can be characterized by the dominance of black volcanic glass and brown volcanic glass, whereas in the upper samples, white volcanic glass and brown volcanic glass are dominant.

The heavy mineral analysis as well as the volcanic glass analysis may be done even with the use of well cuttings. The assemblage of both heavy minerals and volcanic glass could be a good marker and should help future geologic correlation in the Metro Mañila.

Results of analysis of heavy mineral are shown in Table 3.5.3.

3.5.4 Analysis of Chloride Content

Chlöride content of sandy core samples were analyzed to evaluate the degree of contamination caused by saltwater intrusion.

The findings show that the samples taken from shallow aquifers at depths of 10m, 27m and 52.5m yield much higher chloride content than those from deep aquifers. This could indicate that encroachment of salt-water is mainly on the shallow aquifer from Manila Bay and the surface (Table 3.5.4).

3.5.5 Carbon Dating

Carbon dating was carried out for Site No.2, Las Piñas sing two alluvial humic clay samples. Sample No.1 and Sample No.2 were taken from depths of 7.7m and 10.5m, respectively. The measured radiocarbon age before the year 1950 of Sample No.1 is 7040, plus or minus 150 years. That of sample No. 2 is 7360, plus or minus 110 years.

This age shows that the alluvial clay was deposited during the global transgression after Wurm glacial stage (Japanese name "Jomon transgression").

TABLE 3.3.1 RESULTS OF STEP-DRAWDOWN TEST AT WELL NO.1, LAS PIÑAS NO.1

Step	Discharge rate, Q (ℓ/min)	(m³/day)	Drawdown, s (m)	s/Q (d/m²)
1	198	285.1	8.62	0.03023
2	402	578.9	18.20	0.03144
3	606	872.6	26.10	0.02991
4	648	933.1	29.37	0.03148

TABLE 3.3.2 RESULTS OF PUMPING TESTS AND EC & TEMPERATURE LOGS IN LAS PIÑAS NO.1

	Well No.1 (300m)	Well No.2 (200m)	Well No.3 (100m)
Static W.L. (m)	44.48	37.34	4.60
Dynamic W.L. (m)	72.84	40.99	9.72
Discharge(ℓ/min)	404.0	90.6	150.0
Max. & Min. ECt at Logging(μS/cm)	3330 1850	13200 1110	40200 28900
Max.& Min.Temp. at Logging(deg.C)	35.6 34.1	32.9 30.5	30.4 29.5
Max.& Min.EC_{18} at Logging(μS/cm)	2401 1364	10300 1110	31804 22706
EC_{18} before & after pumping (μS/cm)	1060 917	598 546	31542 29876
T by Theis (m²/day)	52.2	35.8	593.0
T by Cooper-Jacob(m²/day)	62.1	29.4	111.4
T by recovery (m²/day)	48.7	30.3	119.8
S by Theis	4.08×10^{-5}	4.63×10^{-2}	1.08×10^{-3}
S by Cooper–Jacob	1.80×10^{-3}	2.05×10^{-1}	1.40×10^{-10}

TABLE 3.3.3 RESULTS OF STEP-DRAWDOWN TEST AT WELL NO.1, LAS PIÑAS NO.2

Step	Discharge rate, Q (ℓ/min)	(m³/day)	Drawdown, s (m)	s/Q (d/m²)
1	101.4	146.0	13.88	0.09506
2	198.6	286.0	23.73	0.08298
3	300.0	432.0	39.95	0.09248
4	402.0	578.9	52.10	0.09000
5	445.8	642.0	55.33	0.08619

TABLE 3.3.4 RESULTS OF PUMPING TEST AND EC & TEMPERATURE LOGS IN LAS PIÑAS NO.2

	Well No.1 (300m)	Well No.2 (200m)	Well No.3 (100m)
Static W.L. (m)	50.03	43.44	3.66
Dynamic W.L. (m)	95.00	51.26	5.07
Discharge(ℓ/min)	300.0	91.2	153.0
Max. & Min. EC_t at Logging(μs/cm)	3830 1510	30100 21300	39800 28000
Max.& Min.Temp. at Logging(deg.C)	36.3 33.2	33.0 30.3	31.0 28.6
Max.& Min.EC_{18} at Logging(μs/cm)	2783 1132	23012 16284	31932 21773
EC_{18} before & after pumping (μs/cm)	1592 765	22784 9483	30757 29654
T by Theis (m²/day)	9.1	34.0	149.5
T by Cooper-Jacob(m²/day)	10.7	227.1	176.8
T by recovery (m²/day)	18.4	11.4	260.2
S by Theis	2.64×10^{-2}	1.43×10^{-7}	7.24×10^{-2}
S by Cooper-Jacob	1.51×10^{-2}	$<1.00 \times 10^{-10}$	1.38×10^{-2}

TABLE 3.3.5 RESULTS OF STEP-DRAWDOWN TEST AT WELL NO.1, LAS PIÑAS NO.3

Step	Discharge rate, Q (ℓ/min)	(m³/day)	Drawdown, s (m)	s/Q (d/m²)
1	102	146.9	7.40	0.05038
2	198	285.1	15.06	0.05282
3	300	432.0	23.70	0.05486
4	402	578.9	29.55	0.05105

TABLE 3.3.6 RESULTS OF PUMPING TESTS AND EC & TEMPERATURE LOGS IN LAS PIÑAS NO.3

	Well No.1 (300m)
Static W.L. (m)	64.90
Dynamic W.L. (m)	86.83
Discharge(ℓ/min)	300.0
Max. & Min. ECt at Logging(μs/cm)	1900 760
Max.& Min.Temp. at Logging(deg.C)	35.2 30.2
Max.& Min.EC₁₈ at Logging(μs/cm)	1380 596
EC₁₈ before & after pumping (μs/cm)	552 526
T by Theis (m²/day)	28.7
T by Cooper-Jacob(m²/day)	33.2
T by recovery (m²/day)	38.8
S by Theis	9.73×10^{-5}
S by Cooper-Jacob	6.18×10^{-5}

TABLE 3.4.1

FISSION TRACK AGES OF ZIRCON

SAMPLE NO.	SPONTANEOUS TRACK NUMBER	SPONTANEOUS TRACK DENSITY X10 cm	INDUCED TRACK NUMBER	INDUCED TRACK DENSITY X10 cm	THERMAL NEUTRON DOSE X10 cm	F	NUMBER OF GRAINS	AGE AND STD. ERROR (Ma)	RELATIVE STD. ERROR (%)	METHOD	ID
PM1	263	8.646 + 0.533	53	1.742 ± 0.239	3.94 + 0.14	1.62	4	116.4 ± 18	15.5	ESED	9104003
PM2	68	5.365 + 0.651	20	1.578 ± 0.353	3.94 + 0.14	0.01	2	80.0 ± 20.6	25.7	ESED	9104004
PM3	125	8.218 + 0.735	21	1.381 ± 0.301	3.94 + 0.14	0.32	4	139.5 ± 33.3	23.8	ESED	9104005
PM4	76	9.993 + 1.146	19	2.495 ± 0.573	3.94 + 0.14	1.82	2	94.1 ± 24.4	25.9	ESED	9104006
PM5	75	7.718 + 0.891	14	1.441 ± 0.385	3.94 + 0.14	0.05	4	125.7 ± 36.9	29.3	ESED	9104007

*1 Thermal neutron dose $\phi = \phi k \times u \times k$ (Ma): Mega-annum

ϕk : thermal neutron dose of standard glass (NBS SRM-913) irradiated at NBS nuclear reactor
$= 4.75 \pm 0.05\ (\times 10^{14} cm^{-2})$

u : track density of muscovite attached to standard glass irradiated with sample
$= 7.370 \times 10^4 cm^{-2} = 2201\ tracks/3.0 \times 10^{-2} \times cm^2$

k : track density of muscovite attached to standard glass which irradiated at NBS nuclear reactor
$= 8.885 \times 10^4 cm^{-2} = 1770\ tracks/2.0 \times 10^{-2} cm^2$

*2 F-value, Hayashi and Sugiyama, 1987

*3 Age $= 6.45 \times 10^9 \ln (1 + 9.32 \times 10^{-18} \times \phi \times s/i)$

s = spontaneous track density of ^{235}U

i = induced track density of ^{235}U

*4 ESED, External-Surface External-Detector method, Daishi et al., 1986

TABLE 3.4.2 DIATOM ANALYSIS OF CORE SAMPLES IN LAS PIÑAS (JICA NO.1 TESTWELL)

NAME OF FOSSILS	M.O.L.	7.7m	-10.5	-24.8	-63-3	-116m	-150.	-238.	-295m
Achnanthes brevipes var intermedia	M	3	8						
Achnanthes covergens	F-B			12					
Achnanthes delicatula	B	1							
Achnanthes sp.	M		1						
Amphora holsatica	M	1	5						
Amphora spp.	F-B			2					
Amphora strigosa	B		2						
Bacillaria paradoxa	F-B		2						
Cyclotella sp.	F					3			
Cyclotella striata? sp.	M	84	1						
Cymbella sp.	F			1					
Diploneis interupta	B	3	6						
Diploneis ovalis?	F			1					
Diploneis smithii	M	1	55						
Diploneis sp.	F							1	
Diploneis suborbicularis	M-B	9	14						
Epthemia sp.	F					2			
Fragilaria sp.	F					1			
Comphonema spp.	F			3					
Grammatophora macilenta	M	7							
Gyrosigma scalproides	F		1						
Gyrosigma spp.	F		2	3					
Hyalodiscus scoticus	B-M	1							
Melosira roeseana	F							2	
Melosira sp.	F			1					

TABLE 3.4.2 (CONTINUATION)

NAME OF FOSSILS	M.O.L.	7.7m	-10.5	-24.8	-63-3	-116m	-150.	-238.	-295m
Navicula contenta	F					1		15	
Navicula gregaria	M			5					
Navicula mutica	F		1			1			
Navicula pupula	F			3					
Navicula spp.	F		2	6				1	
Navicula thienemanni	F			1					
Nitzschia cocconeiformis	M	28	27						
Nitzchia fonticola	F			1					
Nitzschia glanurata	M	11	17						
Nitzshia hohnkii	B		1						
Nitzshia hungarica	F-B		1						
Nitzshia littoralis	B		2						
Nitzschia obtusa	F			21					
Nitzschia palea	F					1			
Nitzschia parvula	F-B			1					
Nitzschia punctata	M	2	2						
Nitzschia sigma	M	2	20						
Nitzschia sp.1	F					1			
Nitzschia sp.2	F					5			
Nitzschia sp.3	F-B			1					
Nitzschia spp.	?	1	4	13					
Nitzschia supralitorea	F			42					
Paralia sulcata	M	20							
Pinnularia hemiptera	F		1						
Pinnularia spp.	F	4		19				2	
Rhaphoneis surirella	M	1							

TABLE 3.4.2 (CONTINUATION)

NAME OF FOSSILS	M.O.L.	7.7m	-10.5	-24.8	-63-3	-116m	-150.	-238.	-295m
Rhopalodia gibberula	F-B	2		71					
Synedra rumpens	F					5			
Synedra sp.	F					32			
Talasiosira sp.	?	6							
Thalassionema nitzschioides	M	14							
Thalassiosira bramaptrae	F-B		1						
gen. et sp. indet	?	1	6	3				5	
TOTAL		202	182	210	0	52	0	26	0

M.O.L. : Mode of Life

F : Fresh, B: Brackish, M: Marine

TABLE 3.4.3(1) GRAIN COMPOSITION

SAMPLE NO.	DEPTH (m)	VOLCANIC GLASS				WEATHER PARTICLES	ROCK FRAGMENTS	LIGHT MINERAL	HEAVY MINERAL
		WHITE	BROWN	BLACK	TOTAL				
1	10.0	49.8	0.0	0.0	49.8	24.9	19.9	5.0	0.5
3	24.0	0.0	0.0	0.0	0.0	68.0	26.6	4.9	0.5
6	41.0	0.0	0.0	0.0	0.0	70.0	11.0	17.0	2.0
10	79.3	0.0	0.0	0.0	0.0	56.9	4.0	7.1	2.0
11	95.9	39.0	31.0	4.0	74.0	0.0	9.0	14.0	3.0
12	105.1	43.9	36.1	7.8	87.8	0.0	7.8	3.9	0.5
13	114.1								
14	123.8	0.0	0.0	0.0	0.0	89.6	5.0	5.0	0.5
15	134.0	26.0	32.0	9.0	67.0	0.0	20.0	8.0	5.0
16	143.9	7.1	49.5	4.0	60.6	0.0	35.4	3.0	1.0
17	156.0	0.0	0.0	0.0	0.0	88.6	5.0	6.0	0.5
18	165.0	0.0	0.0	0.0	0.0	89.6	5.0	5.0	0.5
19	177.5								
20	184.0	90.5	0.0	0.0	90.5	3.0	5.0	1.0	0.5
21	197.0	64.0	14.0	5.0	83.0	0.0	8.0	8.0	1.0
22	207.1	8.1	30.3	6.0	44.4	0.0	30.3	15.2	10.1
23	216.5	25.0	16.0	5.0	46.0	0.0	40.0	12.0	2.0
24	231.7	71.8	17.4	3.1	92.3	0.0	6.2	1.0	0.5
25	241.5	47.3	19.7	14.8	81.8	0.0	13.8	3.9	0.5
26	249.5								
27	264.5	0.0	0.0	0.0	0.0	98.5	0.5	0.5	0.5
28	277.1	36.0	0.0	3.0	39.0	28.0	20.0	16.0	2.0
29	280.7	29.9	24.9	39.8	94.6	0.0	0.5	4.0	1.0
30	283.8								
31	290.5	0.0	0.5	0.5	1.0	97.1	0.5	1.0	0.5
32	297.6	0.0	0.0	0.0	0.0	73.4	15.2	8.9	2.5

TABLE 3.4.3(2) HEAVY MINERAL COMPOSITION (%)

SAMPLE NO.	DEPTH (m)	Au	Hy	Ho	Zi	Mg	Py
1	10.0	70.0	20.0	5.0	0.0	5.0	0.0
3	24.0	96.0	1.0	1.0	0.0	2.0	0.0
6	41.0	71.0	18.0	5.0	0.0	6.0	0.0
10	79.3	0.0	0.0	0.5	0.0	99.5	0.0
11	98.9	31.0	37.0	0.0	0.0	32.0	0.0
12	105.1	50.0	20.0	0.0	0.0	30.0	0.0
13	114.1						
14	123.8	24.0	10.0	10.0	0.0	56.0	0.0
15	134.0	38.0	28.0	0.0	0.0	34.0	0.0
16	143.9	50.5	12.1	0.0	0.0	36.4	1.0
17	156.0	14.0	0.0	0.0	0.0	86.0	0.0
18	165.0	58.5	12.7	8.8	0.0	0.5	19.5
19	177.5						
20	184.0	50.0	20.0	0.0	0.0	30.0	0.0
21	197.0	51.0	34.0	0.0	0.0	15.0	0.0
22	207.1	58.0	5.0	0.0	1.0	36.0	0.0
23	216.5	56.0	32.0	0.0	0.0	7.0	5.0
24	231.7	49.0	13.0	0.0	0.0	23.0	15.0
25	241.5	19.0	53.0	0.0	0.0	28.0	0.0
26	249.5						
27	264.5	35.0	30.0	0.0	0.0	35.0	0.0
28	277.1	59.4	0.5	0.0	0.5	39.6	0.0
29	280.7	64.4	0.5	0.0	0.5	34.7	0.0
30	283.8						
31	290.5	80.0	0.0	0.0	0.0	20.0	0.0
32	297.6	58.0	1.0	0.0	0.0	41.0	0.0

Au: Augite Hy: Hypersthene Ho: Hornblende
Zi: Zircon Mg: Magnetite Py: Pyrite

TABLE 3.4.4 CHLORIDE CONTENT OF CORE SAMPLES IN LAS PIÑAS NO.1

SAMPLE NO.	QUANTITY (g)	CHLORIDE (g)	CHLORIDE QTY. (g) PER SAMPLE (kg)
1	0.5023	2.48×10^{-2}	49.0
4	0.4984	3.9×10^{-3}	7.8
7	0.5132	6.74×10^{-3}	13.0
11	0.5181	5.9×10^{-4}	1.1
15	0.5514	2.4×10^{-4}	0.4
19	0.5412	1.2×10^{-4}	0.2
21	0.5107	1.4×10^{-4}	0.3
24	0.5186	2.1×10^{-4}	0.4
26	0.5017	3.9×10^{-4}	0.8
29	0.5361	3.2×10^{-4}	0.6
32	0.5213	5.7×10^{-4}	1.1

STUDY FOR THE GROUNDWATER DEVELOPMENT IN METRO MANILA

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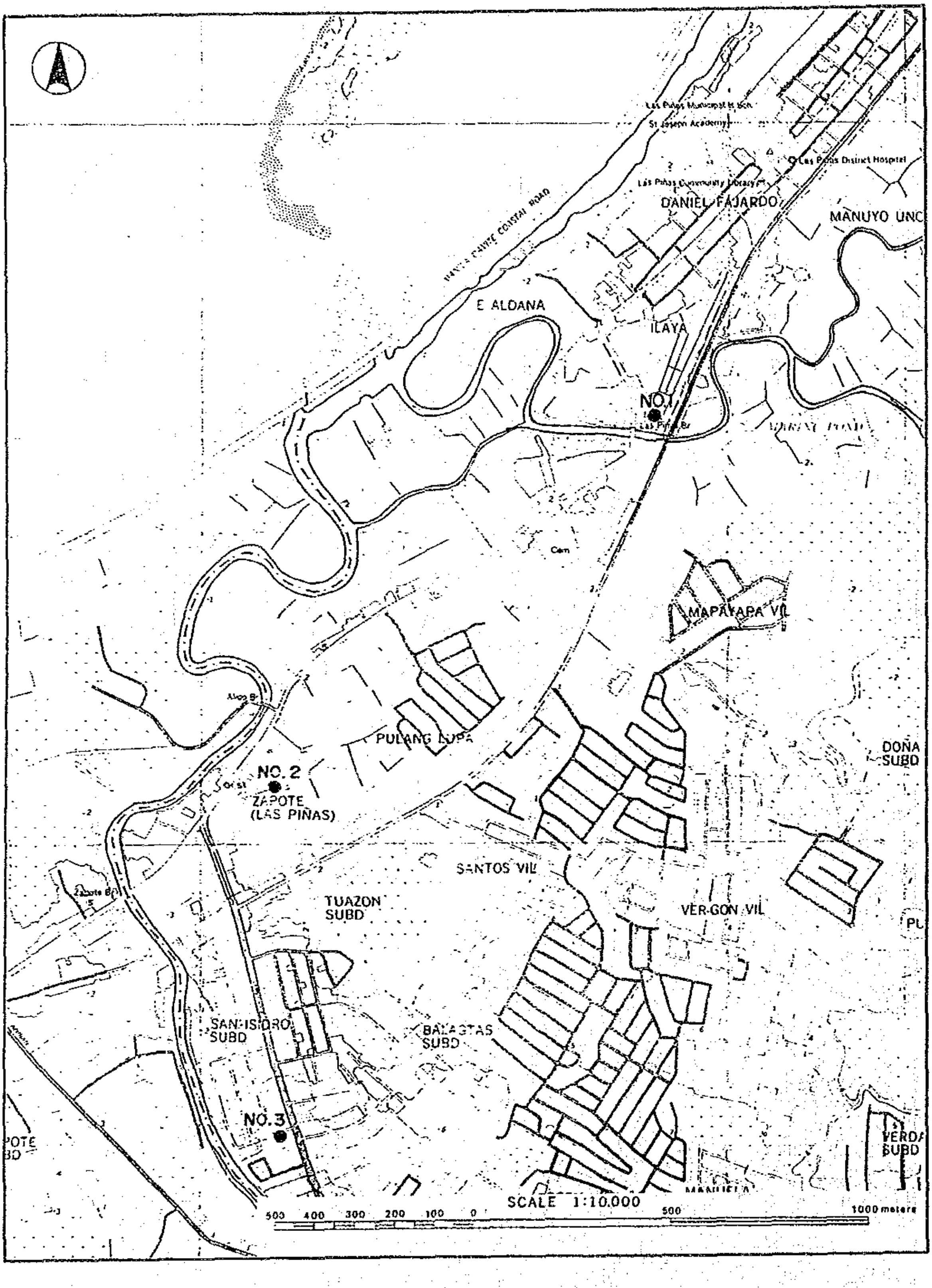
FIGURE 3.1.1 LOCATION OF TEST WELLS IN ANTIPOLO



STUDY FOR THE GROUNDWATER DEVELOPMENT IN METRO MANILA	FIGURE 3.1.2 LOCATION OF TEST WELLS IN LAS PIÑAS
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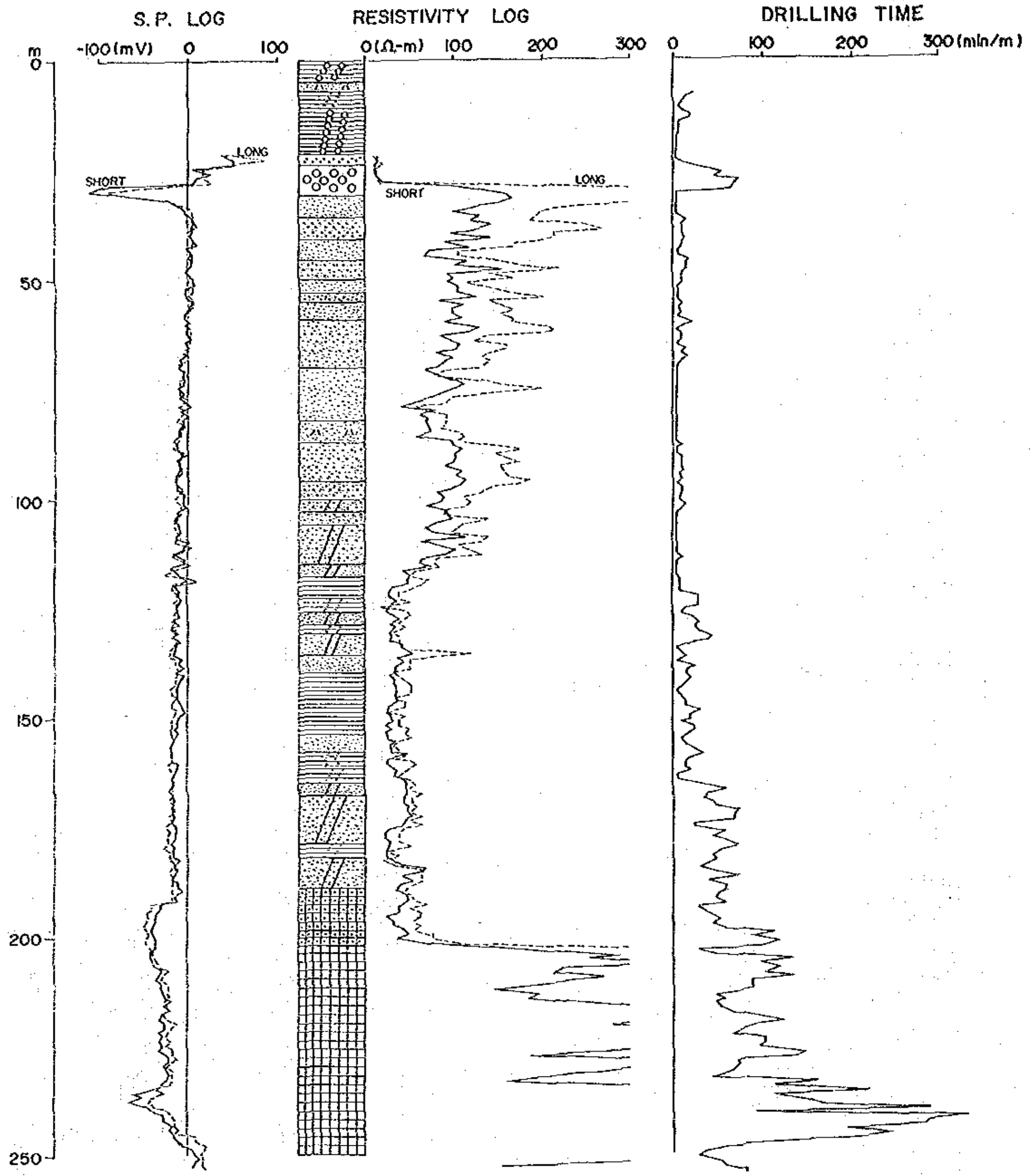

