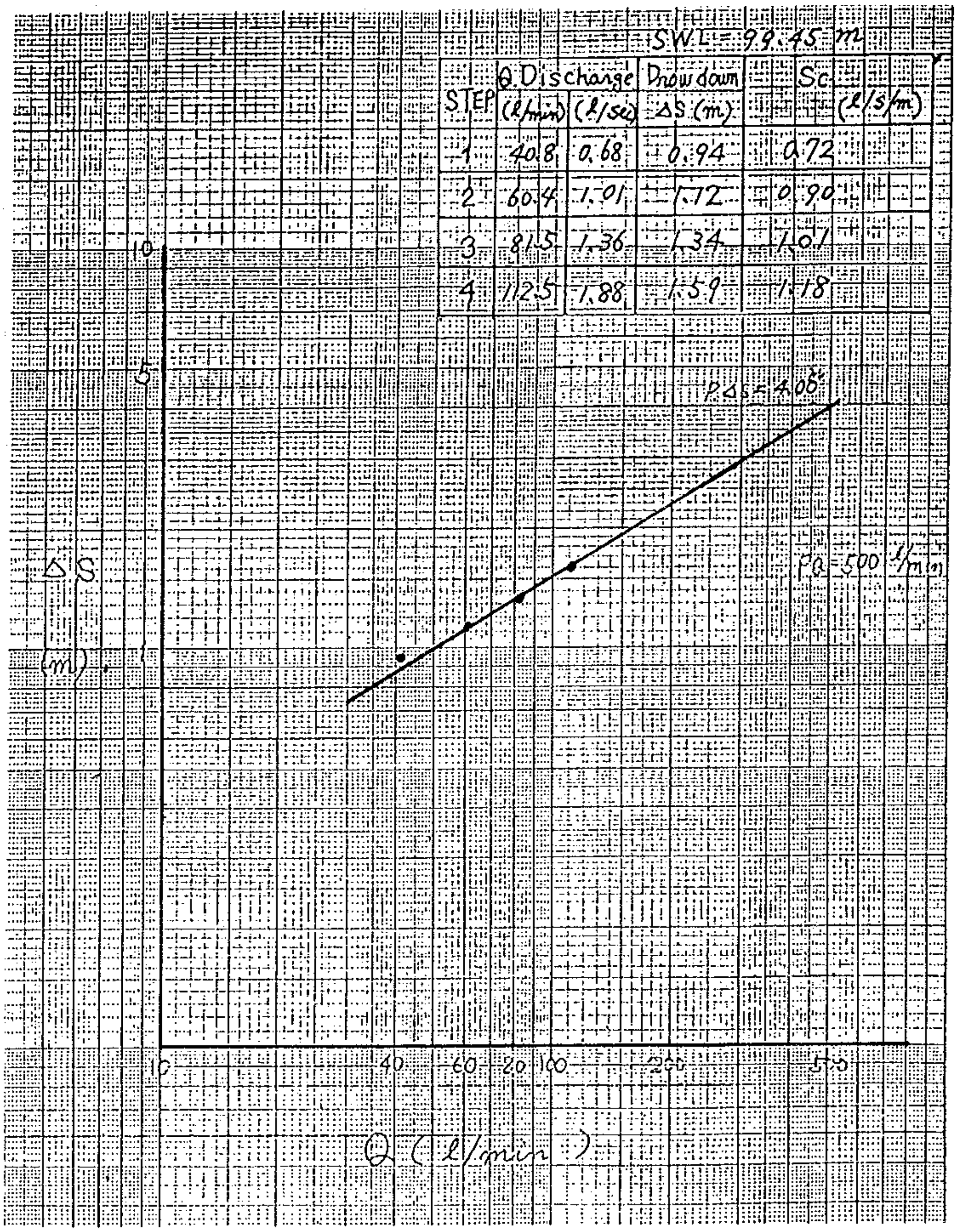
STEP	Discharge Q (l/min)	Discharge Q (l/sec)	Drawdown ΔS (m)	Sc (l/s/m)
1	560	9.33	7.72	1.21
2	1200	20.00	16.81	1.19
3	1680	28.00	27.69	1.01
4	2160	36.00	33.20	1.08

Fig. 1-14
RELATION BETWEEN PUMPING DISCHARGE AND DRAWDOWN OF NAIC TEST WELL



STEP	Discharge Q (l/min)	Discharge Q (l/sec)	Drawdown ΔS (m)	Sc (l/s/m)
1	142.9	2.38	5.26	0.453
2	194.8	3.25	6.63	0.490
3	247.2	4.12	7.81	0.528
4	494.5	8.24	12.60	0.654

Fig. 1-15
RELATION BETWEEN PUMPING DISCHARGE AND DRAWDOWN OF MENDEZ TEST WELL



STEP	Q. Discharge (l/min)	Q. Discharge (l/sec)	Drawdown ΔS (m)	Sc (l/s/m)
1	40.8	0.68	0.94	0.72
2	60.4	1.01	1.12	0.90
3	81.5	1.36	1.34	1.01
4	112.5	1.88	1.59	1.18

Fig. 1-16

RELATION BETWEEN PUMPING DISCHARGE AND DRAWDOWN OF GMA TEST WELL

2. RIVER AND SPRING SURVEY

2. RIVER AND SPRING SURVEY

2.1 MEASUREMENT POINTS

The survey aims to grasp both surface and groundwater conditions of the Study Area by measuring river and spring discharges in both dry and wet seasons, to establish the relationship between rainfall and runoff for water balance analysis and to obtain basic data for groundwater simulation.