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FIGURE 3.2.1
WELL LOGS OF WELL No.1 (250m), ANTIPOLO

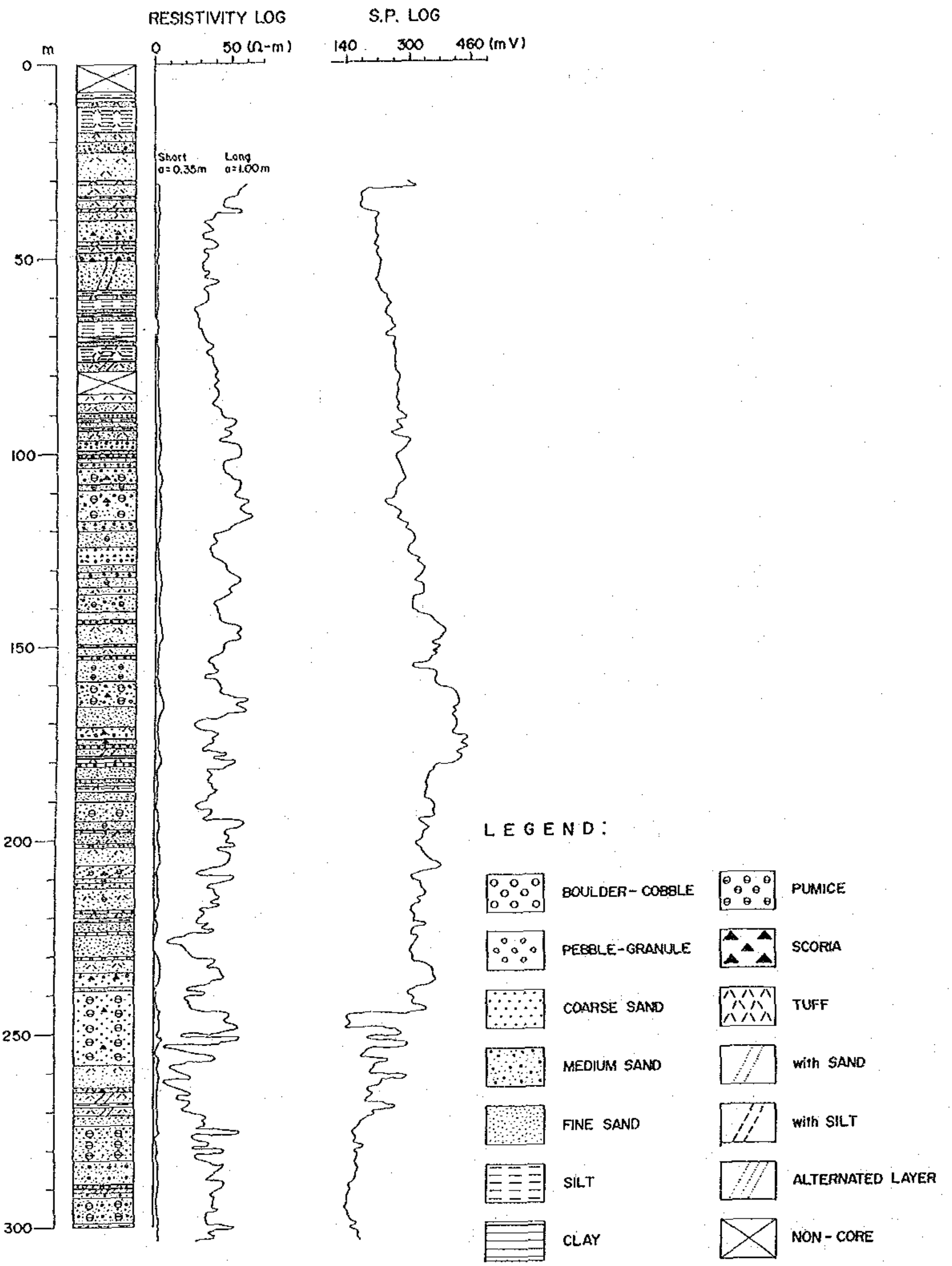

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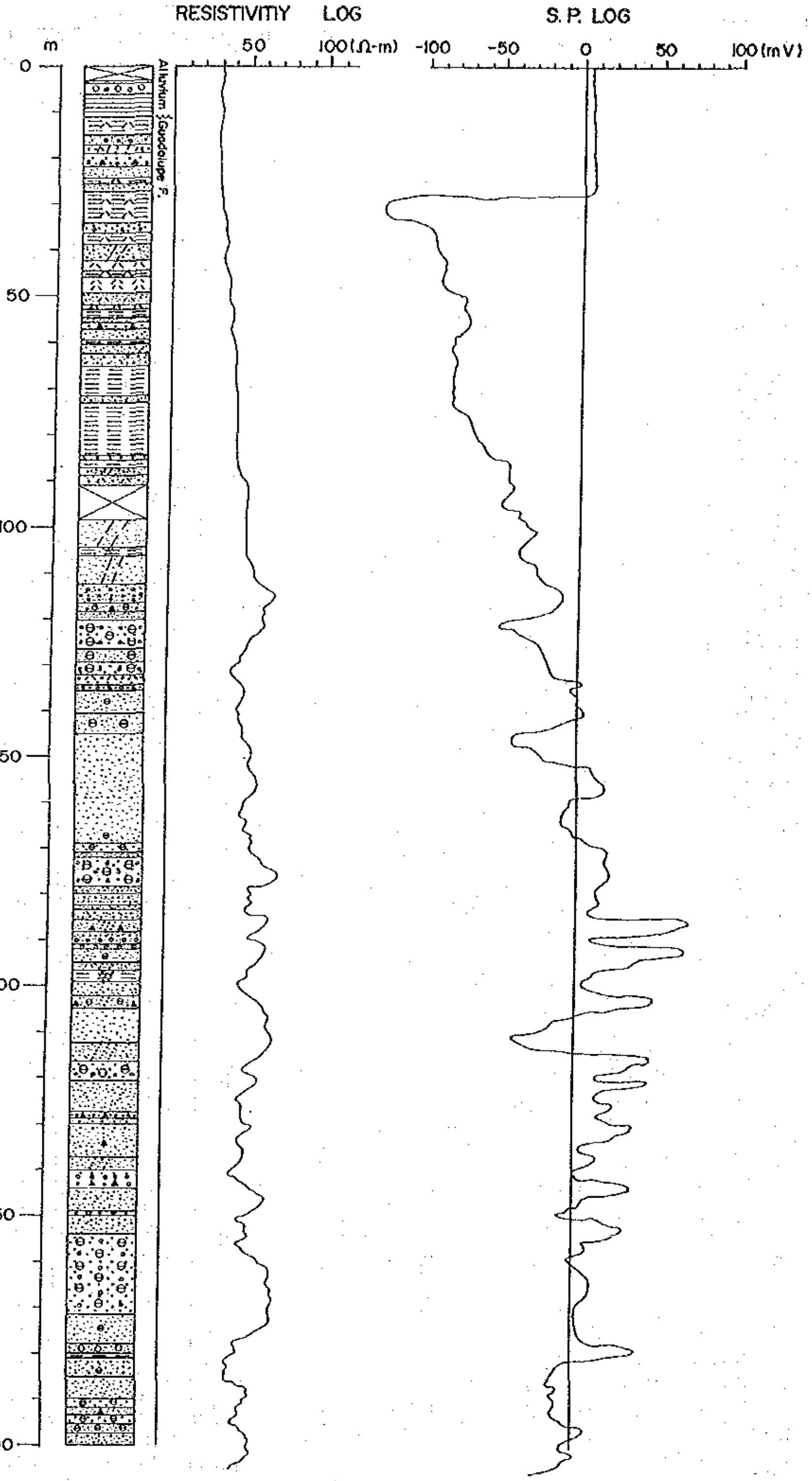
FIGURE 3.2.2 COLUMNAR SECTION OF CORE DRILLING AT SITE NO. 1, LAS PIÑAS



STUDY FOR THE GROUNDWATER DEVELOPMENT IN METRO MANILA	FIGURE 3.2.3 COLUMNAR SECTION OF CORE DRILLING AT SITE NO. 2, LAS PIÑAS
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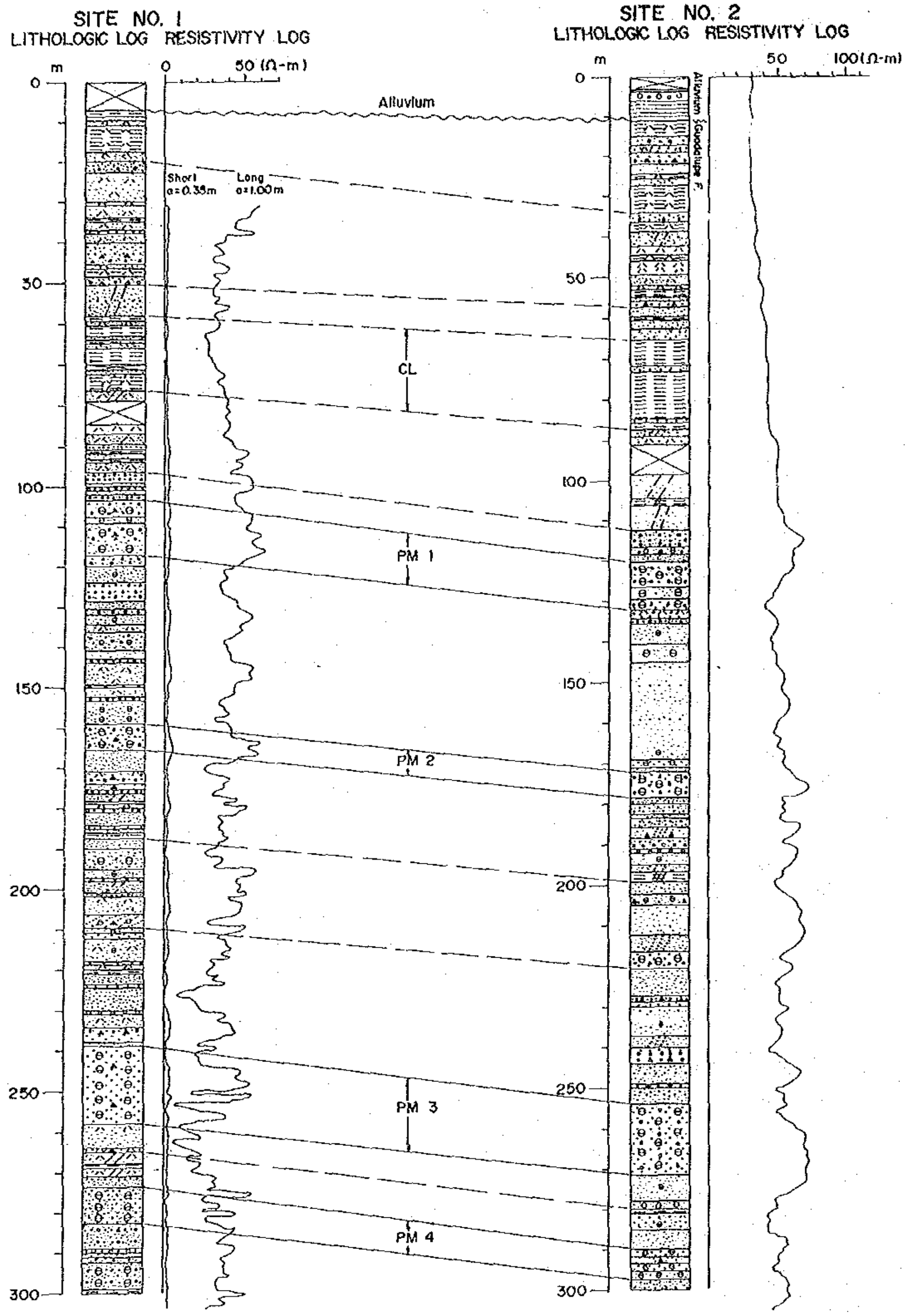
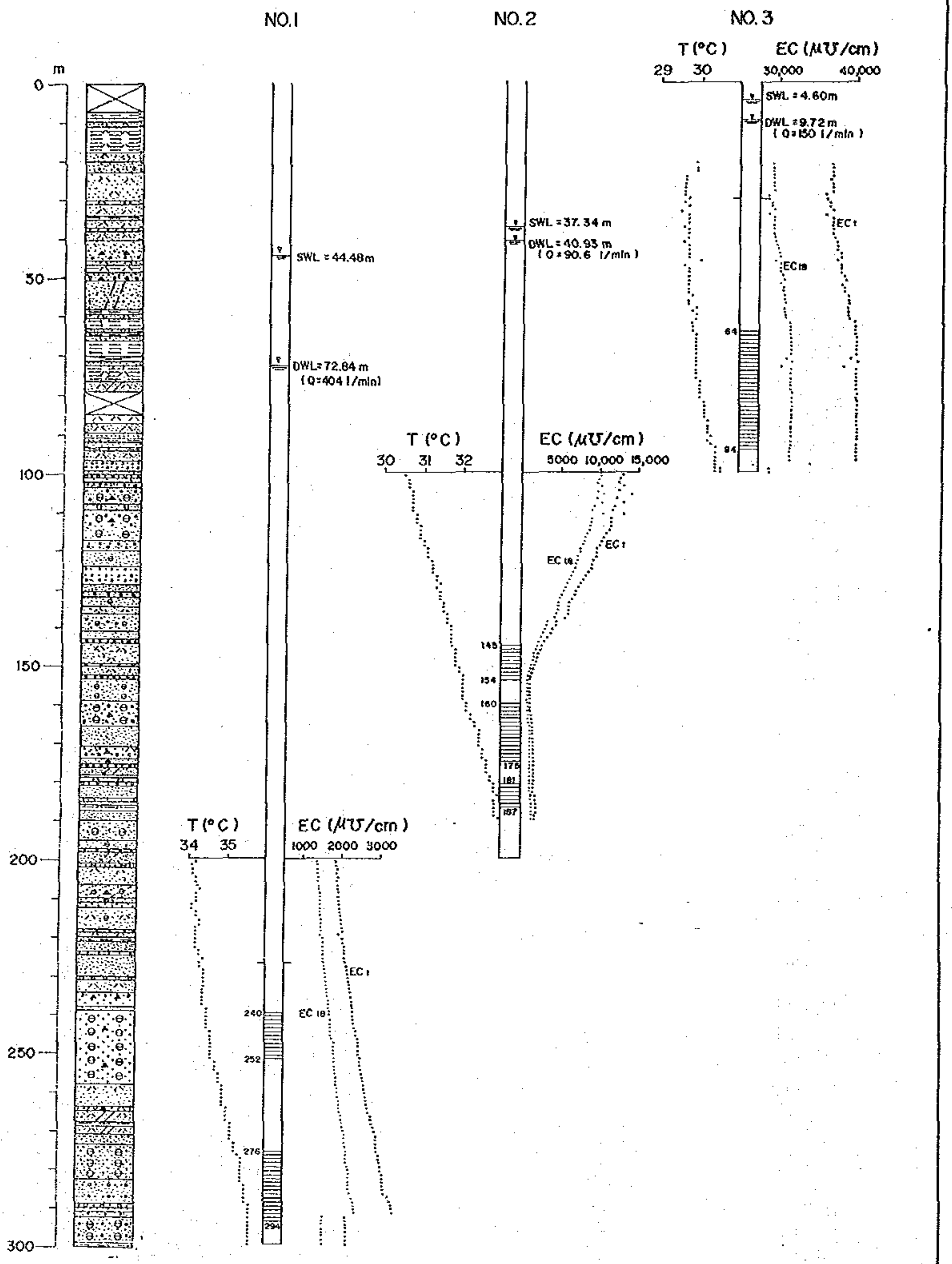
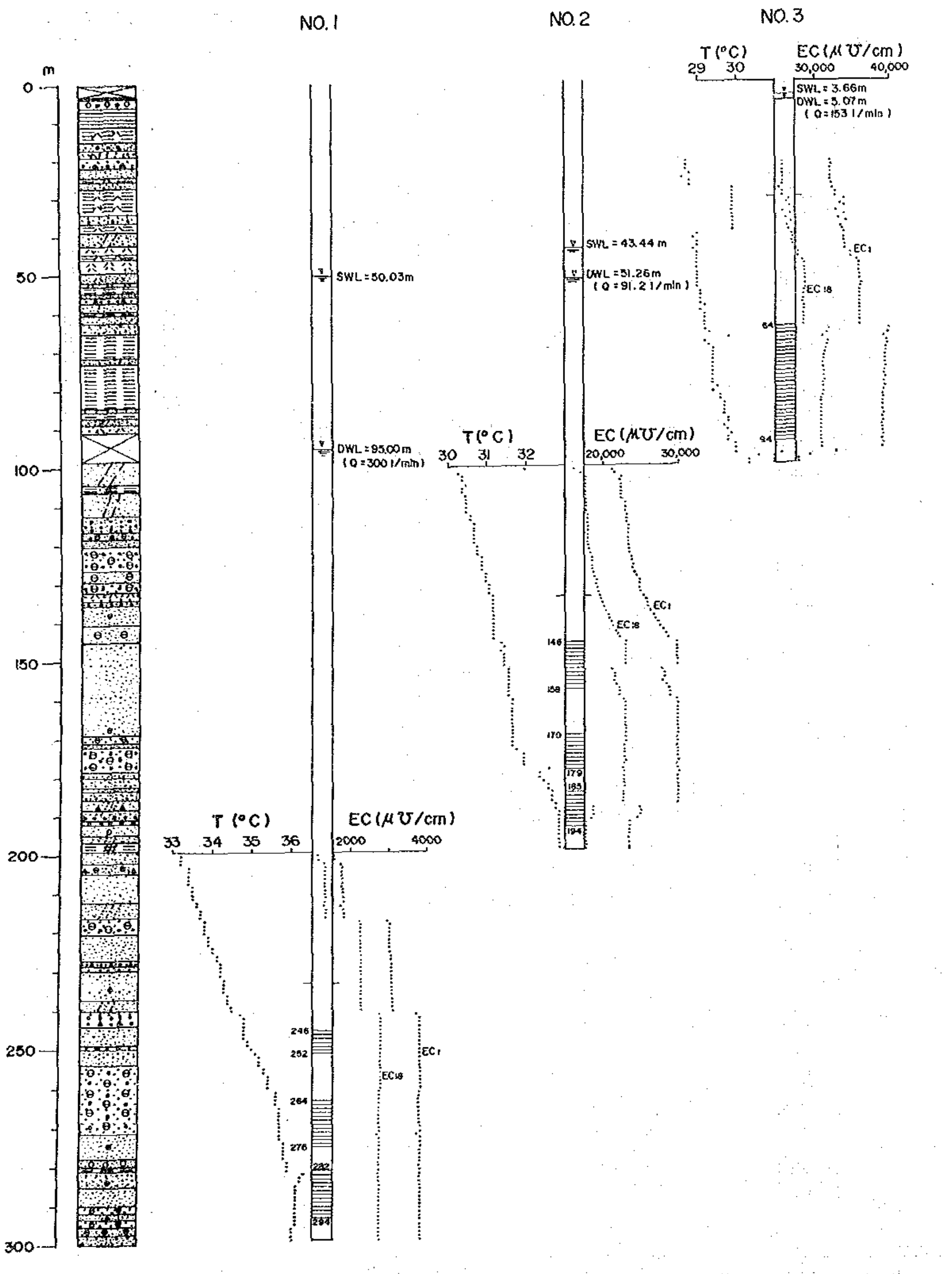


STUDY FOR THE GROUNDWATER DEVELOPMENT IN METRO MANILA	FIGURE 3.2.4 GEOLOGIC CORRELATION BETWEEN SITES NO.1 & NO.2, LAS PIÑAS
JAPAN INTERNATIONAL COOPERATION AGENCY	



STUDY FOR THE GROUNDWATER DEVELOPMENT IN METRO MANILA	FIGURE 3.3.1 TEMPERATURE AND EC LOGS AT SITE NO. 1, LAS PIÑAS
JAPAN INTERNATIONAL COOPERATION AGENCY	



STUDY FOR THE GROUNDWATER DEVELOPMENT IN METRO MANILA	FIGURE 3.3.2 TEMPERATURE AND EC LOGS AT SITE NO. 2, LAS PIÑAS
JAPAN INTERNATIONAL COOPERATION AGENCY	

CHAPTER 4

AQUIFER PARAMETERS

CHAPTER 4 AQUIFER PARAMETERS

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CHAPTER 4 AQUIFER PARAMETERS

4.1 EXISTING DATA

Transmissivity, storativity and leakance are the basic aquifer parameters in the evaluation of groundwater flow, change of storage and leakage.

Pumping test and aquifer data obtained during GWD-MWSP II (1983) from 150 wells in Metro Manila were reviewed. Collected data include well depth, static water level, drawdown, test pumping rate, specific capacity and transmissivity.

Results of one hundred twenty three (123) pumping tests conducted after 1983 were also collected and sifted for data on well depth, static water level, drawdown, test pumping rate and specific capacity. In this collection, a few transmissivity data were included. The Study Team likewise made a list of specific capacities involving one hundred and sixty three (163) MWSS wells.

4.2 PUMPING TESTS OF MWSS WELLS

The step-drawdown test, the constant rate test and recovery test were conducted for fifteen (15) wells selected from the active MWSS deep wells. These pumping tests were done to evaluate well efficiency, specific capacity, transmissivity and storativity. The tests used are applicable to confined aquifers in unsteady-state conditions.

The location map of the 15 selected MWSS wells is shown in Figure 4.2.1. These wells are detailed in Table 4.2.1. Some of these selected wells have pumping test data which were obtained during their construction.

The fifteen(15) selected MWSS deep wells operate twenty four (24) hours a day. This continuity of operation considered, the duration of pumping and recovery tests was shortened. The pumping test program was then set as follows:

(1) Step-drawdown test: five (5) steps at two (2) hours per step

(2) Constant rate test: eight (8) hours pumping at constant discharge

(3) Recovery test : four (4) hours recovery

For five (5) wells, the tests that were conducted are step-drawdown, the constant rate and recovery tests. For the other ten (10) wells, however, the step-drawdown test was omitted because of the need to immediately supply water.

Preparatory works were undertaken prior to the conduct of the pumping tests. These works include the installation of sounding tubes for the measurement of water levels after completion of the pumping test.

4.3 PUMPING TEST OF TEST WELLS

Step-drawdown pumping tests, continuous pumping tests and recovery tests were performed in the seven (7) test wells drilled by the Study Team. Transmissivity and storativity were calculated from the results of continuous and recovery tests using different methods--Theis method, Cooper-Jacob method and Recovery method. Specific capacity was also computed from the results of continuous pumping tests.

The pumping tests in Las Piñas revealed that the transmissivity of the shallow aquifer is higher than that of the deep aquifer; transmissivity values of the 100-m wells vary from 116 m^2/day to 219 m^2/d; transmissivity values of the 200-m and 300-m wells vary from 13 m^2/d to 54 m^2/d. Storativity values range widely from $1x10^{-10}$ to $2x10^{-1}$ and do not show clear correlation with depths.

The test wells in Antipolo tapped the deeper aquifer belonging to Member IV of the Guadalupe formation (Gmd). The results of the pumping tests show small transmissivity (8.8 m^2/d) and poor productivity of the aquifer.

4.4 TRANSMISSIVITY AND SPECIFIC CAPACITY

The transmissivity values collected from results of previous pumping tests plus those obtained from pumping tests conducted by the Study Team are summarized in Table 4.4.1. Figure 4.4.1 shows the distribution of transmissivity values of one hundred and ninety six (196) wells in Metro Manila. The logarithmic average and logarithmic standard deviation were computed for statistical analyses. The average value of the transmissivity in the Metro Manila area is 77.5 m^2/d, with a 90% reliable range of 21.9 m^2/d to 274.3 m^2/d. Figure 4.4.2 shows the transmissivity map of the Metro Manila area. This was drawn based on the statistical analyses.

As mentioned earlier, the amount of transmissivity data is less than the amount of the specific capacity data. Specific capacity were thus used for the estimation of transmissivity. The empirical relation between transmissivity and specific capacity was given by Logan (1964) in the following equation:

$$T = 1.22Sc$$

where, T = transmissivity (m^2/d) and Sc = specific capacity (m^2/d). Figure 4.4.3 shows the correlation between the collected/measured transmissivity and specific capacity as detailed in Table 4.4.1. It also illustrates the applicability of Logan's equation to the Metro Manila area. The advantages of using specific capacity instead of transmissivity lie not only in the increased amount of data produced, but also in making the more reliable data reflect actual aquifer characteristics, considering that transmissivity values obtained from a pumping test often take a wide range, even with a most careful conduct of the test.

Table 4.4.2 presents the transmissivity values estimated from specific capacities of MWSS wells. Transmissivity values culled from existing data by the Study Team are also summarized in Table 4.4.3. Figure 4.4.4 shows the distribution of the estimated transmissivity values of two hundred and seventy eight (278) wells. The logarithmic average is 58.3m^2/d, with a 90% reliable range of 17.3 m^2/d to 197.1 m^2/d. Figure 4.4.5 shows the estimated transmissivity map of the Metro Manila area. The input transmissivity data for the Metro Manila groundwater flow model is prepared from the transmissivity map.

TABLE 4.2.1 BRIEF DESCRIPTION OF 15 MWSS WELLS FOR PUMPING TEST

No.	Owner	No.	Locations	Operating Non-Operating	Casing Size (dia.)	Well Depth (m)	Pumping Rate (l/min)	Screen (m)	Remark
1	MWSS	MLB-21	Catmon, Malabon	Operating	(8")	268	-	164-262	(C+R) test
2	MWSS	NAV-5	NHA-1 Dagat-dagatan	Operating	8"-6"	243.8	(206)	140-237	(C+R) test
3	MWSS	CTA-18	Sto. Domingo, Cainta	Operating	12" -10"	200	(240)	60-178	(C+R) test
4	MWSS	MTL-147	Sucat Elem. Sch., Muntinlupa	Operating	10-8"	287	(521)	119-283	(S+C+R) test
5	MWSS	SMT-1	Public Market, San Mateo	Operating	10"	137.19	(937.5)	NA	(C+R) test
6	MWSS	QCT-202	Lagro No. 1, Q.C.	Operating	8"	243.84	(1323)	NA	(S+C+R) test
7	MWSS	MTB-1	San Jose, Montalban	Operating	12"-10"	202.16	(545)	NA	(S+C+R) test
8	MWSS	CVC-15	Ejercito, Cavite City	Operating	8"-6"	257	(450)	136-298	(C+R) test
9	MWSS	ATP-4	Nursery, Antipolo	Operating	8"-6"	100	(666)	NA	(C+R) test
10	MWSS	ATP-10	Saguinsin, Antipolo	Operating	10"-8"	125	(1304)	51-71 82-88 112-115	(C+R) test
11	MWSS	MTL-149	Turasan, Muntinlupa	Operating	10"-8"	305	(461)	Multi.	(C+R) test
12	MWSS	QCT-269	Escopa, Proj. 4, Q.C.	Operating	10"-8"	244	(500)	146-244	(S+C+R) test
13	MWSS	QCT-195	IBP No. 2, Q.C.	Operating	10"	274	(375)	115-197	(C+R) test
14	MWSS	SMT-II	Banaba-Ampid, San Mateo	Operating	10-8"	174	(642)	73-140	(C+R) test
15	MWSS	TGG-138	Signal Vill. No. 1, Taguig	Operating	10"-8"	171	-	60-170	(S+C+R) test

C: Continuous Pumping Test, R: Recovery Test,
S: Step Drawdown Test

TABLE 4.4.1 ACTUAL TRANSMISSIVITY AND SPECIFIC CAPACITY

MWSS No.	X	Y	T (actual) (m^2/d)	LATI D	LATI M	LATI S	LONGI D	LONGI M	LONGI S	SC (lps/m)	SC (m^2/d)
ATP-101	27	16	444	14	35	31	121	10	55	1.2	105.2
ATP-102	26	13		14	37	35	121	9	51	.13	11.7
BCR-11			700							6	518.4
BCR-13			245							.7	61.4
BCR-3	7	27	137	14	27	17	120	55	43	.61	52.5
BCR-4	9	27	220	14	27	22	120	57	17	2	172.8
CLC-36	12	10	160	14	40	15	120	59	42	.73	59.6
CLC-37	12	10	20	14	39	56	120	59	48	.2	17.3
CLC-B-53			51							.31	26.9
CTA-19	23	18	255	14	34	20	121	7	43	2.2	187.2
CTA-20	21	13	192	14	38	9	121	6	19	.99	85.3
CTA-66	21	13	103	14	38	7	121	6	19	.75	64.5
CTA-67	21	17	63	14	34	58	121	6	28	.65	57.2
CVC-11	4	25	360	14	29	6	120	53	39	1.8	155.5
CVC-12	4	25	350	14	28	57	120	53	49	1.41	121.4
CVC-17	3	26	88	14	27	57	120	52	57	.68	57.9
GTR-2			430							3.4	273.6
GTR-3			350							2.8	240.5
IMS-21	7	29	137	14	25	52	120	56	2	.97	81.5
IMS-3	7	29	100	14	25	48	120	56	4	1.2	103.7
IMS-6			220							2.7	236.8
IMS-7			420							2.5	207.4
IMS-8			600							.9	81.7
LPS-37	11	26	28	14	27	54	120	59	9	.3	24
LPS-48			28							.3	24
LPS-64	11	25	243	14	28	52	120	58	33	2.1	181.4
MDL-10	16	17	65	14	35	1	121	2	27	.5	47.5
MKT-11			118							1	89.2
MKT-12			212							1.7	145.5
MKT-122	16	20	70	14	32	36	121	2	41	.5	45.7
MKT-128	15	18	23	14	33	55	121	1	54	.26	22.3
MKT-136			135							1.1	95
MKT-145			57							.23	20.1
MKT-18			18							1.6	136.4
MKT-23			275							2.4	207.4
MKT-25	14	18	120	14	33	46	121	1	8	1.2	103.7
MKT-31			50							.3	28.8
MKT-33			20							.1	11.8
MKT-46			32							.2	14.4
MKT-48			22							.2	14.7
MKT-67			30							.2	20.9
MLB-110			23							.62	52.5
MLB-113			23							.2	20.5
MLB-20			21							.1	12.3
MLB-32	8	9	25	14	41	6	120	56	23	.2	13.3
MLB-57	9	10	22	14	40	13	120	57	11	.2	18.4
MNL-101			9							.1	4.6
MNL-148	10	13	33	14	37	57	120	57	54	.32	27.5
MRK-3	19	13	120	14	37	39	121	4	40	1.1	93.6
MTB-15	24	5	240	14	43	32	121	8	33	1.47	124.9
MTL-1	16	32	12	14	23	51	121	2	36	.1	9.9
MTL-147	17	26	750	14	27	52	121	3	11	.98	85
MTL-148	16	32	195	14	23	30	121	2	37	.62	53.5
MTL-149	17	33	400	14	23	10	121	3	10	4.72	18.2
MTL-150	16	30	350	14	25	7	121	2	37	2.09	194.9
MTL-151	16	31	222	14	24	24	121	2	56	3.24	283.7
MTL-152			1,150							6.41	511.9
MTL-159			1,192							1.95	168.5
MTL-17			580							1.15	99

TABLE 4.4.1 (CONTINUATION)

MTL-22			40							.3	25.4
MTL-23			70							.5	44.5
MTL-27			31							.3	25.9
MTL-34			455							1.2	100.8
MTL-44			110							.8	72
MTL-59			13							.1	11.2
MTL-69			105							.8	71.5
MTL-7			68							.6	49.4
MTL-8			13							.1	6.7
MTL-91			40							.3	24.5
NAV-17	7	9	30	14	40	54	120	56	2	.3	21.6
NAV-3			45							.3	28.8
NAV-4			38							.3	25.2
NAV-8			30							.2	19.2
NOV-5			302							1.67	142.8
NOV-6	2	30	217							2.24	196.8
NOV-7	3	29	592	14	25	59	120	52	41	4.16	369.4
PRN-135			105							.9	74.1
PRN-14			13							.1	11.7
PRN-153	12	24	48	14	29	18	120	59	25	.2	17.9
PRN-154			85							.66	57.1
PRN-155			80							.38	32.7
PRN-156			55							.56	48.7
PRN-157			14							.12	10.8
PRN-20	14	26	197	14	28	6	121	0	45	1.6	144
PRN-66			35							.3	24
PRN-74			55							.4	38.6
PRN-77	13	23	135							1.1	95.5
PRN-78	13	23	65							.5	39.3
PRN-8			61							.5	44.2
PSC-20			100							.86	74.8
PSC-44			9							.1	12.8
PSC-49	13	21	81	14	31	50	121	0	24	.6	51.8
PSC-55			33							.3	23.6
PSC-69			16							.13	11.2
PSG-12	18	16	47							.4	36.6
PSG-186	20	14	207	14	37	0	121	5	38	.85	74.1
PSG-187			81							.48	41.6
PSG-188			107							.54	46.4
QCT-121			45							.3	28.1
QCT-122			135							1.2	99.7
QCT-195	20	8	30							.2	19.3
QCT-250	16	6	109	14	43	20	121	2	16	.9	80.6
QCT-251	15	8	63	14	41	56	121	1	56	.5	46.5
QCT-257	15	10	110	14	40	25	121	1	37	.9	79.2
QCT-269	18	13	100	14	37	36	121	4	19	.7	56.2
QCT-276	12	13	15	14	38	11	120	59	46	.1	11.7
QCT-277	12	13	8	14	37	45	120	59	46	.1	6.6
QCT-330	20	8	45	14	41	54	121	5	41	.4	38.4
QCT-65			22							.2	15.2
QCT-86			130							1.2	103.7
ROS-10	0	30	402	14	24	52	120	50	47	1.39	116.6
ROS-11	1	30	352	14	24	54	120	51	32	1.66	143.6
ROS-12	1	30	340	14	24	57	120	51	42	1.43	125.6
ROS-13	2	30	490	14	25	2	120	51	50	.95	83.3
ROS-14	2	30	265	14	25	7	120	51	58	1.07	93.1
ROS-15	2	30		14	25	10	120	52	8	1.6	136.8
ROS-16	0	29	230	14	25	59	120	50	56	1.77	153
ROS-17	1	31	266							2.37	214.6
ROS-18			235							1.56	136.9
SJN-6			29							.2	21.2
SMT-10			125							.94	81.6
SMT-11			1,150							4.31	354.2
SMT-2	21	9	365	14	40	32	121	6	35	2.9	252
SMT-3	23	7	70	14	42	24	121	7	34	.6	50.4

TABLE 4.4.1 (CONTINUATION)

SMT-4	23	7	40	14	42	21	121	7	38	.3	22.4
SPD-5			600							7	597.2
TGG-138	17	23	166	14	30	44	121	3	19	.8	68.8
TGG-139	17	23	150	14	30	7	121	3	8	.57	47.3
TGG-16			10							.1	7.6
TGG-18	18	21	87	14	31	51	121	4	19	.7	58.8
TGG-19	18	23	70	14	30	40	121	3	52	.6	49.7
TGG-24			320							2.6	224.6
TGG-32			51							.4	34.6
TGG-48			30							.2	18.6
TGG-97	16	23	52	14	30	13	121	2	51	.48	41.4
TNZ-2			150							1.1	91.2
TNZ-3			495							3.3	271.3
TYY-10	23	17	700	14	34	31	121	7	57	5.7	493.7
TYY-11	23	18	330	14	34	3	121	7	32	2.7	230.4
VLZ-106	8	7	14							.1	12.7
VLZ-125	11	8	25	14	41	18	120	59	8	.27	27.3
VLZ-18	11	9	38	14	40	38	120	59	1	.3	27
VLZ-212	10	8	65	14	41	25	120	57	47	.3	23.8
VLZ-213	8	7	114	14	42	38	120	56	53	.6	53.2
VLZ-214	9	7	110	14	42	31	120	57	44	.8	69.1
VLZ-215	9	6	64	14	43	5	120	57	27	.47	41
VLZ-216			17							.65	57
VLZ-37	11	9	13	14	40	50	120	58	59	.1	9.8
AGN-T351	25	21	6							.2	14.5
ATP-10			324							.8	73.3
CTA-T201	22	16	94							.7	62.1
MKT-T01	14	19	57							.3	25.8
MTL-T01	16	28	504							3	262.3
MTL-T02	15	32	27							5.3	46.2
NAV-T02	9	12	62							.3	24.8
NAV-T01	9	12	93							.4	36.1
PRN-T01	16	28	149							1.7	147.7
PRN-T02	16	27	5							.1	7.2
PRN-T03	10	26	5							.1	6.7
PRN-T101	12	26	55							1.4	118.6
PRN-T206	14	27	92							1.2	102.5
PRN-T212	16	27	3							.1	7.2
PRN-T304	13	24	30							.1	6
PRN-T305	15	26	10							.04	3.9
PSG-T01	19	18	81							.5	41.2
PSG-T351	22	15	396							2.1	183.3
PSC-T01	15	23	22							.2	17.4
QCT-T304	15	11	118							.1	6.4
QCT-T353	16	8	87							1.2	105.2
QCT-T357	17	7	47							.4	30.6
ROS-10			229								
TGG-T351	18	22	15							.6	53.9
TGG-T352	16	25	2							.04	3.8
VLZ-T02	8	6	274							.7	60.6
VLZ-T209			59							.6	55.5
MLB-21	9	10	14.7	14	40	3	120	57	38		10.2
NAV-5	9	12	8.5	14	38	54	120	57	15		6.83
CTA-18	22	16	61.8	14	35	18	121	6	58		13.7
MTL-147	17	26	63.7	14	27	52	121	3	11		40.7
SMT-1	22	8	400	14	41	54	121	7	10		151
QCT-202	18	5	51	14	44	11	121	3	56		70.7
MTB-1	23	5	106	14	43	53	121	8	5		87.4
CVC-15	3	26	12	14	28	26	120	53	13		5.82
ATP-4	26	16	278	14	35	16	121	10	4		42.4
ATP-10	26	16	251	14	35	39	121	10	15		53.6
MTL-149	17	33	223	14	23	10	121	3	10		56.3
QCT-269	18	13	320	14	37	36	121	4	19		144
QCT-195	20	8	32.7	14	41	54	121	5	32		30.7
SMT-II	21	9	197	14	40	32	121	6	35		104

TABLE 4.4.1 (CONTINUATION)

TGG-138	17	23	103	14	30	44	121	3	19		68.2
LPS1-1	11	25	54.3								20.5
LPS1-2	11	25	31.8								35.7
LPS1-3	11	25	115.6								42.2
LPS2-1	10	26	12.7								9.6
LPS2-2	10	26	22.7								16.8
LPS2-3	10	26	218.5								156.3
LPS3	10	27	33.6								19.7
ATP-2			8.8								1.6

TABLE 4.4.2 ESTIMATED TRANSMISSIVITY VALUES
OF MWSS WELLS

MWSS No.	X	Y	Transmis-sivity 1.22*SC	LATI D	M	S	LONGI D	M	S	SC (lps/m)	SC (m^2/d)
ATP-0	26	16	73.8	14	35	39	121	10	15	.7	60.5
ATP-1	26	16	52.7	14	35	25	121	10	29	.5	43.2
ATP-2	27	17	98.0	14	35	14	121	10	39	.93	80.4
ATP-3	27	17	71.7	14	34	58	121	10	35	.68	58.8
ATP-4	26	16	41.1	14	35	16	121	10	4	.39	33.7
ATP-5	26	17	44.3	14	34	54	121	10	12	.42	36.3
ATP-6	27	17	131.8	14	34	55	121	10	50	1.25	108.0
ATP-29	27	13	9.5	14	37	39	121	10	53	.09	7.8
ATP-31	26	13	459.6	14	37	44	121	9	58	4.36	376.7
ATP-54	26	17	168.7	14	35	10	121	10	21	1.6	138.2
ATP-73	27	16	148.6	14	35	35	121	10	48	1.41	121.8
ATP-101	27	16	126.5	14	35	31	121	10	55	1.2	103.7
ATP-102	26	13	13.7	14	37	35	121	9	51	.13	11.2
BCR-1	8	27	66.4	14	27	20	120	56	23	.63	54.4
BCR-2	8	27	72.7	14	27	42	120	56	17	.69	59.6
BCR-3	7	27	62.2	14	27	17	120	55	43	.59	51.0
BCR-4	9	27	210.8	14	27	22	120	57	17	2	172.8
BCR-5	9	26	121.2	14	27	50	120	57	22	1.15	99.4
CTA-0	22	17	200.3	14	34	48	121	7	4	1.9	164.2
CTA-17	22	17	52.7	14	34	46	121	6	57	.5	43.2
CTA-18	22	16	52.7	14	35	18	121	6	58	.5	43.2
CTA-19	23	18	231.9	14	34	20	121	7	43	2.2	190.1
CTA-20	21	13	101.2	14	38	9	121	6	19	.96	82.9
CTA-66	22	13	79.1	14	38	7	121	6	52	.75	64.8
CTA-67	21	17	68.5	14	34	58	121	6	28	.65	56.2
CTA-75	22	18	164.4	14	34	21	121	7	18	1.56	134.8
CLC-37	12	10	21.1	14	39	56	120	59	48	.2	17.3
CLC-36	12	10	64.3	14	40	15	120	59	42	.61	52.7
CLC-39	12	11	44.3	14	39	2	120	59	18	.42	36.3
CVC-1	5	25	23.2	14	29	2	120	54	27	.22	19.0
CVC-2	5	25	25.3	14	29	3	120	54	17	.24	20.7
CVC-3	4	25	61.1	14	29	0	120	53	57	.58	50.1
CVC-4	4	25	15.8	14	29	7	120	53	59	.15	13.0
CVC-5	5	24	23.2	14	29	25	120	54	7	.22	19.0
CVC-6	4	24	72.7	14	29	28	120	53	58	.69	59.6
CVC-7	4	24	148.6	14	29	31	120	53	50	1.41	121.8
CVC-8	4	24	24.2	14	29	25	120	53	38	.23	19.9
CVC-9	4	24	110.7	14	29	17	120	53	46	1.05	90.7
CVC-10	4	25	21.1	14	29	10	120	53	52	.2	17.3
CVC-11	4	25	28.5	14	29	6	120	53	39	.27	23.3
CVC-12	4	25	27.4	14	28	57	120	53	49	.26	22.5
CVC-13	4	25	147.6	14	28	57	120	53	41	1.4	121.0
CVC-14	4	25	179.2	14	28	42	120	53	25	1.7	146.9
CVC-15	3	26	73.8	14	28	26	120	53	13	.7	60.5
CVC-16	3	26	89.6	14	28	4	120	52	57	.85	73.4
CVC-17	3	26	71.7	14	27	57	120	52	57	.68	58.8
CVC-18	4	25	44.3	14	28	59	120	53	21	.42	36.3
CVC-19	4	25	122.3	14	28	43	120	53	40	1.16	100.2
IMS-1	8	29	61.1	14	25	38	120	56	17	.58	50.1
IMS-2	7	29	8.4	14	26	2	120	56	12	.08	6.9
IMS-3	7	29	126.5	14	25	48	120	56	4	1.2	103.7
IMS-21	7	29	102.2	14	25	52	120	56	2	.97	83.8
KWT-1	7	27	54.8	14	27	8	120	55	39	.52	44.9
KWT-2	6	27	15.8	14	27	27	120	55	17	.15	13.0
KWT-4	5	28	175.0	14	26	37	120	54	9	1.66	143.4
LPS-37	11	26	79.1	14	28	19	120	58	36	.75	64.8
LPS-39	11	26	108.6	14	28	22	120	58	38	1.03	89.0
LPS-63	11	25	27.4	14	29	10	120	58	53	.26	22.5
LPS-64	11	25	221.4	14	28	52	120	58	33	2.1	181.4
LPS-62	11	25	28.5	14	28	58	120	58	56	.27	23.3
MKT-1	15	18	32.7	14	34	11	121	1	30	.31	26.8

TABLE 4.4.2 (CONTINUATION)

MKT-5	14	18	19.0	14	33	52	121	1	14	.18	15.6
MKT-8	14	19	279.3	14	33	25	121	1	17	2.65	229.0
MKT-9	15	19	11.6	14	33	45	121	2	0	.11	9.5
MKT-16	14	18	71.7	14	33	51	121	0	45	.68	58.8
MKT-17	15	19	216.1	14	33	38	121	2	10	2.05	177.1
MKT-19	15	18	22.1	14	33	50	121	1	39	.21	18.1
MKT-22	16	19	4.2	14	33	44	121	2	20	.04	3.5
MKT-25	14	18	126.5	14	33	46	121	1	8	1.2	103.7
MKT-26	14	19	114.9	14	33	14	121	0	53	1.09	94.2
MKT-28	15	19	209.8	14	33	38	121	1	52	1.99	171.9
MKT-30	14	19	34.8	14	33	12	121	1	2	.33	28.5
MKT-32	15	19	17.9	14	33	9	121	1	42	.17	14.7
MKT-128	15	18	27.4	14	34	12	121	1	42	.26	22.5
MKT-122	16	20	52.7	14	32	36	121	2	41	.5	43.2
MLB-0	9	8	26.4	14	41	18	120	57	9	.25	21.6
MLB-0	9	8	55.9	14	41	16	120	57	31	.53	45.8
MLB-21	9	10	16.9	14	40	3	120	57	38	.16	13.8
MLB-32	8	9	21.1	14	41	6	120	56	23	.2	17.3
MLB-57	9	10	23.2	14	40	13	120	57	11	.22	19.0
MDL-10	16	17	111.7	14	34	56	121	2	17	1.06	91.6
MDL-63	15	18	12.6	14	34	25	121	1	53	.12	10.4
MRK-1	21	11	3.2	14	39	36	121	6	10	.03	2.6
MRK-3	19	13	115.9	14	37	39	121	4	40	1.1	95.0
MRK-4	20	11	168.7	14	39	5	121	5	37	1.6	138.2
MTB-1	23	5	161.3	14	44	7	121	8	5	1.53	132.2
MTB-15	24	5	154.9	14	43	32	121	8	33	1.47	127.0
MTL-1	16	32	11.6	14	23	51	121	2	36	.11	9.5
MTL-147	17	27	103.3	14	27	42	121	3	11	.98	84.7
MTL-148	16	32	65.4	14	23	30	121	2	37	.62	53.6
MTL-149	17	33	497.5	14	23	10	121	3	10	4.72	407.8
MTL-150	16	30	220.3	14	25	7	121	2	37	2.09	180.6
MTL-151	16	31	341.5	14	24	8	121	2	56	3.24	279.9
NAV-5	9	12	16.9	14	38	54	120	57	15	.16	13.8
NAV-17	7	9	31.6	14	40	54	120	56	2	.3	25.9
NOV-5	2	30	176.0	14	25	17	120	52	26	1.67	144.3
NOV-6	3	30	236.1	14	25	21	120	52	35	2.24	193.5
NOV-7	3	29	438.5	14	25	59	120	52	41	4.16	359.4
PRN-19	13	26	54.8	14	28	24	121	0	14	.52	44.9
PRN-20	14	26	168.7	14	28	6	121	0	45	1.6	138.2
PRN-37	12	23	75.9	14	30	16	120	59	41	.72	62.2
PRN-73	12	23	4.2	14	30	1	120	59	24	.04	3.5
PRN-78	13	23	527.0	14	30	32	121	0	28	5	432.0
PRN-153	12	24	21.1	14	29	18	120	59	25	.2	17.3
PRN-74	12	24	421.6	14	29	43	120	59	17	4	345.6
PSC-0	13	21	87.5	14	31	59	121	0	19	.83	71.7
PSC-0	13	21	30.6	14	31	41	121	0	35	.29	25.1
PSC-49	13	21	64.3	14	31	50	121	0	24	.61	52.7
PSC-62	14	22	52.7	14	31	4	121	1	6	.5	43.2
PSC-63	14	22	40.1	14	31	3	121	1	3	.38	32.8
PSC-69	12	19	13.7	14	33	3	120	59	57	.13	11.2
PSC-77	13	22	160.2	14	30	54	121	0	11	1.52	131.3
PSG-20	19	19	11.6	14	33	36	121	4	40	.11	9.5
PSG-42	19	14	209.8	14	36	54	121	4	56	1.99	171.9
PSG-186	20	14	93.8	14	37	0	121	5	38	.89	76.9
QCT-195	20	8	24.2	14	41	54	121	5	32	.23	19.9
QCT-197	20	8	50.6	14	41	35	121	5	37	.48	41.5
QCT-199	18	7	65.4	14	42	11	121	4	11	.62	53.6
QCT-201	18	7	120.2	14	42	39	121	4	17	1.14	98.5
QCT-202	18	5	34.8	14	44	11	121	3	56	.33	28.5
QCT-203	18	6	84.3	14	43	29	121	3	57	.8	69.1
QCT-204	18	6	94.9	14	43	10	121	3	48	.9	77.8
QCT-205	18	5	94.9	14	43	53	121	3	51	.9	77.8