A total of 30 measurement points were selected for river discharge survey in the dry season. Besides these 30 points, there were three (3) additional measurements made in the wet season, Hasaan Creek (R-31), Ilang-Ilang River (R-32) and Imus River (R-33). These additional measurements were made in order to checked the actual discharge resulting from the diversion. The coordinates of the measurement points were determined in the field using the Global Positioning System (GPS). Since the coördinates of discharge measurement and sampling points in Phase I were based from the topographic map, they were adjusted using the actual readings taken from the field. Discharge measurements were conducted using the Price-type current meter. Of all thirty (33) measurement points selected for rivers, in the wet season eight (8) points while in the dry season, 6 points were located inside the groundwater simulation area.

Twenty four (24) measurement points were made for springs. Each measurement points were photographed by the survey team. Water samples were also taken for water quality, analysis, ten (10) for rivers and ten (10) for springs.

The selection of measurement points for discharge considered the cross-section, topography and catchment area and channel characteristics. Existence of hydraulic structures such as diversion dams was also considered as basis for the selection of discharge measurement points. As much as possible, measurements were made in straight reach were the velocity threads are parallel to each other, stable stream bed free of bed rocks, weeds and protruding obstructions which would create turbulence and flat streamed profile to minimize vertical velocity components. For springs, previous studies made by LWUA were used to determine the locations.

2.2 METHODOLOGY

For discharge measurement using the current meter, the basic principle is based on the proportionality between the velocity of the stream and revolution of the rotor.

The velocity can be expressed as follows:

$$v = a + b \times N$$

where:

v	=	velocity of current at a point
a,b	=	constant to be determined by calibration

N	=	number of revolutions

The discharge measurement procedure that was used is as follows. After selecting the section for discharge measurement, set the taglines and determine the width of the stream. Determine the spacing of vertical such that no partial section should discharge 5% of the total discharge. Unless discharge is uniformly distributed, equal widths of partial sections are not recommended. Indicate the distance of the initial point from the edge of the water and also the depth of water. Decide on the method of velocity measurement. For shallow depths less than 0.50 meter, use the 0.6 D method (current meter placed at 0.6 of depth below the water surface). During times of high water, when velocities are great and it is impossible to place the meter of 0.6 or 0.8 depth, the current meter may be placed at 0.2 of depth below the surface and then apply a coefficient to the observed velocity to get the mean in the interval. After the meter position has been computed and meter placed at the proper depth, allow the meter to adjust to the current before starting the velocity observation. Then, get the number of revolutions made by the rotor for about 40 to 60 seconds. It will be convenient if counting is ended on a convenient number given in the meter rating column heading. Stop the stop watch on that exact count and record the number of revolutions and time interval. Move to the next vertical and repeat the same procedure, always recording the distance from the initial point, depth, meter position depth, revolution, and time interval until the entire stream section is covered.

Then, the discharge can be computed using the equation:

$$q = a \times v$$

where:

q	=	discharge at a point
v	=	velocity of current at a point
a	=	area of the section

The total discharge is the summation of all the discharge at a point.

Fig. 2-1 to **2-7** illustrates the flow scheme for the river basins of Maragondon, Labac, Canas, San Juan, Imus and Binan rivers, and river systems below tagaytay ridge.

For springs, the Volumetric Procedure in computing the spring yield were used in the survey. The discharge can be expressed as:

$$Q = \frac{V}{T}$$

where:

Q	=	discharge
V	=	volume of container
T	=	required time to fill the container

2.3 RUNOFF THROUGH RIVERS

Streamflow data were collected from BRS for four stream gaging stations located within the Study Area. Unfortunately, these stations which were established by the former Bureau of Public Works (BPW) as early as 1952 were already abandoned by BRS. The respective coordinates, drainage areas and periods of record of the four (4) gaging stations are shown in **Table 2-1**. All four stations have about twenty years of available data. However, only data up to 1979 are discharge data. The data from 1980 to the present are recorded in terms of gage height and not converted to discharge value.

Streamflow measurements made by BPW in Maragondon River, Ilang-Ilang River, Balsahan River and Panaysayan River seem to be underestimated due to heavy diversion for irrigation use upstream of the gaging stations. This is illustrated in **Figs. 2-1 to 2-4** as a result of the river and spring surveys . At least 2,041 lps is being diverted from Ilang-Ilang River above the gaging station, 830 lps from Panaysayan River, 1,241 lps from Balsahan River, and 1,100 lps from Maragondon River. **Table 2-2** details the volume of water being diverted by NIA for irrigation of some 14,650 has. of paddy fields in the Study Area. As shown in **Table 2-3**, these data were needed to adjust the discharge records to obtain a better estimates of surface runoff for water balance analysis.

2.4 WATER SAMPLING PROCEDURE

Twenty (20) water samples were taken, ten (10) for rivers and ten (10) for springs. The sampling requirements are as follows:

For Bacteriological Analysis:

- minimum sample amount is one (1) liter;
- bottle is full of sample and airtight;
- bottle is a clean amber glass;
- sample is kept in ice box as a low temperature storage and;
- sample is taken to the laboratory analysis within six (6) hours.

For Physical and Chemical Analyses:

- minimum sample amount is two (2) liters;
- bottle is full of sample and airtight;
- bottle is a clean ordinary glass and;
- sample is taken to the laboratory analysis within twenty four (24) hours.