TABLE 4.4.2 (CONTINUATION)

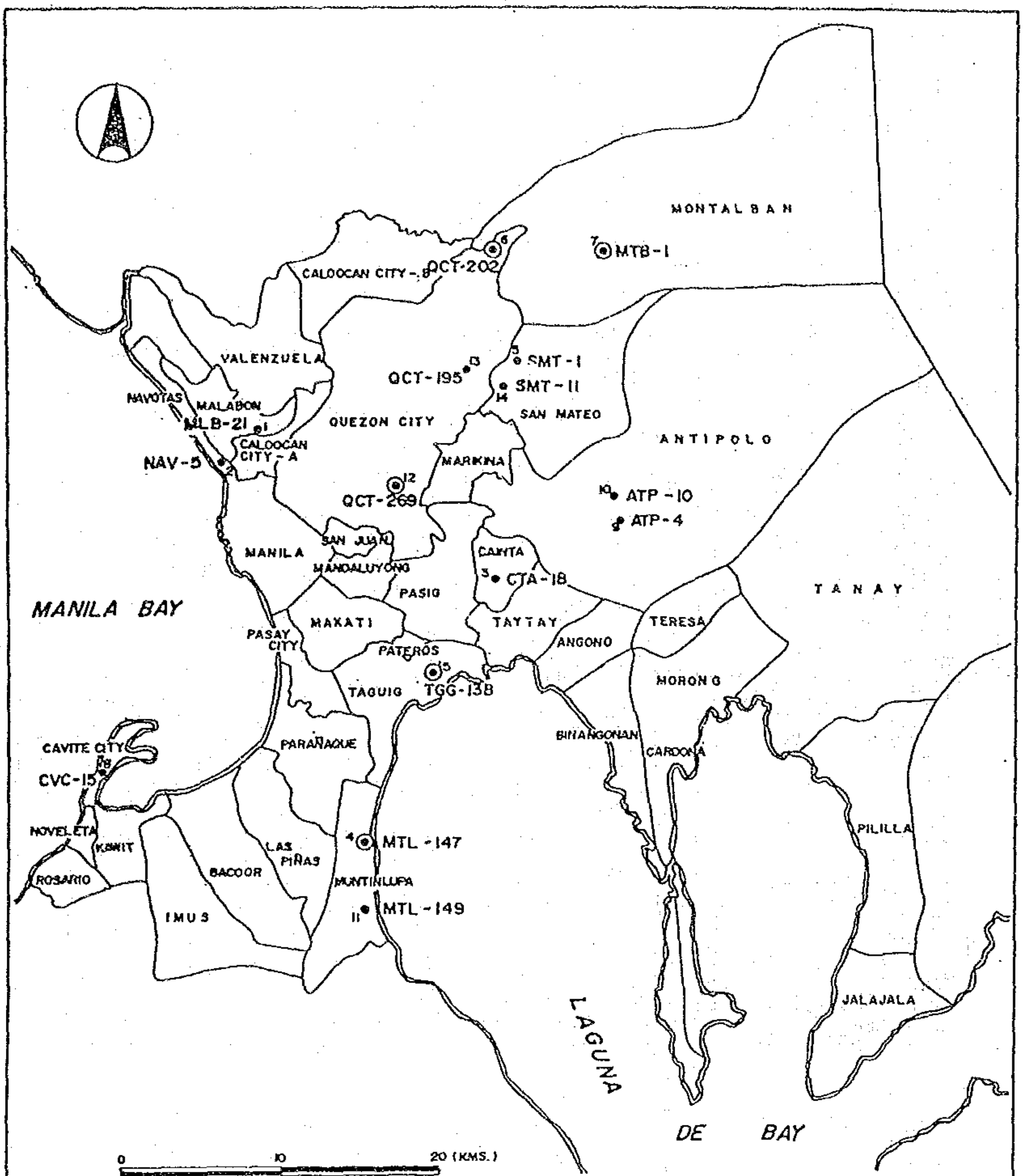
QCT-209	17	7	186.6	14	42	40	121	3	41	1.77	152.9
QCT-250	16	6	94.9	14	43	20	121	2	16	.9	77.8
QCT-251	15	8	52.7	14	41	56	121	1	56	.5	43.2
QCT-257	15	10	94.9	14	40	25	121	1	37	.9	77.8
QCT-269	18	13	73.8	14	37	36	121	4	19	.7	60.5
QCT-276	12	13	10.5	14	38	11	120	59	46	.1	8.6
QCT-277	12	13	10.5	14	37	45	120	59	46	.1	8.6
QCT-330	20	8	47.4	14	41	54	121	5	41	.45	38.9
ROS-10	0	30	42.2	14	24	52	120	50	47	.4	34.6
ROS-11	1	30	175.0	14	24	54	120	51	32	1.66	143.4
ROS-12	1	30	150.7	14	24	57	120	51	42	1.43	123.6
ROS-13	2	30	100.1	14	25	2	120	51	50	.95	82.1
ROS-14	2	30	112.8	14	25	7	120	51	58	1.07	92.4
ROS-15	2	30	168.7	14	25	10	120	52	8	1.6	138.2
ROS-16	0	29	249.8	14	25	59	120	50	56	2.37	204.8
SMT-0	22	8	315.2	14	41	41	121	6	48	2.99	258.3
SMT-2	21	9	305.7	14	40	32	121	6	35	2.9	250.6
SMT-3	23	7	63.2	14	42	24	121	7	34	.6	51.8
SMT-4	23	6	31.6	14	42	47	121	7	47	.3	25.9
TGG-18	18	21	73.8	14	31	51	121	4	19	.7	60.5
TGG-19	18	23	63.2	14	30	40	121	3	52	.6	51.8
TGG-20	18	21	154.9	14	32	10	121	3	58	1.47	127.0
TGG-97	16	23	21.1	14	30	13	121	2	51	.2	17.3
TGG-138	17	23	84.3	14	30	44	121	3	19	.8	69.1
TGG-139	17	23	60.1	14	30	25	121	3	8	.57	49.2
TYY-0	23	18	171.8	14	33	51	121	7	41	1.63	140.8
TYY-8	23	18	69.6	14	34	9	121	7	45	.66	57.0
TYY-9	23	18	69.6	14	34	17	121	7	49	.66	57.0
TYY-10	23	17	600.8	14	34	31	121	7	57	5.7	492.5
TYY-11	23	18	284.6	14	34	3	121	7	32	2.7	233.3
TYY-47	23	18	47.4	14	34	29	121	7	48	.45	38.9
VLZ-0	8	7	14.8	14	42	20	120	56	52	.14	12.1
VLZ-8	11	9	32.7	14	40	50	120	58	59	.31	26.8
VLZ-18	11	9	31.6	14	40	38	120	59	1	.3	25.9
VLZ-37	11	9	10.5	14	40	34	120	58	59	.1	8.6
VLZ-125	11	8	28.5	14	41	18	120	59	8	.27	23.3
VLZ-212	10	8	31.6	14	41	25	120	57	47	.3	25.9
VLZ-213	8	7	63.2	14	42	38	120	56	53	.6	51.8
VLZ-214	9	7	84.3	14	42	31	120	57	44	.8	69.1
VLZ-215	9	6	49.5	14	42	52	120	57	27	.47	40.6

TABLE 4.4.3 SPECIFIC CAPACITY DATA AND ESTIMATED TRANSMISSIVITY (COLLECTED BY THE STUDY TEAM)

WELL No.	X	Y	T (SC*1.22) (m^2/d)	LATI D	LATI M	LATI S	LONGI D	LONGI M	LONGI S	SC (lps/m)	SC (m^2/d)
ATP-8			137.0							1.3	112.3
ATP-T301	24	13	10.5							.1	8.6
ATP-T302			1.1							.01	.9
ATP-T351	23	14	3.2							.03	2.6
BCR-1	7	27	221.4							2.1	181.4
BCR-2	7	27	73.8							.7	60.5
BCR-5	8	27	84.3	14	27	24	120	56	32	.8	69.1
CTA-17	22	17	158.1							1.5	129.6
CTA-27	22	17	21.1							.2	17.3
IMS-2	7	29	105.4							1	86.4
KWT-3	4	28	179.2							1.7	146.9
LPS-37	11	26	94.9							.9	77.8
MDL-47	16	17	63.2							.6	51.8
MDL-55	17	16	73.8							.7	60.5
MDL-T201			2.1							.02	1.7
MKT-129			31.6							.3	25.9
MKT-68	14	19	94.9							.9	77.8
MKT-71	14	19	52.7							.5	43.2
MKT-73	15	18	42.2							.4	34.6
MKT-74	15	18	63.2							.6	51.8
MKT-75	15	18	31.6							.3	25.9
MKT-76	13	19	115.9							1.1	95.0
MKT-78	14	20	42.2							.4	34.6
MNL-T202	11	18	1.1							.01	.9
MNL-T203	11	17	7.4							.07	6.0
MNL-T204	10	17	10.5							.1	8.6
MTL-10	17	28	316.2							3	259.2
MTL-11	17	28	158.1							1.5	129.6
MTL-13	16	30	421.6							4	345.6
MTL-14	16	30	5765.8							54.7	4726.1
MTL-2	16	29	63.2							.6	51.8
MTL-3	16	27									
MTL-6	16	28	168.7							1.6	138.2
MTL-9			769.5							7.3	630.7
MTL-T202	16	30	21.1							.2	17.3
MTL-T203	15	30	115.9							1.1	95.0
MTL-T204	15	31	115.9							1.1	95.0
MTL-T208	13	30									
NOV-6	2	30	21.1							.2	17.3
PRN-153	12	24	115.9							1.1	95.0
PRN-T104	16	27	21.1							.2	17.3
PRN-T303	16	27	10.5							.1	8.6
PSC-13	14	21	52.7							.5	43.2
PSC-42	12	20	189.7							1.8	155.5
PSC-63	14	22	42.2							.4	34.6
PSG-10	17	16	105.4							1	86.4
PSG-11	18	16	42.2							.4	34.6
PSG-13	17	16	42.2							.4	34.6
PSG-14	19	17	126.5							1.2	103.7
PSG-16	19	18	4.2							.04	3.5
PSG-5	19	17	210.8							2	172.8
PSG-8	17	17	10.5							.1	8.6
PSG-T202	19	17	10.5							.1	8.6
QCT-20	15	14	42.2							.4	34.6
QCT-T01	13	12	579.7							5.5	475.2
QCT-T201	18	14	168.7							1.6	138.2

TABLE 4.4.3 (CONTINUATION)'

QCT-T302	14	12	10.5							.1	8.6
QCT-T352			21.1							.2	17.3
QCT-T354	15	8	42.2							.4	34.6
QCT-T355	16	7	147.6							1.4	121.0
QCT-T356	20	8	21.1							.2	17.3
ROS-17	1	31	242.4							2.3	198.7
T401	19	13	168.7							1.6	138.2
T402	17	23									
T403	9	8									
T404	15	18	10.5							.1	8.6
T405	12	24	21.1							.2	17.3
T406	21	11	1570.6							14.9	1287.4
T407	15	10	105.4							1	86.4
T408	13	23	210.8							2	172.8
T410	16	2	21.1							.2	17.3
T411	12	10	21.1							.2	17.3
T412	16	24	21.1							.2	17.3
T413	15	19	31.6							.3	25.9
T414	13	21	63.2							.6	51.8
T416	9	6	52.7							.5	43.2
T418	10	13	31.6							.3	25.9
T419	11	25	179.2							1.7	146.9
T420	13	21	31.6							.3	25.9
T421	23	18	179.2							1.7	146.9
T422	8	8	21.1							.2	17.3
T423	22	17	73.8							.7	60.5
T425	11	7	31.6							.3	25.9
T426	18	21	453.3							4.3	371.5
T427			1465.2							13.9	1201.0
T428	22	8	316.2							3	259.2
T429	16	17									
T430	17	35									
T431	13	13	600.8							5.7	492.5
T432			21.1							.2	17.3
TGG-T202	16	24	10.5							.1	8.6
VLZ-15	9	7	42.2							.4	34.6
VLZ-16	11	9	84.3							.8	69.1
VLZ-213	8	8	10.5							.1	8.6
VLZ-79	10	8	21.1							.2	17.3
VLZ-T01	10	9	94.9							.9	77.8
VLZ-T204	10	9	73.8							.7	60.5
VLZ-T206	9	6	10.5							.1	8.6

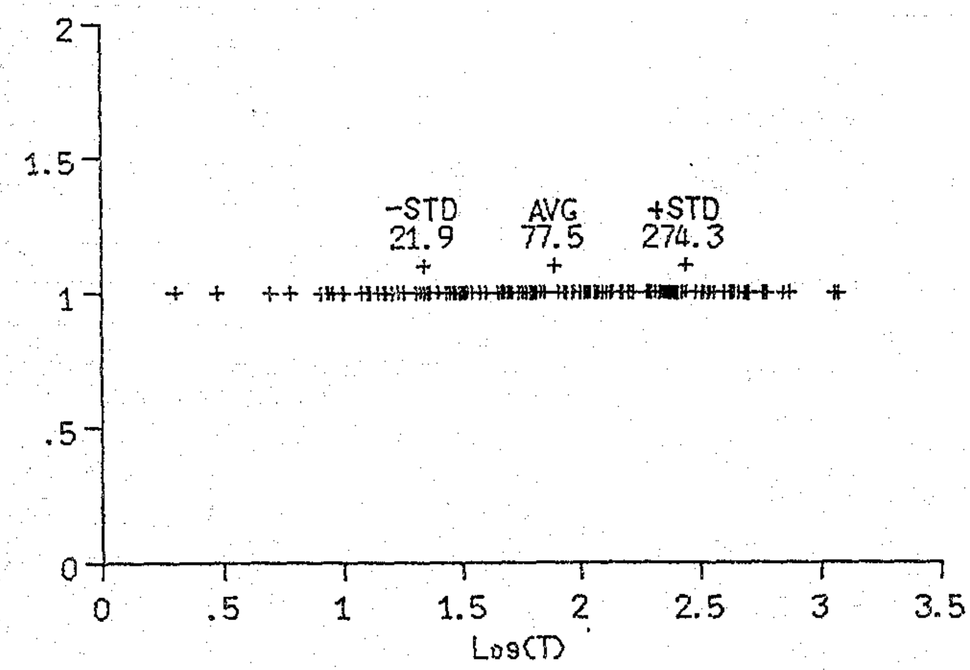


LEGEND :

• PUMPING TEST SITES (CONTINUOUS DISCHARGE TEST & RECOVERY TEST)

◉ PUMPING TEST SITES (STEP-DRAWDOWN, CONTINUOUS DISCHARGE TEST & RECOVERY TEST)

STUDY FOR THE GROUNDWATER DEVELOPMENT IN METRO MANILA	FIGURE 4.2.1 FIFTEEN WELLS PUMPING TEST SITES
JAPAN INTERNATIONAL COOPERATION AGENCY	

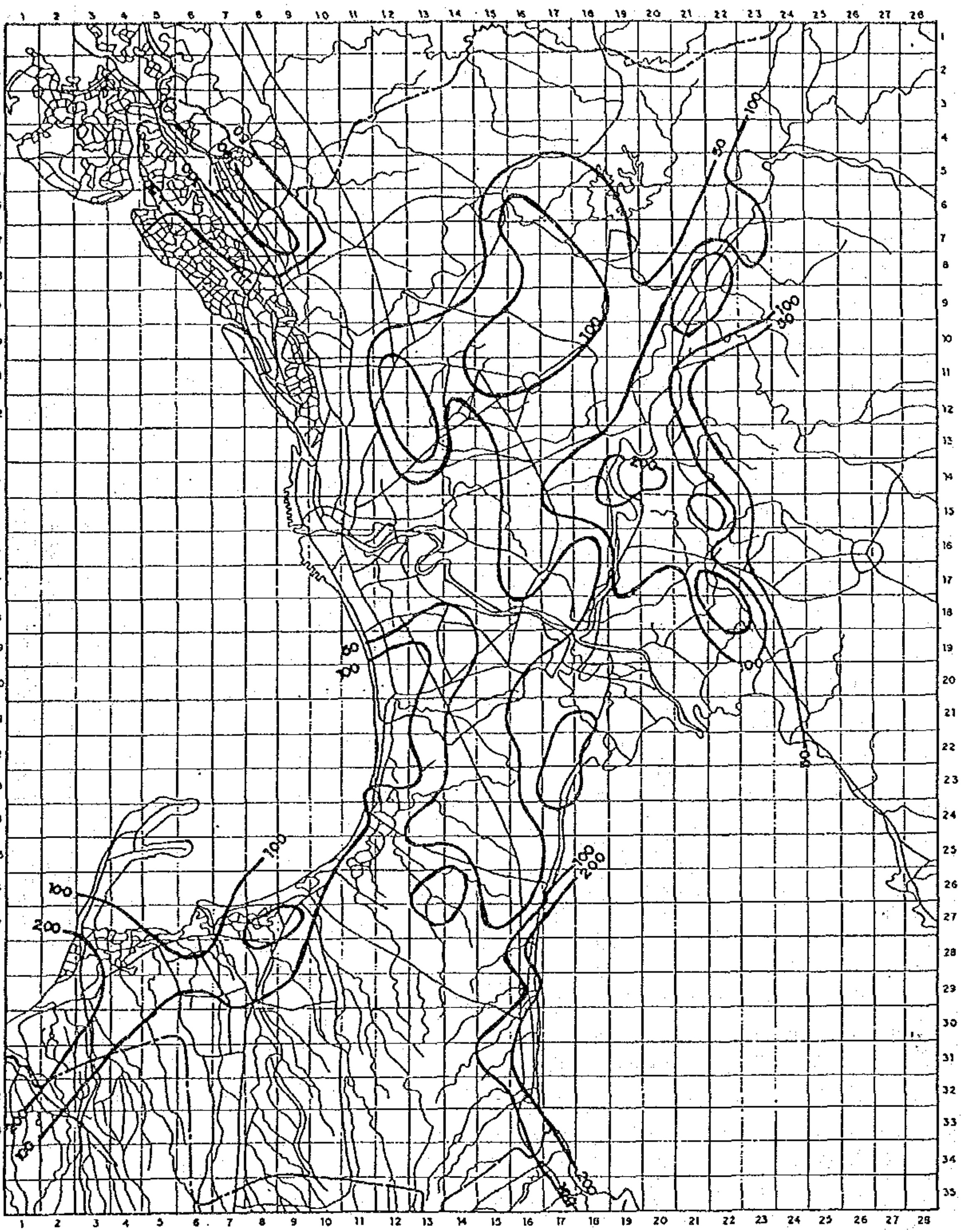


STUDY FOR THE GROUNDWATER DEVELOPMENT IN METRO MANILA

JAPAN INTERNATIONAL COOPERATION AGENCY

FIGURE 4.4.1

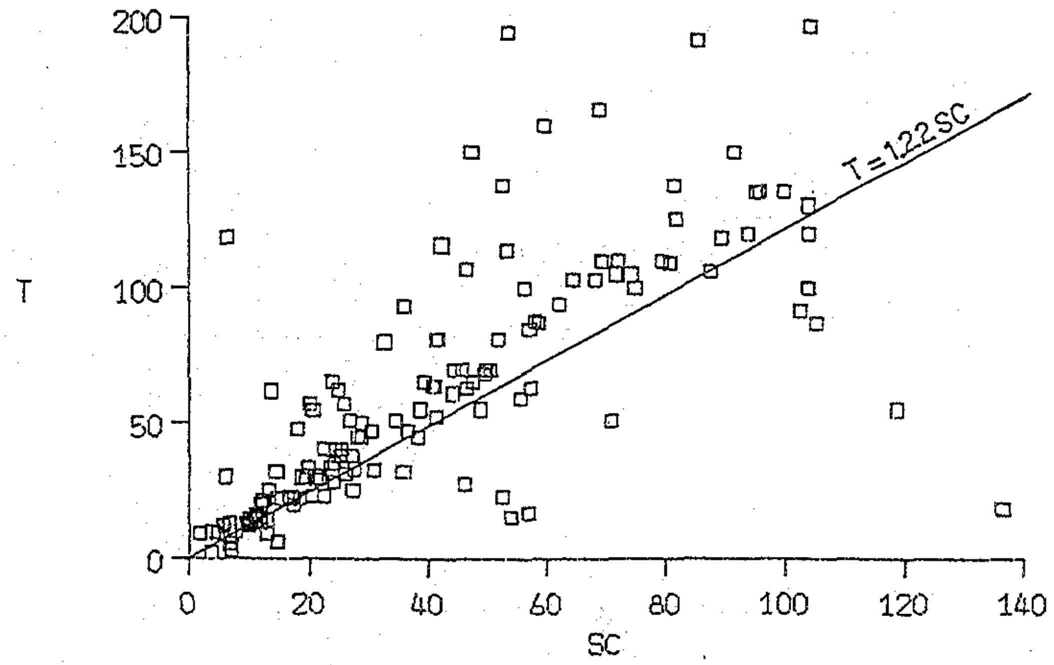
DISTRIBUTION OF TRANSMISSIVITY (m^2/d)
(number of samples = 196)



STUDY FOR THE GROUNDWATER DEVELOPMENT IN METRO MANILA

JAPAN INTERNATIONAL COOPERATION AGENCY

FIGURE 4.4.2
TRANSMISSIVITY MAP OF METRO MANILA

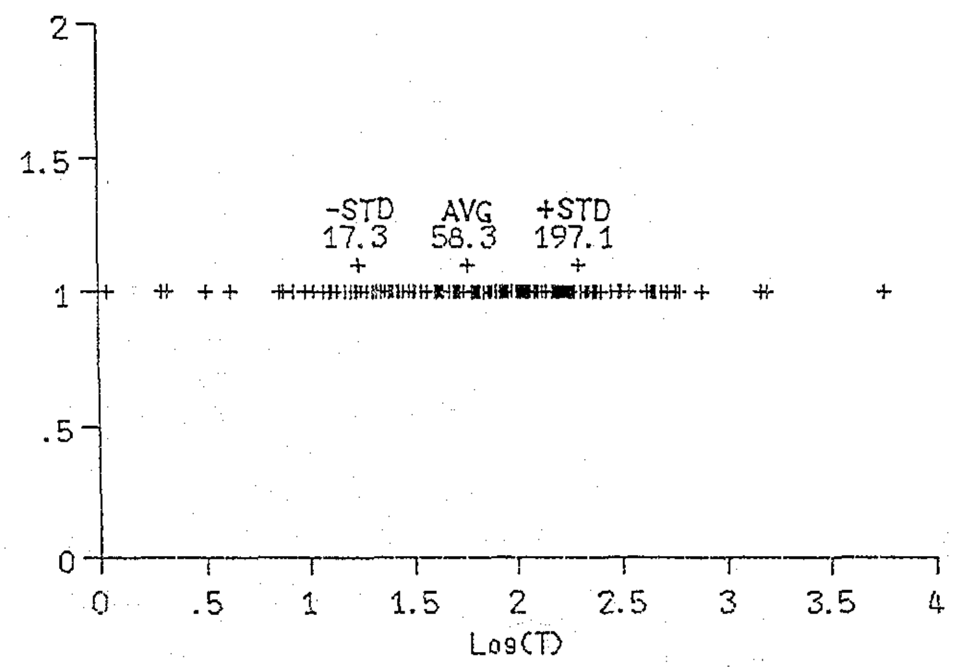


STUDY FOR THE GROUNDWATER DEVELOPMENT IN METRO MANILA

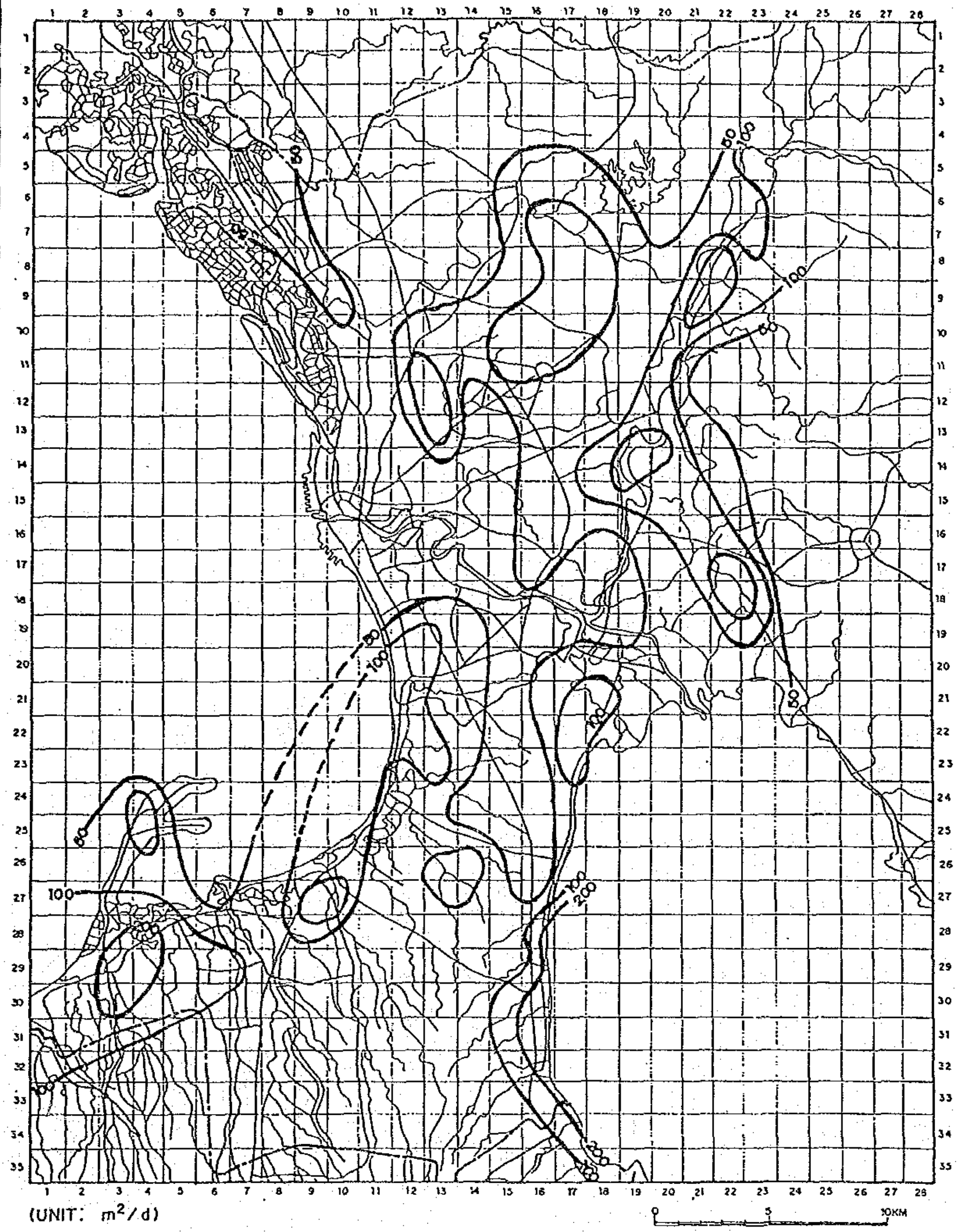
JAPAN INTERNATIONAL COOPERATION AGENCY

FIGURE 4.4.3

CORRELATION BETWEEN TRANSMISSIVITY AND SPECIFIC CAPACITY (m^2/d)



STUDY FOR THE GROUNDWATER DEVELOPMENT IN METRO MANILA	FIGURE 4.4.4
JAPAN INTERNATIONAL COOPERATION AGENCY	DISTRIBUTION OF TRANSMISSIVITY (m^2/d) (T=1.22*S, Number of samples = 278)



STUDY FOR THE GROUNDWATER DEVELOPMENT IN METRO MANILA

JAPAN INTERNATIONAL COOPERATION AGENCY

FIGURE 4.4.5

ESTIMATED TRANSMISSIVITY MAP FROM SPECIFIC CAPACITY

CHAPTER 5

HYDROLOGICAL OBSERVATIONS

CHAPTER 5 HYDROLOGICAL OBSERVATIONS

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CHAPTER 5 HYDROLOGICAL OBSERVATIONS

5.1 METEOROLOGICAL AND HYDROLOGICAL DATA

Basic hydrological and meteorological data needed for water balance analysis were collected from BRS and PAGASA. These data were then processed and entered into Lotus 123 files. After some counter-checking with the original PAGASA records, these data were transferred into the groundwater database system where they will be preserved and managed.

The meteorological data consist of records of rainfall, temperature, evaporation, relative humidity, wind speed and sunshine hours, while the hydrological data constitute records of discharge.

5.1.1 Meteorological Data

(1) Temperature and Humidity

PAGASA has four (4) synoptic stations recording atmospheric temperature and relative humidity observations. The stations are all situated within the Study Area, specifically in Port Area, Diliman, Pasay City, and Cavite City.

Present data indicate that, on the average, monthly temperature ranges from a minimum of 20°C to a maximum of 35°C. Mean monthly temperature varies from 25°C to 35°C. The coldest months are from December to February while the warmest are April and May.

The monthly average relative humidity ranges from a maximum of 86% to a minimum of 64%. The months of August and September recorded the highest relative humidity readings, while the months of March to May the lowest. Mean annual relative humidity was recorded at 74% for Port Area, 78% for Diliman, 76% for Pasay City and 76% for Cavite City. For the Study Area, annual relative humidity is approximately 76%. Monthly relative humidity plots are presented in Figure 5.1.1.

(2) Evaporation

There is only one (1) evaporation station within the Study Area and it is at the Science Garden in Diliman, Quezon City. The data collected from this station consist of records from 1976 to 1989.

Monthly pan evaporation shows a minimum of 62mm in July 1988 and a maximum of 24mm in May 1978. Estimated annual mean is set at 1,649mm (Refer to Figure 5.1.1)

(3) Rainfall

Monitoring of rainfall has been done in the Study Area as early as 1865 at Port Area, and since 1956 by the PAGASA. There are presently twenty four (24) rainfall stations within the Study Area, all manage by PAGASA. Table 5.1.1 lists the coordinates and periods of records of the stations. The approximate point locations of the stations are plotted in Figure 5.1.2.

The mean monthly rainfall values of the selected stations are plotted in Figure 5.1.3. Based on the given figure, it may be noted that much of the rainfall occurs from May to November, with August generally as the month of heaviest precipitation. Annual rainfall ranges from 1684mm (as observed in Cavite City) to 2356mm (as observed in Diliman). On the other hand, monthly mean varies from 2.1mm (as observed in Cavite City) to 505mm (as observed in Diliman).

5.1.2 Hydrological Data

Twelve (12) stream-gaging stations are within the Study Area and these were established by the former Bureau of Public Works (BPW). They are presently managed by the Bureau of Research and Standard (BRS). Streamflow observations started as early as the 1950s, and mainly at the Pasig River. The respective coordinates, drainage areas and periods of records of the different gaging stations are provided in Table 5.1.2; the approximate point locations are shown in Figure 5.1.4. The mean monthly values of the selected stations are plotted in Figure 5.1.5

5.2 SIMULTANEOUS HYDROLOGICAL OBSERVATIONS

Simultaneous hydrological observations were carried out in the Metro Manila groundwater basin area and the Antipolo Plateau. These observations were done at the end of the wet season (November 1990), at the end of the dry season (April 1991), and at the peak of the wet season (August 1991). Observation items include groundwater levels of wells in both areas, and spring and stream flows around the Antipolo Plateau.

5.2.1 Groundwater Leveling

(1) Simultaneous Observations

The purposes of groundwater leveling are:

- To prepare a groundwater contour map of the Study Area
- To investigate the changes between the 1981 and 1990 ground water levels in the study Area.
- To determine the seasonal changes of groundwater levels in the Study Area

The aforecited three simultaneous observations of groundwater levels were done by MWSS Staff under the supervision of the Study Team. Figure 5.2.1 shows the approximate locations of the 231 observation wells. Of the 231 wells, 117 were measured in November 1990, 190 in May 1991, and 152 in August 1991. Some of the wells previously visited were excluded from the observation because they were already operational, clogged, filled up, or simply unreliable.

Details of the survey data on groundwater leveling are given in the Data Report of this Study.

Comparison of the results of these three measurements indicates that some of the measurements were affected by either tidal fluctuations (those wells near the shore) or nearby pumping.

Of the 231 observation wells, only 204 were considered in the preparation of groundwater contour maps. The other wells were unreliable. Missing data were estimated using regression analysis. Table 5.2.1 presents three sets of augmented groundwater level data together with the observation wells' geographical location. Groundwater contours were calculated and plotted using computer programs. These programs provide nodal or grid values for the piezometric contours, which are important input data for groundwater modeling.

Figures 5.2.2, 5.2.3 and 5.2.4 show the observed piezometric contours in MSA in November 1990, May 1991 and August 1991, respectively. Figures 5.2.5, 5.2.6 and 5.2.7 show the piezometric contours in the Antipolo basin during the said periods.

(2) Continuous Observations

For the continuous monitoring of groundwater levels, 10 automatic water level recorders were installed: 5 in Las Piñas (Site No. 1: Wells 1 and 3, Site No. 2: Wells 1 and 3, and Site No 3: Well 1); 2 in Antipolo (JICA Test Well and new in MWSS Well in Buliran); 1 in Makati (abandoned MWSS Well in Magallanes Village); 1 in Quezon City (inactive MWSS Well in D. Tuazon Pumping Station); and 1 in Valenzuela (abandoned MWSS Well in Marulas Elementary School). Their locations are shown in Figure 5.2.8. Charts of said automatic water level recorders are collected monthly and processed by MWSS Staff.

Figures 5.2.9 (a) to (j) show the observed groundwater level hydrographs of these 10 wells.

5.2.2 Spring/Stream Flow Measurements

The discharge measurement aims for a quantitative estimate of the groundwater outflow from the Antipolo Plateau. This estimate shall be used in making a detailed water balance analysis of this area.

The Antipolo Plateau is located on the eastern portion of the Study Area. It sits on an area of about 22km² at an elevation of 200m above sea level. The Antipolo proper is drained by streams flowing westward to Marikina Valley or cascading through steep cliffs. Streams located east and north of the plateau originate from springs. Some of the springs are being used for domestic water supply or irrigation. The streams measured on the northwestern boundary feed the Nangka River. These are: on the western side, the Sapang Baho River and Napindan Creek; southwestern border, the Bogad Creek, Bonguod Creek and Angono River; on the southern portion, the smaller creeks draining into Laguna de Bay; and on the eastern side, the Morong River.

Figure 5.2.10 shows the locations of abovesaid springs and streams. The selection of sites for measurement of discharge considered both the geology and hydrogeology of the area. The discharge measurements points are located just outside the hydrogeological boundaries previously determined during the geological investigation.

Three sets of simultaneous measurements were conducted for 15 small streams and 9 springs. These were done in November 1990 (end of wet season), May 1991 (end of dry season), and August 1991 (during the rainy season). Table 5.2.2 shows the results of measurements.

In November 1990, the spring discharge totaled 212.17 lps, while total stream flow was 1465.761 lps. The total spring flow was 0.85 lps at the end of the dry season (May 1991) and 304.29 lps during the rainy season (August 1991). The spring flows were quite limited-either very low or dry in the dry season. Total stream discharge was 238.36 lps in May 1991 and 3,216.08 lps in August 1991.

TABLE 5.1.1

DETAILS OF RAINFALL STATIONS

No.	LOCATION	COORDINATES LATITUDE	COORDINATES LONGITUDE	TYPE	RESPONSIBLE AGENCY	TIME OF MEASUREMENTS	PERIODS OF RECORD	PRESENT STATUS	DATA BEING OBSERVED
1	OBANDO, BULACAN	14' 43' N	120' 55' E	OR	PAGASA	8AM, 5PM	1969 - 1986	ABANDONED	R
2	CAMARIN, CALOOCAN, M.M.	14' 39' N	120' 58' E	OR	PAGASA	8AM, 5PM	1974 - PRESENT	ACTIVE	R
3	NOVALICHES, QUEZON CITY, M.M.	14' 43' N	121' 02' E	OR	PAGASA	8AM, 5PM	1956 - 1962	ABANDONED	R
4	NAVOTAS, METRO MANILA	14' 39' N	120' 57' E	OR	PAGASA	8AM, 5PM	1972-73; 1975-80	ABANDONED	R
5	ANTIPOLO, RIZAL	14' 35' N	121' 12' E	OR	PAGASA	8AM, 5PM	1972 - PRESENT	ACTIVE	R
6	PASIG, METRO MANILA	14' 34' N	121' 05' E	OR	PAGASA	8AM, 5PM	1976 - PRESENT	ACTIVE	R
7	BPI CUYAMBAY, TANAY, RIZAL	14' 32' N	121' 21' E	AGRO	PAGASA	8AM, 5PM	1970 - PRESENT	ACTIVE	T, SD, E, R
8	MARIKINA, METRO MLA	14' 37' N	121' 06' E	OR	PAGASA	8AM, 5PM	1976 - PRESENT	ACTIVE	R
9	MUNTINLUPA, METRO MANILA	14' 23' N	121' 03' E	OR	PAGASA	8AM, 5PM	1972 - PRESENT	ACTIVE	R
10	LAS PIÑAS, METRO MANILA	14' 29' N	120' 59' E	OR	PAGASA	8AM, 5PM	1976 - 1979	ABANDONED	R
11	QUEZON INSTITUTE, QUEZON CITY, M.M.	14' 37' N	121' 01' E	OR	PAGASA	8AM, 5PM	1972 - 1980	ABANDONED	R
12	BALARA FILTER, QUEZON CITY, M.M.	14' 39' N	121' 05' E	CR	PAGASA	8AM, 5PM	1956 - 1972	ABANDONED	R
13	PORT AREA, MANILA	14' 35' N	120' 58' E	SYNOP	PAGASA	8AM,2PM; 8PM,2AM	1957 - PRESENT	ACTIVE	T, H, WV, R
14	MIA PASAY CITY, METRO MANILA	14' 31' N	121' 00' E	SYNOP	PAGASA	8AM,2PM; 8PM,2AM	1951 - PRESENT	ACTIVE	T, H, WV, R
15	SCIENCE GARDEN, DILIMAN, Q.C.	14' 39' N	121' 03' E	SYNOP	PAGASA	8AM,2PM; 8PM,2AM	1961 - PRESENT	ACTIVE	T, H, WV, R
16	BOSO-BOSO ANTIPOLO, RIZAL	14' 38' N	121' 14' E	OR	PAGASA	8AM, 5PM	1972 - PRESENT	ACTIVE	R
17	ANGONO, RIZAL	14' 31' N	121' 09' E	OR	PAGASA	8AM, 5PM	-	ABANDONED	R
18	SITIO TABAK, MONTALBAN, RIZAL	14' 46' N	121' 11' E	OR	PAGASA	8AM, 5PM	1976 - PRESENT	ACTIVE	R
19	SANGLEY POINT, CAVITE CITY	14' 30' N	121' 55' E	SYNOP	PAGASA	8AM,2PM; 8PM,2AM	1974 - PRESENT	ACTIVE	T, H, WV, R
20	MABOLO ELEM. SCH. BACOOR, CAVITE	14' 27' N	120' 56' E	OR	PAGASA	8AM, 5PM	1975 - PRESENT	ACTIVE	R
21	BAGUMBAYAN, TAGUIG, M.M.	14' 28' N	121' 03' E	OR	PAGASA	8AM, 5PM	1975 - PRESENT	ACTIVE	R
22	TIPAS, TAGUIG, M.M.	14' 31' N	121' 05' E	OR	PAGASA	8AM, 5PM	1975 - PRESENT	ACTIVE	R
23	JUAN SUMULONG, ANTIPOLO, RIZAL			OR	PAGASA	8AM, 5PM	1971 - PRESENT	ACTIVE	R
24	BOS, CUYAMBAY, TANAY RIZAL	14' 35' N	121' 21' E	AGRO	PAGASA	8AM, 5PM	1969 - 1971	ABANDONED	T, SD, E, R

TYPE OF STATION:

OR - OFFICIAL RAINFALL STATION
CR - CLIMATOLOGICAL/COOPERATIVE RAINFALL STATION
AGROMET - AGROMETEOROLOGICAL STATION
SYNOP - SYNOPTIC STATION

NOTE:

R - RAINFALL
T - TEMPERATURE
E - EVAPORATION
H - HUMIDITY
SD - SUNSHINE DURATION
WV - WIND VELOCITY

TABLE 5.1.2

DETAILS OF STREAM GAGING STATIONS

STATION No.	RIVER/LOCATION	RIVER BASIN	COORDINATES LATITUDE	COORDINATES LONGITUDE	DRAINAGE AREA (SQ. KM.)	PERIODS OF RECORD
1	PASIG R - BEATA, PANDACAN, M. M.	PASIG - LAGUNA DE BAY	14' 35' 47"	121' 00' 37"	3923	1945 - 1970
2	PASIG R - SAN JOSE, MAKATI, M. M.	PASIG - LAGUNA DE BAY	14' 34' 13"	121' 02' 40"	3824	1946 - 1974
3	PASIG R - PINEDA, PASIG, M. M.	PASIG - LAGUNA DE BAY	14' 33' 50"	121' 03' 39"	3821	1946 - 1979
4	PASIG R - MCKINLEY, MAKATI, M. M.	PASIG - LAGUNA DE BAY	14' 33' 51"	121' 03' 42"	3807	1958 - 1975
5	MARIKINA R - ROSARIO, PASIG, M. M.	MARIKINA	14' 36' 12"	121' 05' 11"	532	1960 - 1977
6	MARIKINA R - MANGGAHAN, PASIG, M. M.	MARIKINA	14' 35' 12"	121' 05' 22"	527	1959 - 1970
7	MARIKINA R - STO NIÑO, MARIKINA, M. M.	MARIKINA	14' 38' 15"	121' 05' 30"	499	1958 - 1977
						1986 - PRESENT
8	NANGKA R - NANGKA, MARIKINA M. M.	MARIKINA	14' 41' 53"	121' 06' 30"	54	1960 - 1978
9	MARIKINA R - SAN RAFAEL, MONTALBAN, RIZAL	MARIKINA	14' 44' 00"	121' 10' 20"	282	1957 - 1979
10	PASIG R - NAPINDAN, TAGUIG, M. M.	PASIG - LAGUNA DE BAY	14' 32' 28"	121' 05' 44"	3159	1946 - 1978
						1984 - PRESENT
11	LAGUNA LAKE-TAYUMAN, BINANGONAN, RIZAL	PASIG - LAGUNA DE BAY	14' 31' 22"	121' 09' 16"	3158	1959 - PRESENT
12	LAGUNA LAKE - POBLACION, MUNTINLUPA, M. M.	PASIG - LAGUNA DE BAY	14' 21' 29"	121' 02' 46"	3158	1959 - PRESENT

TABLE 5.2.1 OBSERVED PIEZOMETRIC WATER LEVELS

WELL CODE	PIEZOMETRIC WATER LEVEL(m)			LATITUDE			LONGITUDE		
	NOV.'90	MAY '91	AUG.'91	D	M	S	D	M	S
1	76.3	71.3	75.3	14	35	24	121	12	13
3	167.6	163.4	163.6	14	34	47	121	11	23
4	114.5	108.1	112.0	14	37	39	121	10	53
5	114.0	107.6	108.9	14	37	28	121	10	1
6	-5.2	-6.1	-5.7	14	38	6	121	6	58
7	70.6	65.6	65.7	14	37	48	121	8	29
8	67.8	62.9	65.6	14	37	29	121	8	18
9	172.4	168.9	170.9	14	35	55	121	10	45
10	166.2	164.0	164.6	14	34	55	121	10	50
11	163.8	159.6	160.1	14	35	16	121	10	4
12	181.0	174.7	175.6	14	35	35	121	10	48
13	168.4	161.6	164.8	14	35	31	121	10	55
14	168.0	162.7	165.9	14	35	39	121	10	15
15	172.6	167.0	168.8	14	35	25	121	10	29
16	164.6	161.2	164.1	14	35	10	121	10	21
17	168.6	168.4	170.4	14	35	14	121	10	39
18	169.2	162.8	167.9	14	34	54	121	10	12
19	169.1	165.8	167.0	14	34	58	121	10	35
20	171.1	166.8	168.8	14	35	9	121	11	32
21	197.9	192.9	197.8	14	34	11	121	10	52
22	-87.0	-90.5	-93.1	14	27	15	120	56	28
23	-40.0	-42.0	-43.2	14	27	22	120	57	17
24	-51.2	-52.2	-53.0	14	27	42	120	56	17
25	17.8	14.6	17.0	14	24	26	120	59	7
26	18.2	14.9	15.7	14	24	0	120	58	14
27	23.5	20.1	22.5	14	23	58	120	59	17
28	-78.0	-81.2	-83.5	14	43	5	121	0	8
30	-16.4	-17.2	-17.3	14	38	9	121	6	18
32	-36.6	-38.5	-39.6	14	34	45	121	6	55
33	-2.2	-2.9	-1.7	14	37	40	121	7	35
34	-20.5	-20.9	-22.3	14	29	52	120	54	42
35	-20.3	-20.6	-22.1	14	29	59	120	54	47
36	-36.0	-37.8	-38.8	14	28	52	120	53	39
37	-11.1	-12.2	-11.2	14	28	57	120	53	36
38	-34.9	-36.7	-35.7	14	27	57	120	52	57
39	-16.0	-17.2	-17.7	14	29	39	120	54	13
40	3.9	1.5	3.9	14	25	46	120	56	3
41	34.3	32.9	34.7	14	21	58	120	56	17
42	0.3	-0.4	3.1	14	25	50	120	55	10
43	23.9	20.4	22.0	14	23	3	120	56	7
44	5.5	2.7	5.0	14	25	15	120	56	29
45	0.4	-0.3	-0.3	14	26	8	120	56	46
46	33.8	30.0	32.5	14	22	19	120	58	33
47	16.7	13.5	15.7	14	23	51	120	56	12
48	-34.1	-35.9	-36.5	14	26	31	120	54	37
49	-49.3	-51.6	-53.1	14	26	52	120	54	37
51	-28.3	-30.9	-31.2	14	26	1	120	52	58
52	-37.8	-38.6	-39.2	14	27	43	120	57	19

TABLE 5.2.1 (CONTINUATION)

WELL CODE	PIEZOMETRIC WATER LEVEL(m)			LATITUDE			LONGITUDE		
	NOV.'90	MAY '91	AUG.'91	D	M	S	D	M	S
54	-14.8	-16.0	-16.4	14	26	20	121	0	54
55	-7.6	-8.5	-9.1	14	25	40	120	59	48
56	-11.4	-12.5	-11.7	14	26	2	121	0	11
57	-64.2	-67.0	-68.9	14	27	46	120	57	59
58	-42.2	-44.3	-45.5	14	28	17	120	58	29
61	-92.6	-96.3	-99.0	14	26	27	120	58	24
62	-22.8	-23.8	-24.5	14	34	11	121	1	30
63	-21.7	-23.0	-24.1	14	33	52	121	1	14
64	-22.4	-23.8	-25.2	14	33	50	121	1	39
65	-18.6	-19.3	-19.5	14	33	45	121	2	0
67	-27.9	-29.2	-29.7	14	33	38	121	2	10
68	-25.6	-27.4	-28.8	14	33	25	121	1	17
69	-18.8	-21.2	-23.2	14	33	12	121	1	2
70	-18.0	-20.6	-21.9	14	33	46	121	1	8
71	-23.1	-24.5	-25.2	14	33	14	121	0	53
72	-14.0	-15.1	-15.2	14	33	51	121	0	45
74	-33.2	-35.0	-35.1	14	32	15	121	2	5
75	-54.9	-60.6	-59.7	14	32	48	121	1	53
76	-20.3	-21.2	-19.9	14	32	1	121	1	10
77	-24.0	-25.5	-26.2	14	34	4	121	2	9
78	-29.3	-31.0	-31.8	14	33	10	121	1	42
79	-65.0	-62.3	-64.0	14	32	54	121	2	13
80	-72.9	-69.9	-71.9	14	32	36	121	2	7
81	-24.4	-25.9	-26.6	14	33	25	121	2	18
82	-32.1	-33.8	-34.8	14	33	9	121	2	52
83	-34.3	-36.1	-37.2	14	32	44	121	2	36
85	-77.7	-80.6	-82.8	14	40	25	120	59	27
86	-13.9	-15.0	-17.5	14	41	8	120	56	28
87	-32.6	-34.3	-35.3	14	40	13	120	57	11
88	-23.3	-22.7	-23.3	14	34	23	121	2	25
89	-25.4	-26.9	-27.7	14	34	47	121	3	11
90	-21.2	-21.9	-22.9	14	34	51	121	2	32
93	-28.8	-31.0	-31.4	14	36	19	120	59	6
96	-76.9	-80.1	-75.1	14	34	59	120	58	22
97	-69.0	-71.9	-72.3	14	37	53	120	57	56
98	-1.4	-2.1	-2.3	14	37	13	120	58	12
99	4.5	1.7	1.6	14	35	42	121	0	21
100	-5.1	-5.9	-6.0	14	36	33	120	58	19
101	4.0	1.6	3.4	14	39	51	121	6	18
102	4.9	1.6	4.0	14	40	6	121	6	23
104	-21.1	-21.8	-22.4	14	37	39	121	4	39
105	-11.4	-13.2	-11.1	14	39	5	121	5	37
106	15.7	12.5	14.0	14	38	41	121	6	57
107	16.4	13.2	14.3	14	38	28	121	7	1
108	13.2	10.1	11.0	14	38	48	121	7	6
109	22.7	19.3	21.9	14	39	0	121	7	13
112	8.5	5.3	7.2	14	42	50	121	8	15
113	17.7	14.4	19.8	14	44	36	121	7	44

TABLE 5.2.1 (CONTINUATION)

WELL CODE	PIEZOMETRIC WATER LEVEL(m)			LATITUDE			LONGITUDE		
	NOV.'90	MAY '91	AUG.'91	D	M	S	D	M	S
115	13.7	10.6	10.7	14	43	57	121	8	6
116	-5.3	-5.2	-7.8	14	22	53	121	1	46
117	-22.9	-24.3	-25.0	14	27	19	121	2	39
118	-108.3	-112.5	-115.7	14	26	53	121	2	34
119	-11.8	-12.8	-11.1	14	23	50	121	2	35
120	-20.2	-21.5	-18.2	14	27	42	121	3	9
121	-10.0	-11.0	-8.7	14	25	52	121	2	55
122	-12.4	-13.5	-12.1	14	25	9	121	2	35
123	-8.7	-9.7	-7.9	14	23	9	121	3	0
124	-12.2	-13.3	-11.7	14	24	8	121	2	57
125	-80.5	-83.8	-86.6	14	38	26	120	57	22
126	-36.6	-38.4	-39.5	14	38	44	120	57	12
127	-28.6	-30.5	-30.8	14	25	59	120	52	41
128	-33.0	-38.8	-39.9	14	25	32	120	52	32
129	-33.6	-35.3	-34.1	14	25	25	120	52	20
130	-33.0	-34.7	-34.6	14	30	4	121	0	50
131	-18.1	-19.4	-20.5	14	26	31	121	1	16
132	-94.6	-98.4	-101.2	14	27	37	121	0	27
133	-76.8	-80.0	-79.7	14	28	58	121	2	5
134	-39.2	-41.2	-39.3	14	28	36	120	59	24
135	-59.5	-62.1	-61.2	14	29	36	121	2	18
136	-82.4	-85.7	-88.1	14	26	46	121	0	35
137	-23.0	-24.4	-23.7	14	28	24	121	0	14
138	-24.7	-26.2	-27.5	14	29	18	120	59	25
139	-65.7	-69.5	-68.6	14	28	21	121	1	15
140	-66.0	-73.1	-73.4	14	25	58	121	1	9
141	-65.9	-68.7	-70.6	14	26	19	121	1	24
142	-65.2	-68.0	-67.3	14	28	45	121	1	44
143	-66.9	-69.7	-71.7	14	27	5	121	0	19
144	-64.2	-67.0	-68.9	14	28	42	121	2	0
145	-17.6	-18.4	-18.5	14	32	48	120	59	32
146	-52.8	-55.2	-56.7	14	32	37	120	59	38
147	-96.8	-100.6	-103.4	14	33	28	120	59	37
148	-54.9	-57.4	-56.0	14	30	54	121	1	11
149	-41.7	-43.7	-42.1	14	31	27	121	0	57
150	-42.0	-44.1	-43.0	14	31	32	121	1	22
151	-41.9	-43.9	-43.7	14	31	43	121	0	39
152	-0.6	-1.3	-1.0	14	32	38	120	59	28
153	-21.9	-23.8	-23.9	14	32	51	121	5	22
154	-36.4	-38.3	-36.6	14	34	54	121	4	57
155	-20.2	-21.6	-21.8	14	33	18	121	4	15
156	-52.6	-55.0	-56.5	14	35	22	121	4	29
157	-20.0	-21.3	-21.9	14	34	31	121	3	49
158	-49.4	-51.7	-53.2	14	36	57	121	4	57
159	-59.0	-61.6	-66.2	14	36	52	121	5	16
160	-43.6	-45.7	-48.7	14	34	54	121	5	2
162	-41.8	-43.8	-45.0	14	42	13	121	1	19
163	30.6	27.0	26.8	14	40	24	121	5	23

TABLE 5.2.1 (CONTINUATION)

WELL CODE	PIEZOMETRIC WATER LEVEL(m)			LATITUDE			LONGITUDE		
	NOV.'90	MAY '91	AUG.'91	D	M	S	D	M	S
164	-0.5	-1.2	1.2	14	37	28	121	1	35
165	-60.4	-63.1	-65.0	14	38	29	121	2	6
166	50.2	45.9	48.5	14	43	45	121	2	50
167	7.5	4.6	7.0	14	36	54	121	2	3
168	59.1	54.5	57.2	14	43	10	121	3	48
170	-35.2	-37.1	-37.7	14	37	50	121	0	4
171	15.8	12.7	15.1	14	43	50	121	7	2
172	-71.4	-74.4	-76.5	14	36	40	121	4	46
173	-56.2	-58.7	-60.4	14	36	49	121	4	38
174	75.1	69.5	73.7	14	41	33	121	5	15
175	73.6	68.7	71.4	14	41	29	121	5	13
176	63.1	58.4	57.8	14	41	35	121	5	37
178	10.9	7.9	7.6	14	39	40	121	1	49
179	-1.0	-1.7	0.6	14	36	38	121	2	41
180	-47.0	-49.5	-49.6	14	41	55	121	1	21
181	-36.6	-38.4	-39.2	14	40	15	121	2	51
182	24.0	16.8	23.6	14	40	45	121	4	10
183	45.1	40.9	43.5	14	40	53	121	4	59
184	7.3	4.4	2.9	14	38	11	120	59	46
186	63.0	58.2	60.9	14	41	0	121	5	24
188	-40.8	-42.9	-44.1	14	39	54	121	0	2
189	-30.6	-32.6	-33.6	14	40	36	121	2	43
191	-36.7	-38.5	-39.6	14	25	20	120	52	10
192	-25.0	-25.8	-26.6	14	25	3	120	51	33
193	-26.3	-27.9	-28.6	14	25	10	120	51	48
194	-18.8	-20.4	-21.1	14	24	52	120	50	47
195	-14.1	-15.8	-18.6	14	24	59	120	50	56
196	-17.1	-18.3	-17.0	14	36	12	121	1	18
198	73.5	68.4	73.1	14	39	33	121	8	9
199	9.7	6.7	13.0	14	40	59	121	6	59
200	10.9	6.7	7.8	14	41	8	121	6	54
201	15.5	15.3	17.7	14	41	30	121	7	30
202	17.0	13.8	16.2	14	40	49	121	7	35
203	-18.6	-19.9	-18.9	14	29	15	121	3	16
204	-44.1	-49.3	-49.5	14	29	9	121	3	6
205	-21.1	-23.0	-23.4	14	31	51	121	4	8
206	-66.5	-67.0	-65.1	14	30	23	121	2	28
207	-65.8	-68.6	-64.3	14	30	11	121	2	41
208	89.6	83.9	83.8	14	35	5	121	9	5
209	-42.2	-44.2	-45.4	14	34	19	121	7	51
210	-104.9	-110.3	-105.1	14	40	22	120	58	55
211	-72.6	-69.1	-71.0	14	41	58	120	57	42
212	-122.7	-127.4	-130.9	14	40	38	120	59	1
213	-117.6	-122.1	-122.7	14	42	52	120	57	28
214	-57.4	-59.9	-61.6	14	41	58	120	59	27
215	-92.5	-96.2	-95.1	14	44	10	120	57	23
216	-53.7	-56.1	-55.2	14	42	32	120	56	13
217	-61.6	-64.3	-66.1	14	42	31	120	56	17

TABLE 5.2.1 (CONTINUATION)

WELL CODE	PIEZOMETRIC WATER LEVEL(m)			LATITUDE			LONGITUDE		
	NOV.'90	MAY '91	AUG.'91	D	M	S	D	M	S
218	-89.1	-92.7	-93.1	14	42	7	120	56	36
219	-60.5	-62.5	-64.2	14	44	35	120	58	15
220	89.8	84.2	85.1	14	18	14	120	54	26
221	90.2	84.8	87.6	14	18	15	120	55	20
222	75.3	70.2	70.0	14	19	14	120	57	8
223	56.8	52.2	52.5	14	19	55	120	56	15
224	-9.7	-10.7	-10.5	14	22	14	121	2	56
227	-9.4	-10.4	-10.6	14	31	59	121	9	2
228	50.6	46.3	49.4	14	33	38	121	13	1
229	-39.8	-41.7	-44.1	14	28	34	120	58	38
230	-45.0	-47.2	-50.1	14	28	5	120	58	7
231	-55.1	-57.6	-61.8	14	27	35	120	58	8

TABLE 5.2.2

RESULTS OF SPRINGFLOW MEASUREMENTS

STATION CODE	LOCATION	END OF WET SEASON DATE OF MEASUREMENT	END OF WET SEASON DISCHARGE (LPS)	END OF DRY SEASON DATE OF MEASUREMENT	END OF DRY SEASON DISCHARGE (LPS)
H0028	DULONG BAYAN, TERESA, RIZAL	NOV. 29, 1990	1.51	MAY 17, 1991	0
H0029	DULONG BAYAN, TERESA, RIZAL	NOV. 29, 1990	9.22	MAY 17, 1991	0
H0030	GULOD, BINANGONAN, RIZAL (KAISAPAN)	NOV. 29, 1990	11.90	MAY 17, 1991	0
H0031	GULOD, BINANGONAN, RIZAL	NOV. 29, 1990	2.77	MAY 17, 1991	0
H0032	MAPUTING BATO, BINANGONAN, RIZAL (LIBERTY FARMS)	NOV. 29, 1990	140.00	MAY 17, 1991	0
H0033	MAPUTING BATO, BINANGONAN, RIZAL	NOV. 29, 1990	10.69	MAY 17, 1991	0.05
H0034	TAGBAK, ANTIPOLO, RIZAL	DEC. 01, 1990	18.30	MAY 16, 1991	0.80
H0035	TAGBAK, ANTIPOLO, RIZAL	DEC. 01, 1990	17.78	MAY 16, 1991	0

RESULTS OF STREAMFLOW MEASUREMENTS

STATION CODE	LOCATION	DRAINAGE AREA km2	END OF WET SEASON DATE OF MEASUREMENT	END OF WET SEASON DISCHARGE (LPS)	END OF DRY SEASON DATE OF MEASUREMENT	END OF DRY SEASON DISCHARGE (LPS)
H0013	MARCOS HI-WAY (AFTER JUNCTION) (NANGKA RIVER) COGEO, ANTIPOLO, RIZAL	2.791	NOV. 24, 1990	268.60	MAY 18, 1991	51.03
H0014	MARCOS HI-WAY (BEFORE JUNCTION) (NANGKA RIVER) COGEO, ANTIPOLO, RIZAL	0.970	NOV. 24, 1990	29.27	MAY 16, 1991	0
H0015	COGEO, ANTIPOLO, RIZAL (NANGKA RIVER)	1.821	NOV. 24, 1990	58.08	MAY 16, 1991	5.94
H0016	TAKTAK ROAD, ANTIPOLO, RIZAL (SAPANG BAHO RIVER)	0.541	NOV. 24, 1990	33.29	MAY 16, 1991	0
H0017	TAKTAK ROAD, ANTIPOLO, RIZAL (SAPANG BAHO RIVER)	7.012	NOV. 24, 1990	290.00	MAY 16, 1991	78.30
H0018	BILIBIRAN, BINANGONAN, RIZAL (LAGUNA BAY)	2.626	NOV. 25, 1990	15.30	MAY 18, 1991	0
H0019	CONCRETE AGGREGATES, ANGONO, RIZAL (ANGONO RIVER)	4.093	NOV. 25, 1990	140.27	MAY 18, 1991	5.51
H0020	CONCRETE AGGREGATES, ANGONO, RIZAL (ANGONO RIVER)	3.386	NOV. 25, 1990	146.71	MAY 18, 1991	30.98
H0021	GRANDSPAN, BILIBIRAN, BINANGONAN, RIZAL (LAGUNA BAY)	8.030	NOV. 26, 1990	106.88	MAY 18, 1991	1.08
H0022	LORESVILLE SUBDIVISION, ANTIPOLO, RIZAL (MAPINDAN CREEK)	0.480	NOV. 27, 1990	37.38	MAY 16, 1991	0
H0023	PROVINCIAL ROAD, ANTIPOLO, RIZAL (SAPANG BAHO RIVER)	8.595	NOV. 27, 1990	188.79	MAY 16, 1991	50.97
H0024	MAYIBA, TERESA, RIZAL (MORONG RIVER)	0.937	DEC. 01, 1990	47.25	MAY 17, 1991	2.84
H0025	TERESA, RIZAL (MORONG RIVER)	0.464	DEC. 01, 1990	9.09	MAY 17, 1991	0
H0026	TAGBAK, ANTIPOLO, RIZAL (MORONG RIVER)	0.400	DEC. 01, 1990	41.61	MAY 16, 1991	11.71
H0027	TAGBAK, ANTIPOLO, RIZAL (MORONG RIVER)	1.896	DEC. 01, 1990	53.84	MAY 16, 1991	STAGNANT

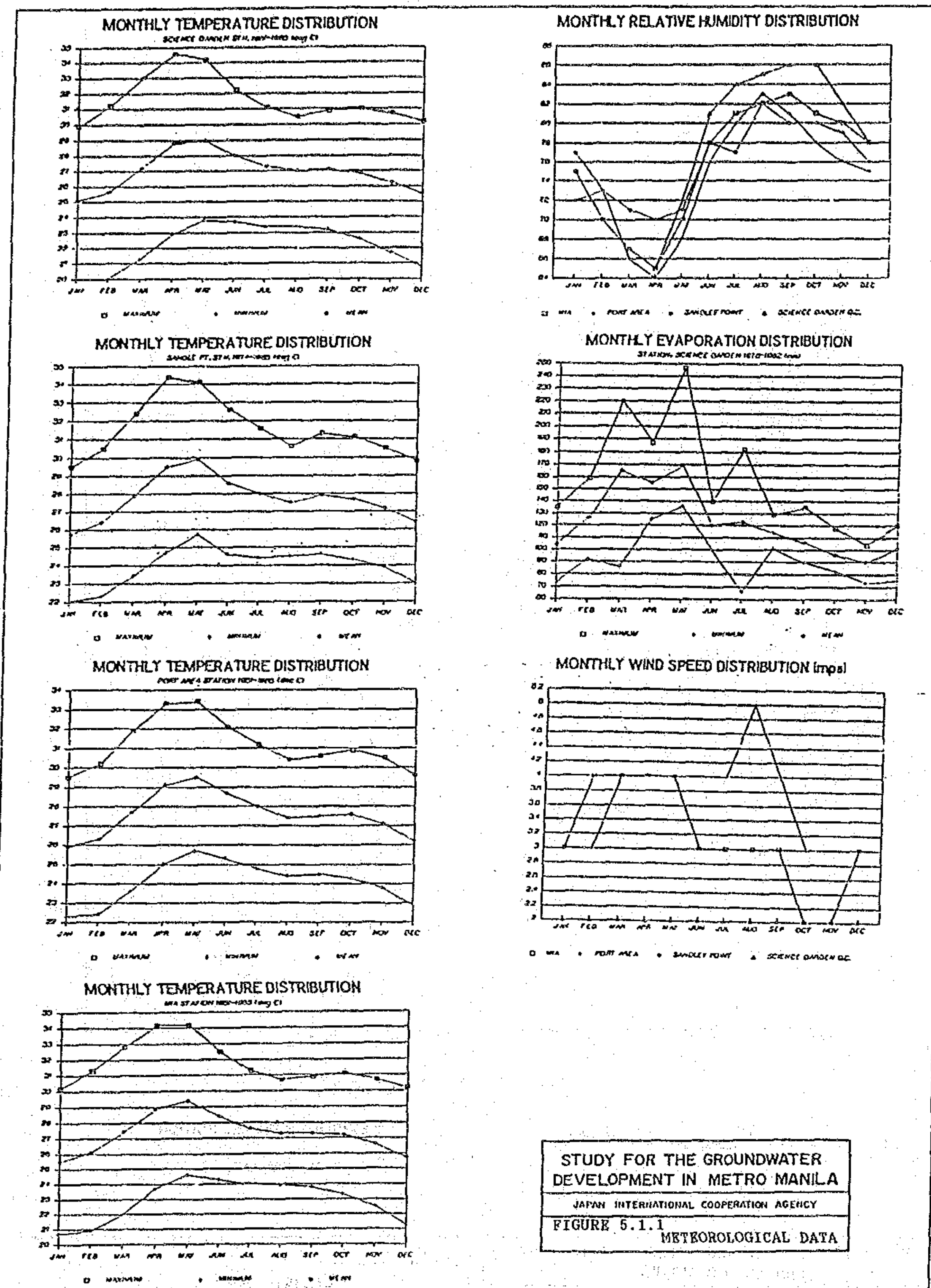
TABLE 5.2.2 (CONTINUATION)

RESULTS OF SPRING FLOW MEASUREMENTS
(SEPTEMBER 1991)

DATABASE NUMBER	LOCATION	DATE OF MEASUREMENT	DISCHARGE (LPS)
H0028	DULONG BAYAN, TERESA, RIZAL	12-Sep-91	3.78
H0029	DULONG BAYAN, TERESA, RIZAL	12-Sep-91	20.54
H0030	GULOD, BINANGONAN, RIZAL (XAISAPON)	12-Sep-91	14.98
H0031	GULOD, BINANGONAN, RIZAL	12-Sep-91	4.57
H0032	MAPUTING BATO, BINANGONAN, RIZAL (LIBERTY FARMS)	12-Sep-91	175.00
H0033	MAPUTING BATO, BINANGONAN, RIZAL	12-Sep-91	17.72
H0034	TAGBAK, ANTIPOLO, RIZAL	11-Sep-91	41.05
H0035	TAGBAK, ANTIPOLO, RIZAL	11-Sep-91	26.67

RESULTS OF STREAM FLOW MEASUREMENTS
(SEPTEMBER 1991)

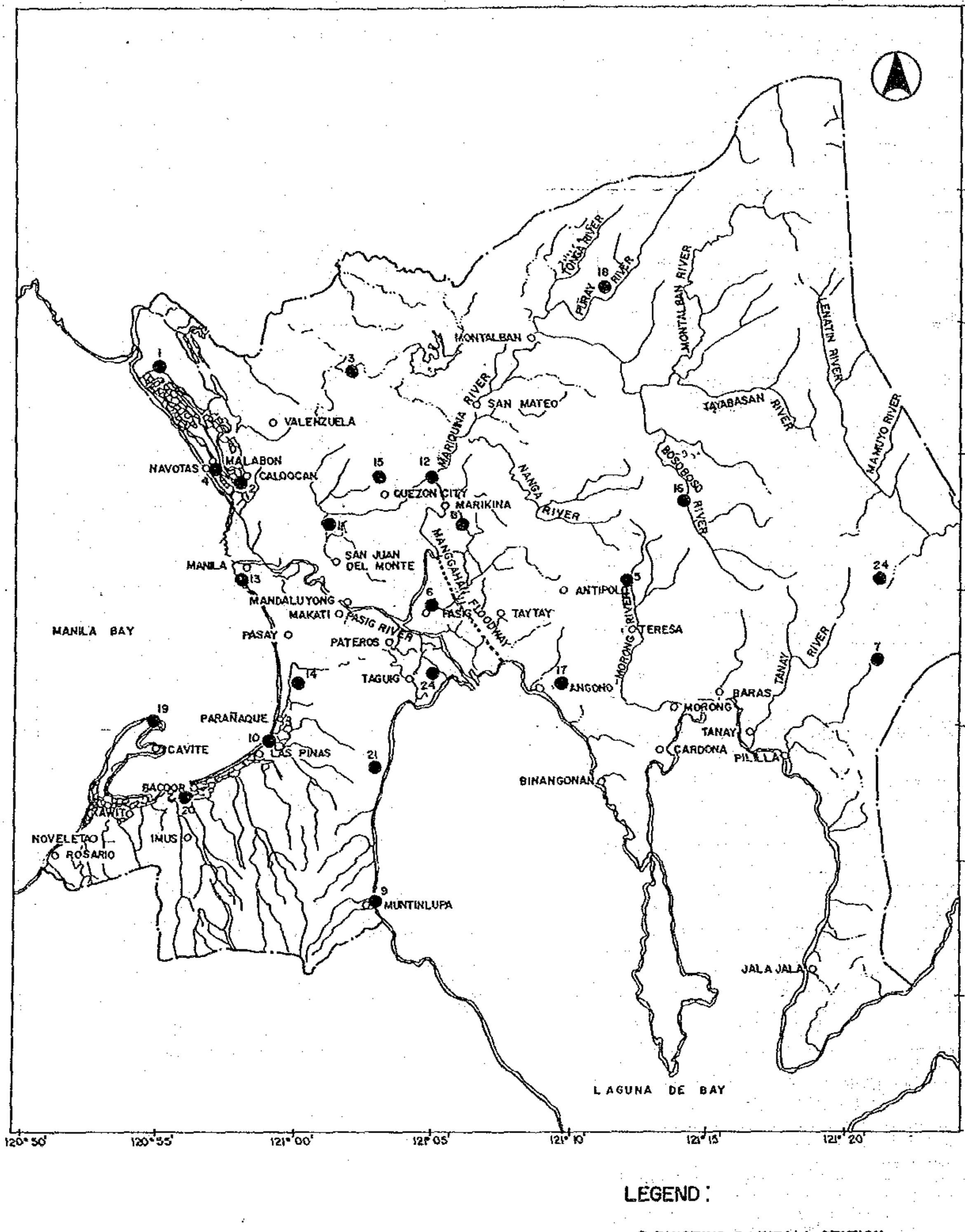
DATABASE NUMBER	LOCATION	DRAINAGE AREA (km^2)	DATE OF MEASUREMENT	DISCHARGE (LPS)
H0013	MARCOS HI-WAY (AFTER JUNCTION) (NANGKA RIVER) COGEO, ANTIPOLO, RIZAL	2.791	10-Sep-91	410.50
H0014	MARCOS HI-WAY (BEFORE JUNCTION) (NANGKA RIVER) COGEO, ANTIPOLO, RIZAL	0.970	10-Sep-91	68.22
H0015	COGEO, ANTIPOLO, RIZAL (NANGKA RIVER)	1.821	10-Sep-91	84.76
H0016	TAKTAK ROAD, ANTIPOLO, RIZAL (SAPANG BAHO RIVER)	0.541	10-Sep-91	60.22
H0017	TAKTAK ROAD, ANTIPOLO, RIZAL (SAPANG BAHO RIVER)	7.012	10-Sep-91	524.60
H0018	BILIBIRAN, BINANGONAN, RIZAL (LAGUNA DE BAY)	2.626	13-Sep-91	69.71
H0019	CONCRETE AGGREGATES, ANGONO, RIZAL (ANGONO RIVER)	4.093	13-Sep-91	503.64
H0020	CONCRETE AGGREGATES, ANGONO, RIZAL (ANGONO RIVER)	3.386	13-Sep-91	492.60
H0021	GRANDSPAN, BILIBIRAN, BINANGONAN, RIZAL (LAGUNA DE BAY)	0.030	13-Sep-91	232.96
H0022	LORESVILLE SUBDIVISION, ANTIPOLO, RIZAL (NAPINDAN CREEK)	0.480	11-Sep-91	46.72
H0023	PROVINCIAL ROAD, ANTIPOLO, RIZAL (SAPANG BAHO RIVER)	8.595	11-Sep-91	420.65
H0024	MAY-IBA, TERESA, RIZAL (MORONG RIVER)	0.937	12-Sep-91	106.34
H0025	TERESA, RIZAL (MORONG RIVER)	0.464	12-Sep-91	43.40
H0026	TAGBAK, ANTIPOLO, RIZAL (MORONG RIVER)	0.400	11-Sep-91	66.07
H0027	TAGBAK, ANTIPOLO, RIZAL (MORONG RIVER)	1.896	12-Sep-91	85.49



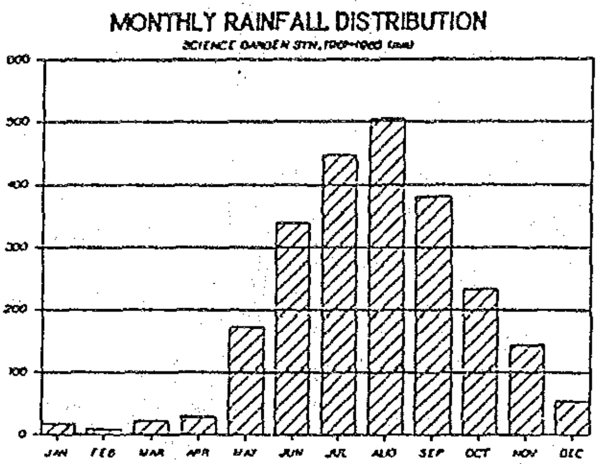
STUDY FOR THE GROUNDWATER DEVELOPMENT IN METRO MANILA

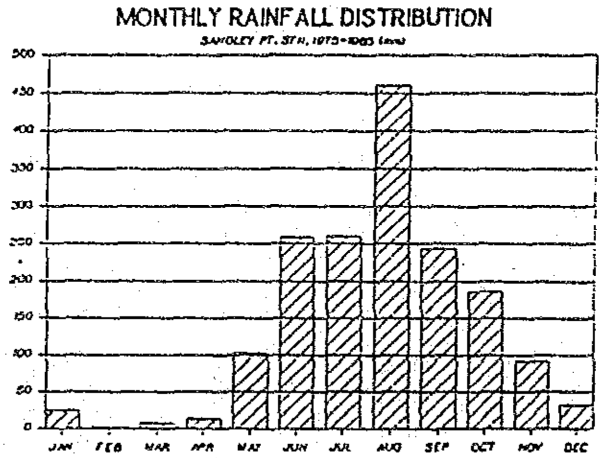
JAPAN INTERNATIONAL COOPERATION AGENCY

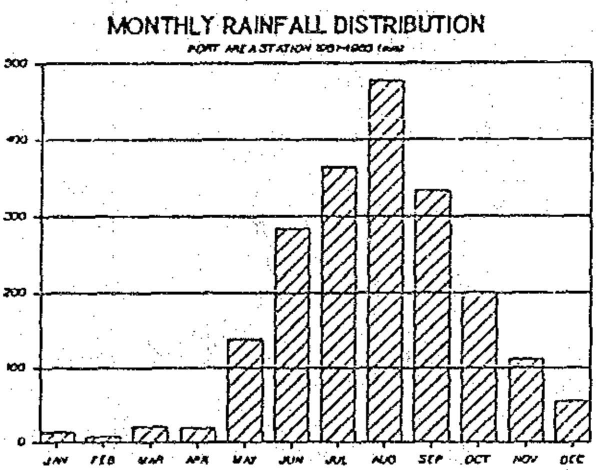
FIGURE 5.1.1 METEOROLOGICAL DATA

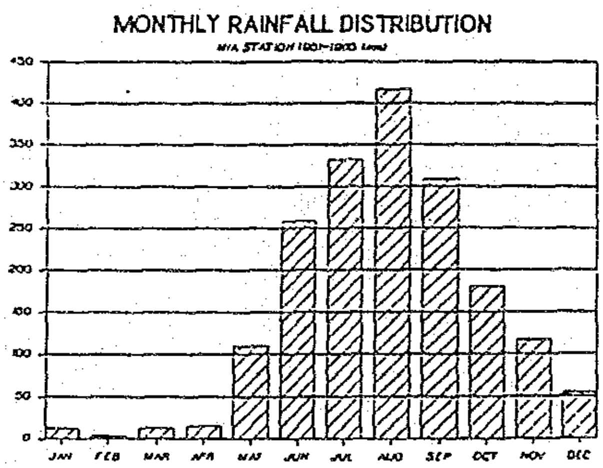


STUDY FOR THE GROUNDWATER DEVELOPMENT IN METRO MANILA	FIGURE 5.1.2 LOCATION MAP OF EXISTING RAINFALL STATIONS
JAPAN INTERNATIONAL COOPERATION AGENCY	

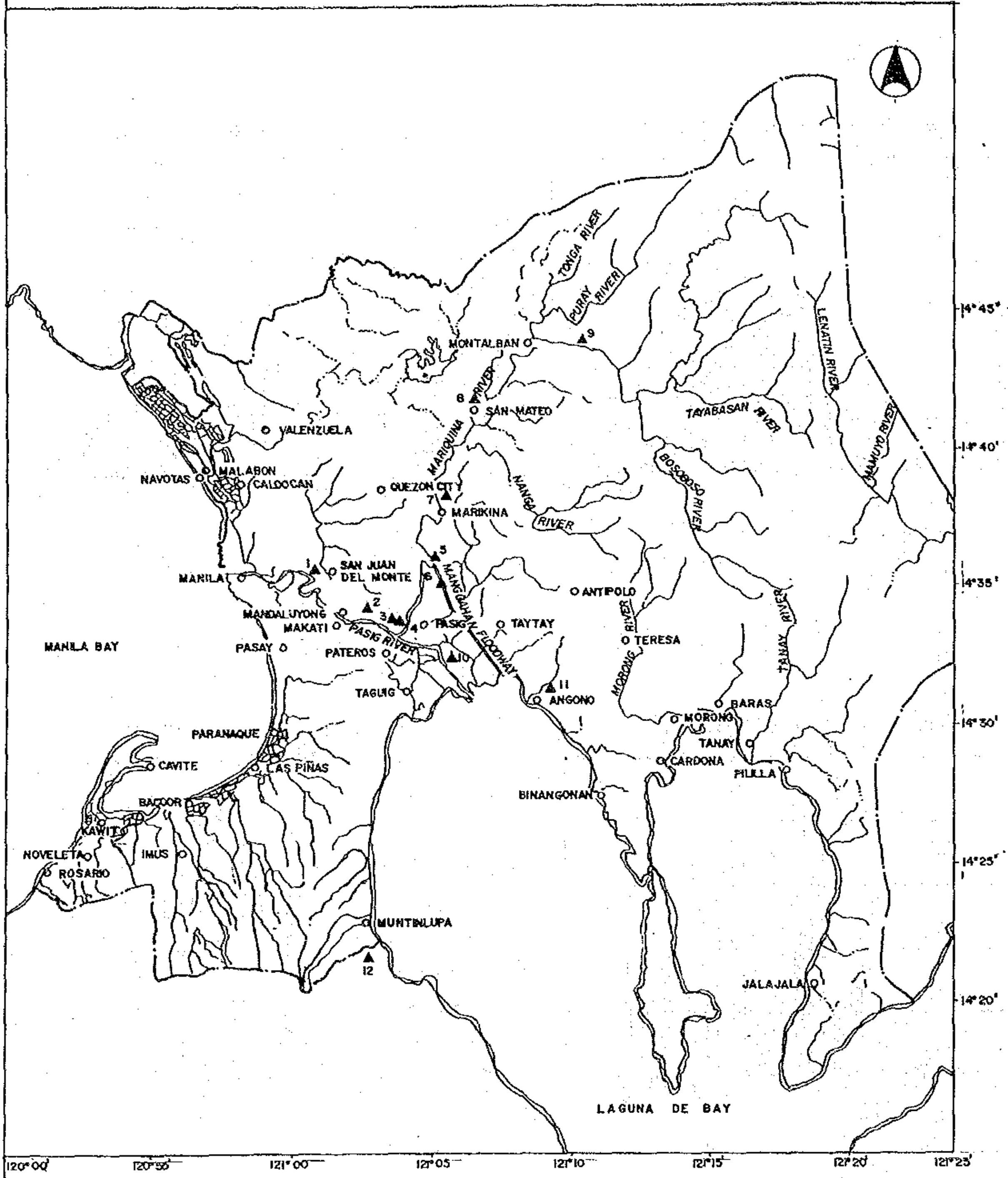








STUDY FOR THE GROUNDWATER DEVELOPMENT IN METRO MANILA	FIGURE 5.1.3
JAPAN INTERNATIONAL COOPERATION AGENCY	MONTHLY RAINFALL DISTRIBUTION

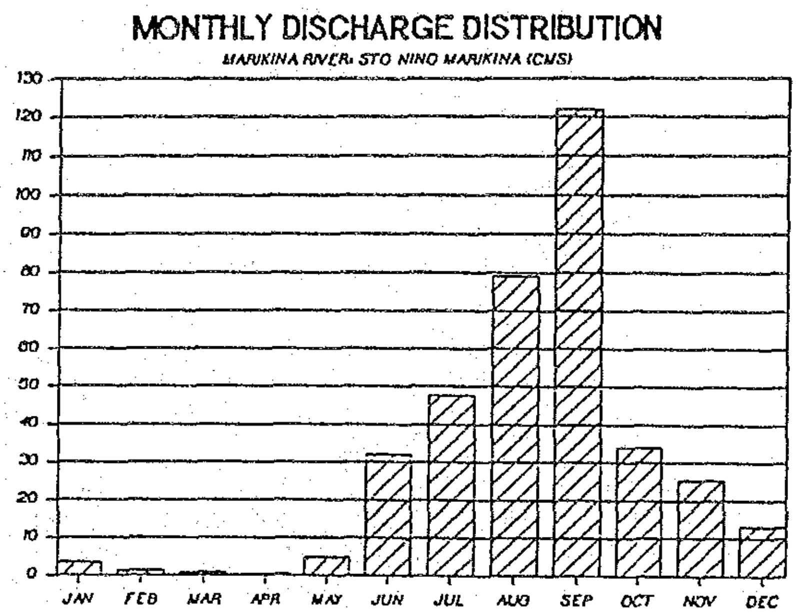


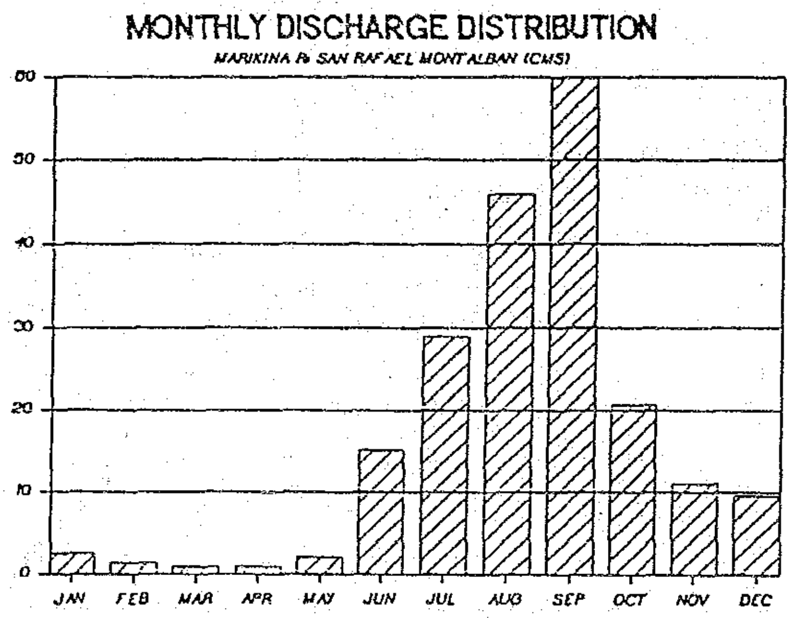
LEGEND:

▲ EXISTING STREAM-GAGING STATION

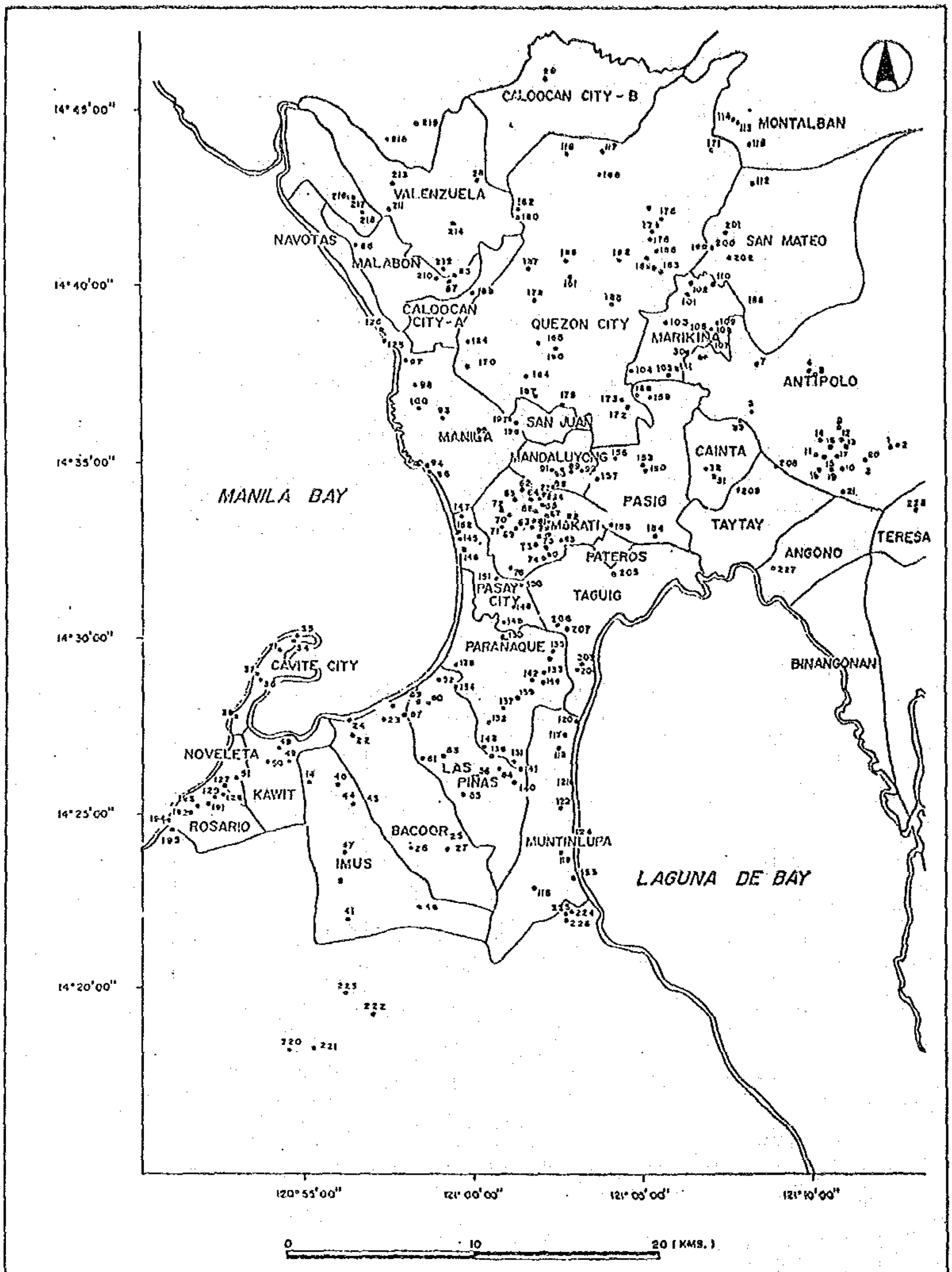
0 10 20 (Kms.)

STUDY FOR THE GROUNDWATER DEVELOPMENT IN METRO MANILA	FIGURE 5.1.4 LOCATION MAP OF STREAM GAGING STATIONS
JAPAN INTERNATIONAL COOPERATION AGENCY	

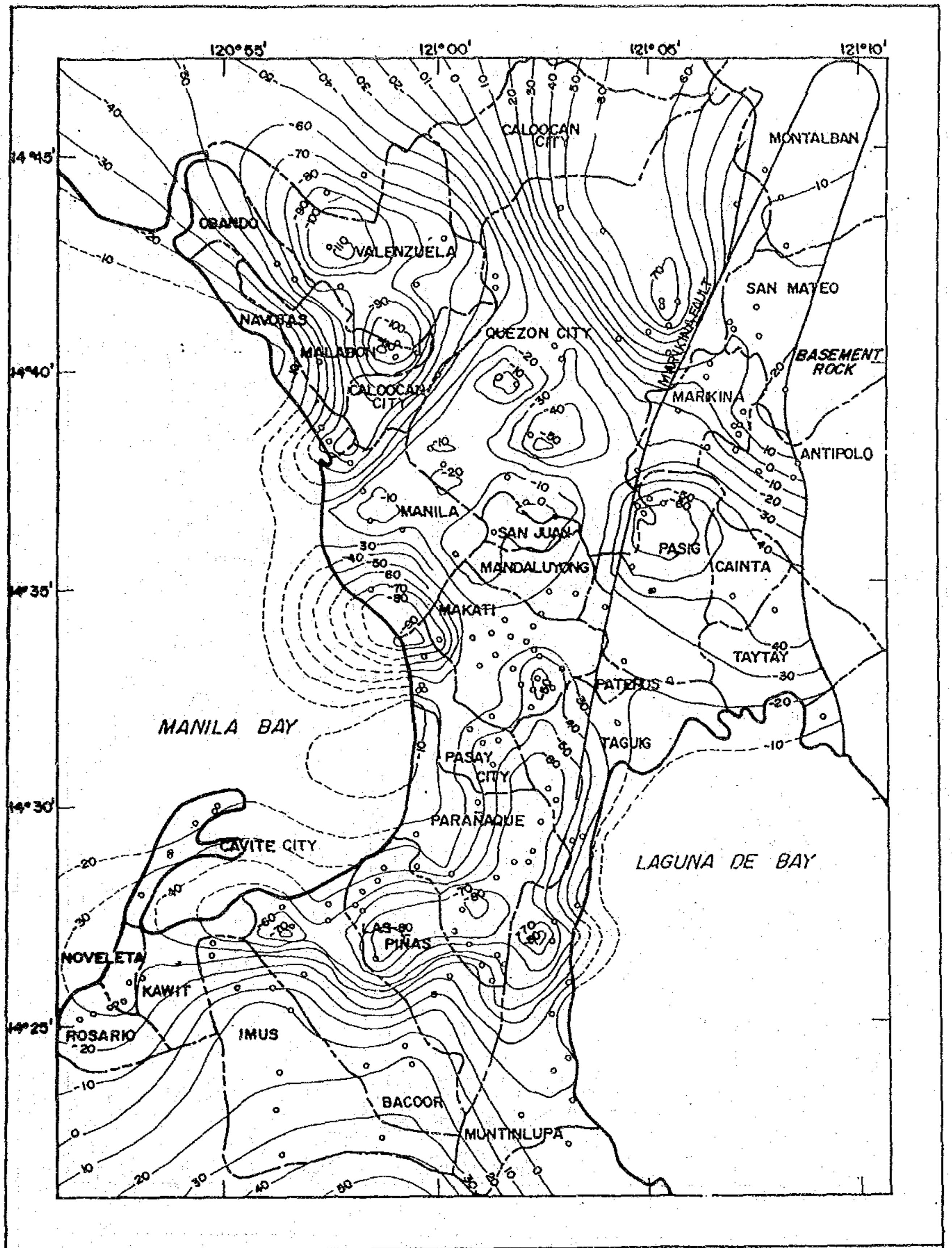




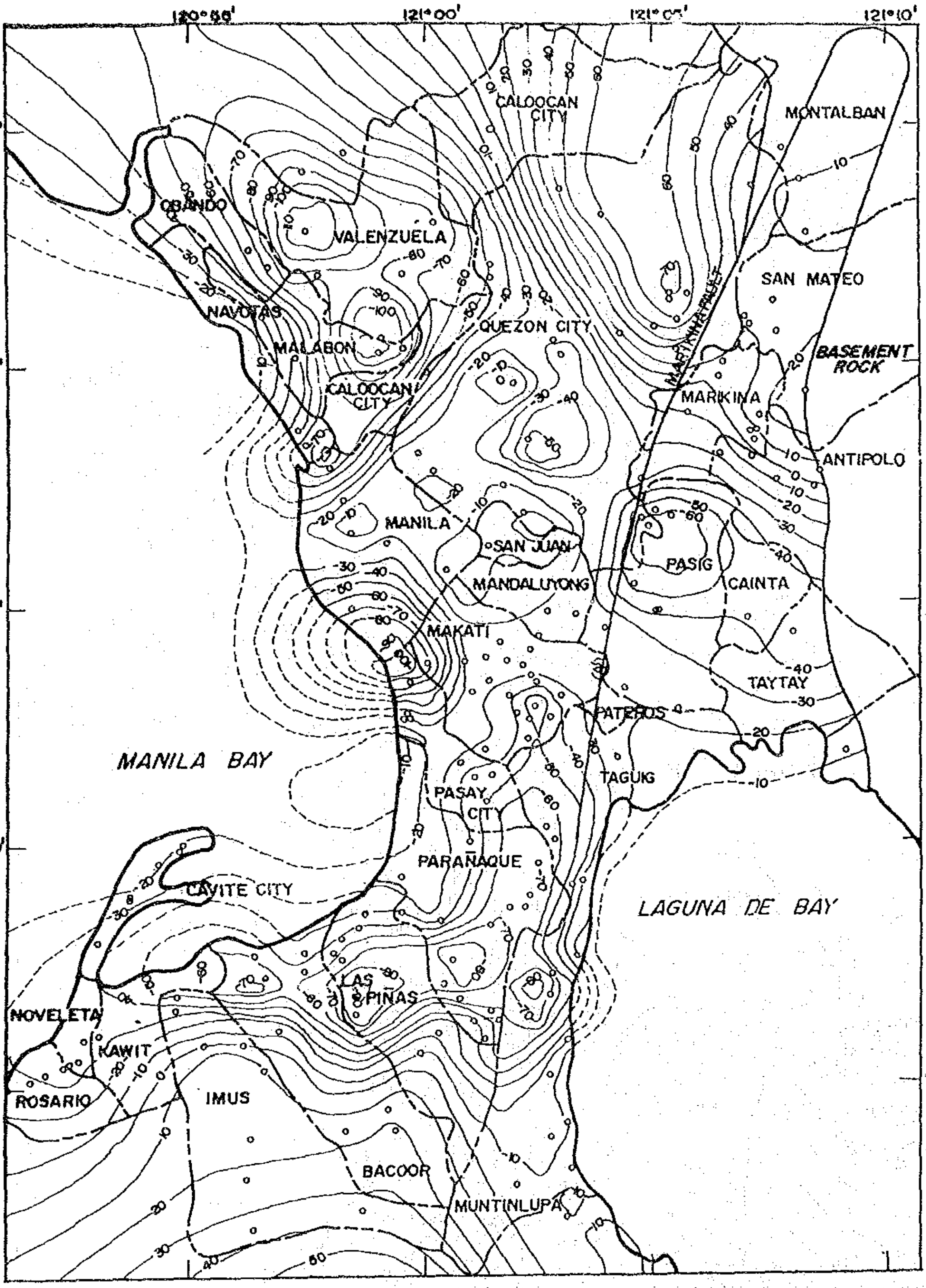
STUDY FOR THE GROUNDWATER DEVELOPMENT IN METRO MANILA	FIGURE 5.1.5 MONTHLY DISCHARGE DISTRIBUTION
JAPAN INTERNATIONAL COOPERATION AGENCY	



STUDY FOR THE GROUNDWATER DEVELOPMENT IN METRO MANILA	FIGURE 5.2.1 LOCATION MAP OF GROUNDWATER LEVEL OBSERVATION WELLS
JAPAN INTERNATIONAL COOPERATION AGENCY	



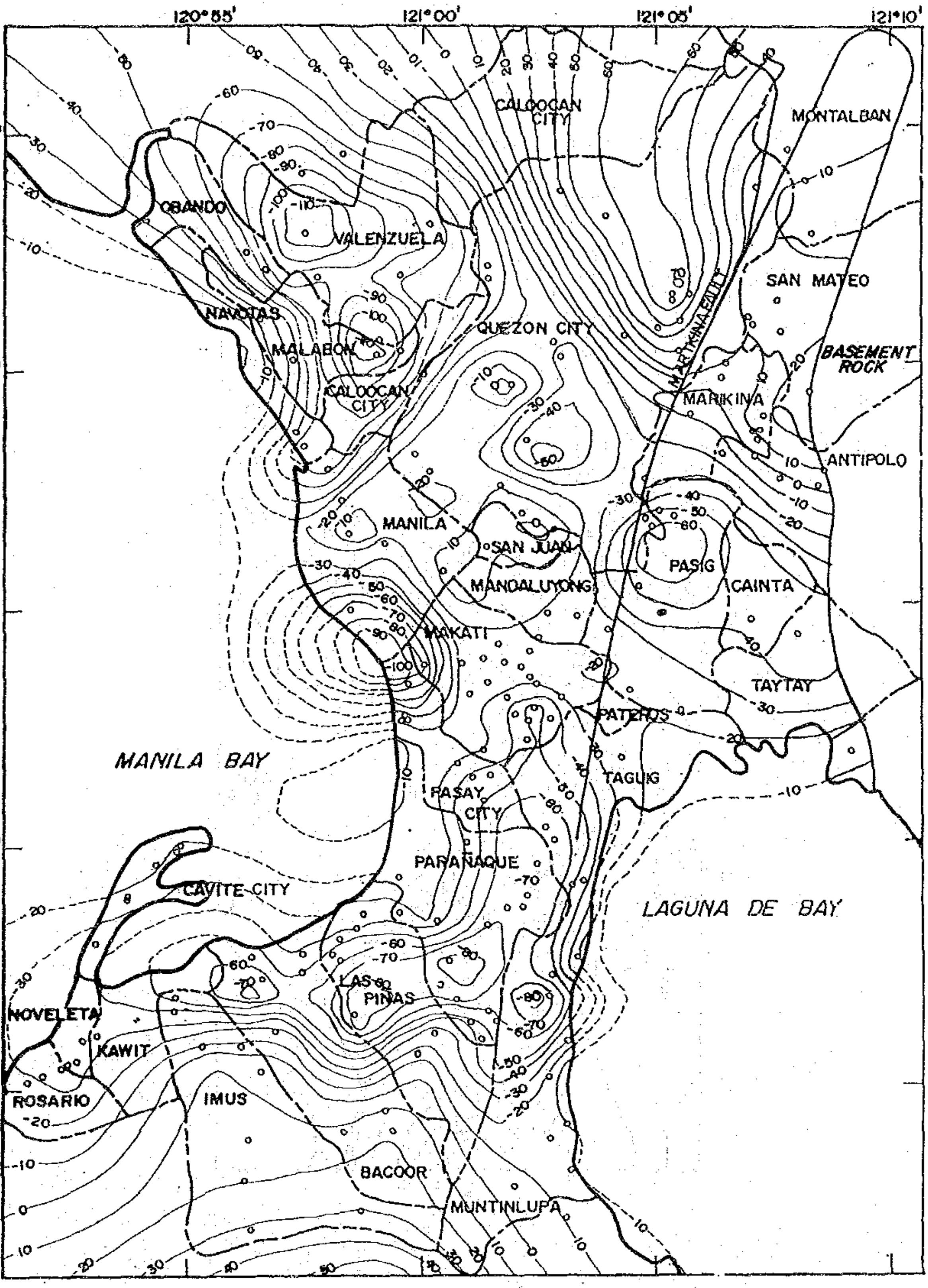
STUDY FOR THE GROUNDWATER DEVELOPMENT IN METRO MANILA	FIGURE 5.2.2
JAPAN INTERNATIONAL COOPERATION AGENCY	PIEZOMETRIC CONTOUR MAP OF THE STUDY AREA (END OF WET SEASON, NOV. 1990)



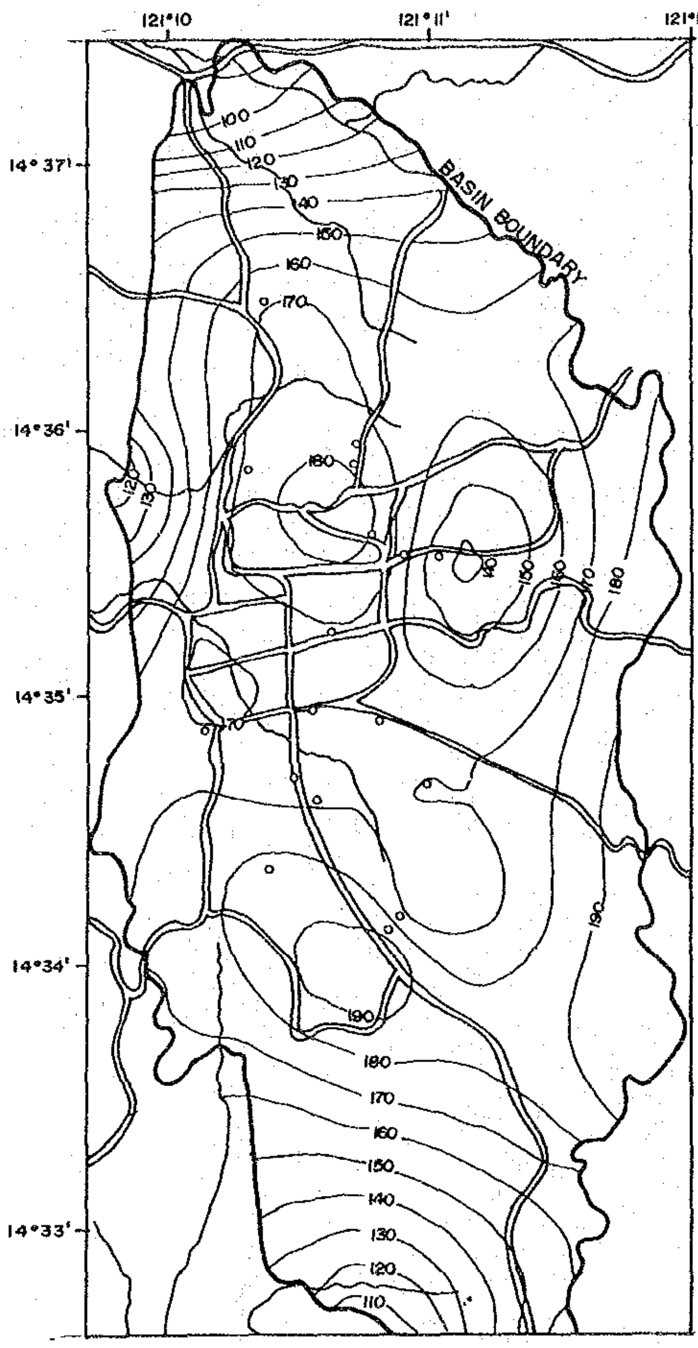
STUDY FOR THE GROUNDWATER DEVELOPMENT IN METRO MANILA

JAPAN INTERNATIONAL COOPERATION AGENCY

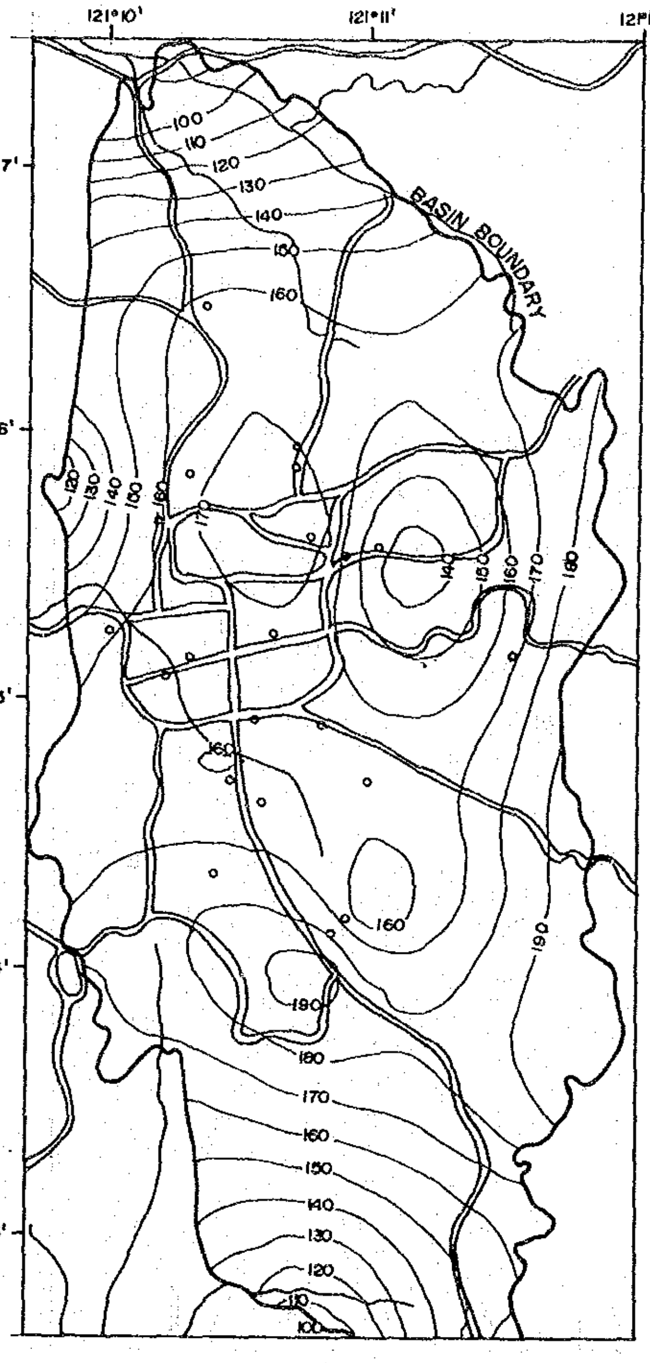
FIGURE 5.2.3
PIEZOMETRIC CONTOUR MAP OF THE STUDY AREA(WET SEASON, AUG. 1991)



STUDY FOR THE GROUNDWATER DEVELOPMENT IN METRO MANILA	FIGURE 5.2.4 PIEZOMETRIC CONTOUR MAP OF THE STUDY AREA (END OF DRY SEASON, MAY 1991)
JAPAN INTERNATIONAL COOPERATION AGENCY	



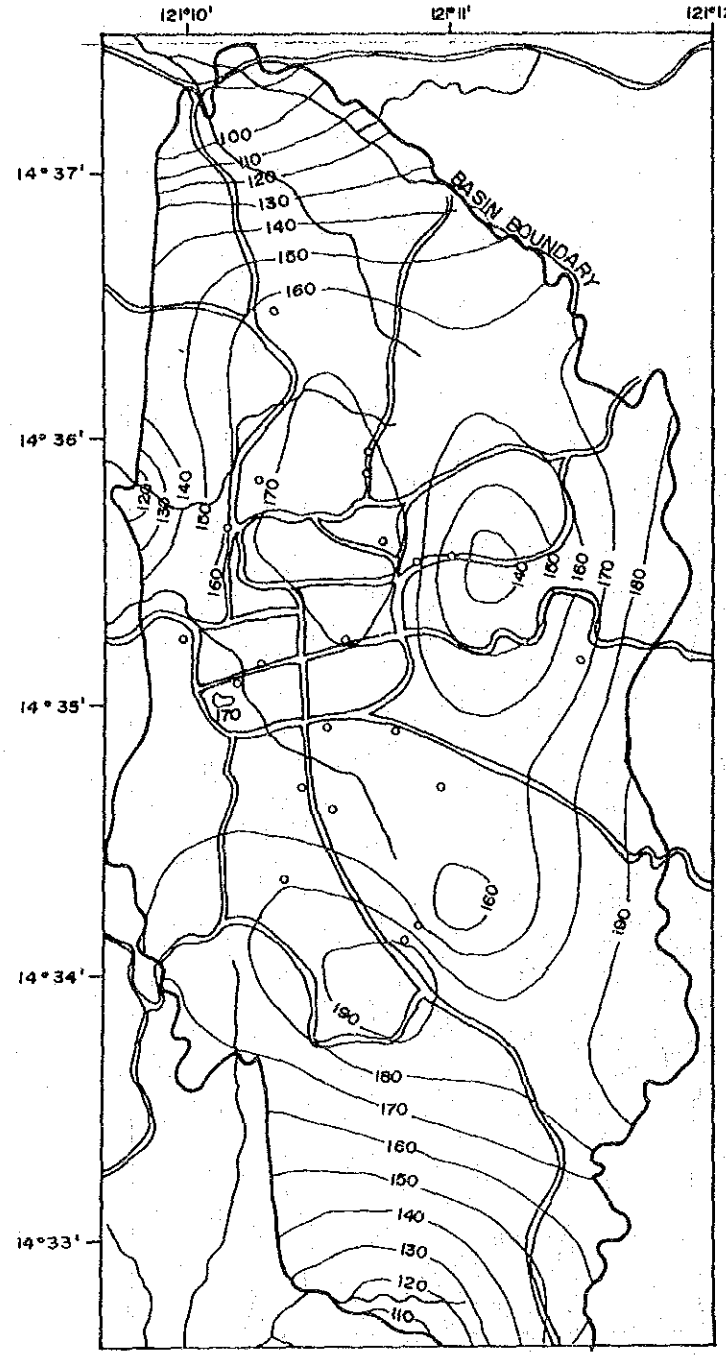
STUDY FOR THE GROUNDWATER DEVELOPMENT IN METRO MANILA	FIGURE 5.2.5 PIEZOMETRIC CONTOUR MAP OF THE ANTIPOLO AREA (END OF WET SEASON, NOV. 1990)
JAPAN INTERNATIONAL COOPERATION AGENCY	



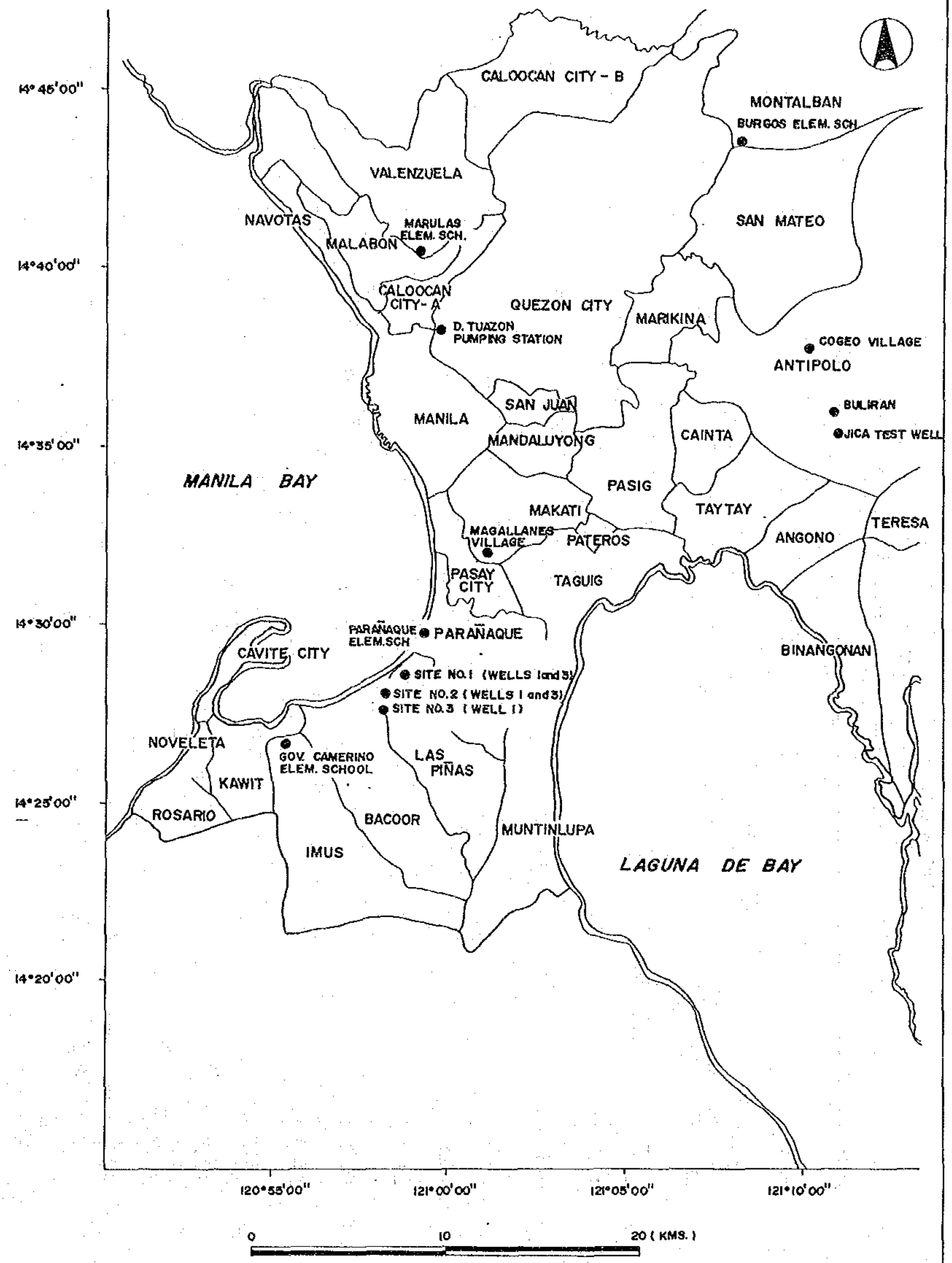
STUDY FOR THE GROUNDWATER DEVELOPMENT IN METRO MANILA

JAPAN INTERNATIONAL COOPERATION AGENCY

FIGURE 5.2.6
PIEZOMETRIC CONTOUR MAP OF THE ANTIPOLO AREA (END OF DRY SEASON, MAY 1991)



STUDY FOR THE GROUNDWATER DEVELOPMENT IN METRO MANILA	FIGURE 5.2.7
JAPAN INTERNATIONAL COOPERATION AGENCY	PIEZOMETRIC CONTOUR MAP OF THE ANTIPOLO AREA (WET SEASON, AUG. 1991)



STUDY FOR THE GROUNDWATER DEVELOPMENT IN METRO MANILA	FIGURE 5.2.8 LOCATION MAP OF INSTALLED WATER LEVEL RECORDERS
JAPAN INTERNATIONAL COOPERATION AGENCY	

FIGURE 5.2.9

WELL HYDROGRAPH
WELL NO.1, SITE NO. 1, LAS PIÑAS

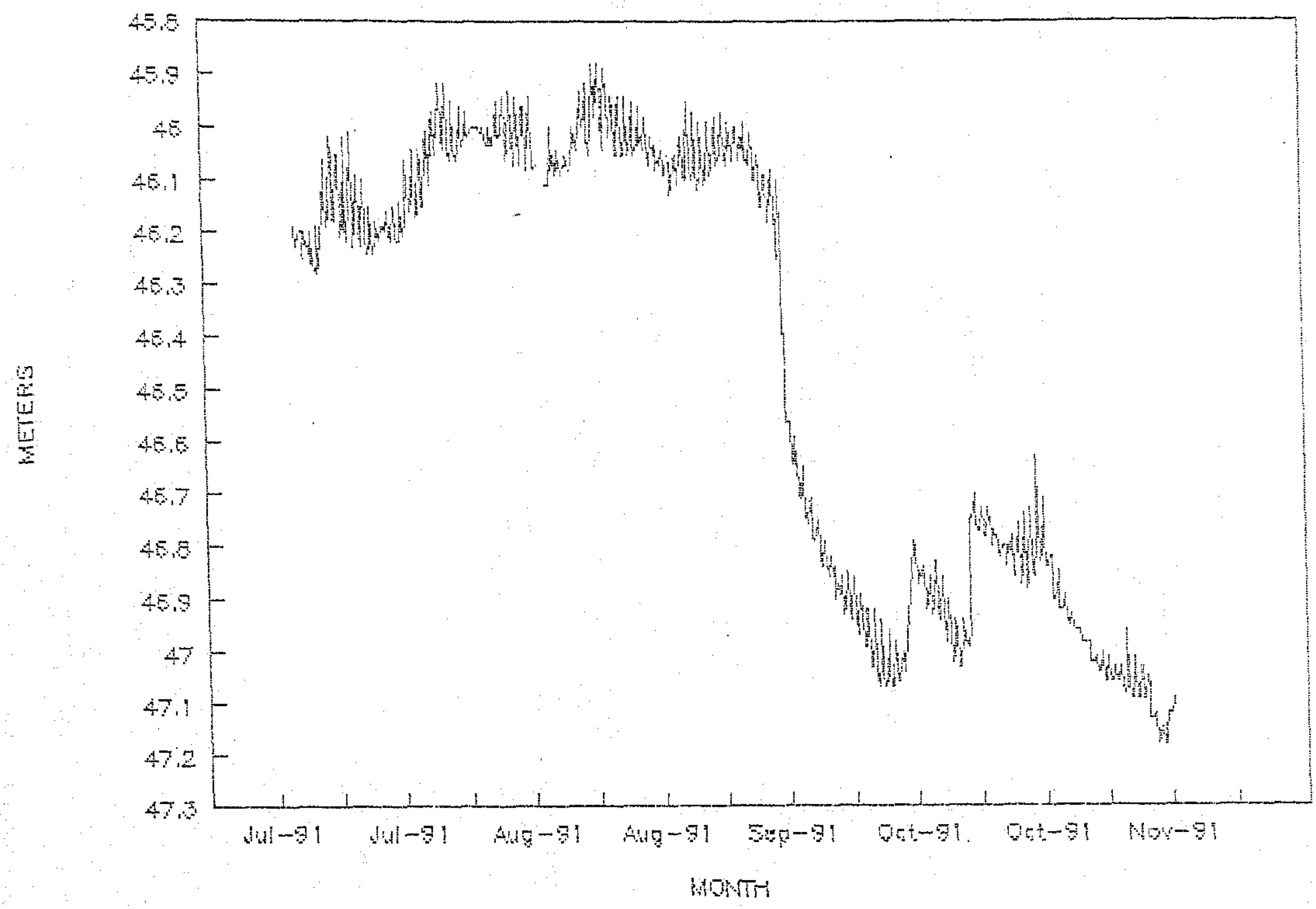


FIGURE 5.2.9 (CONTINUATION)
WELL HYDROGRAPH
WELL NO.3, SITE NO. 1, LAS PIÑAS

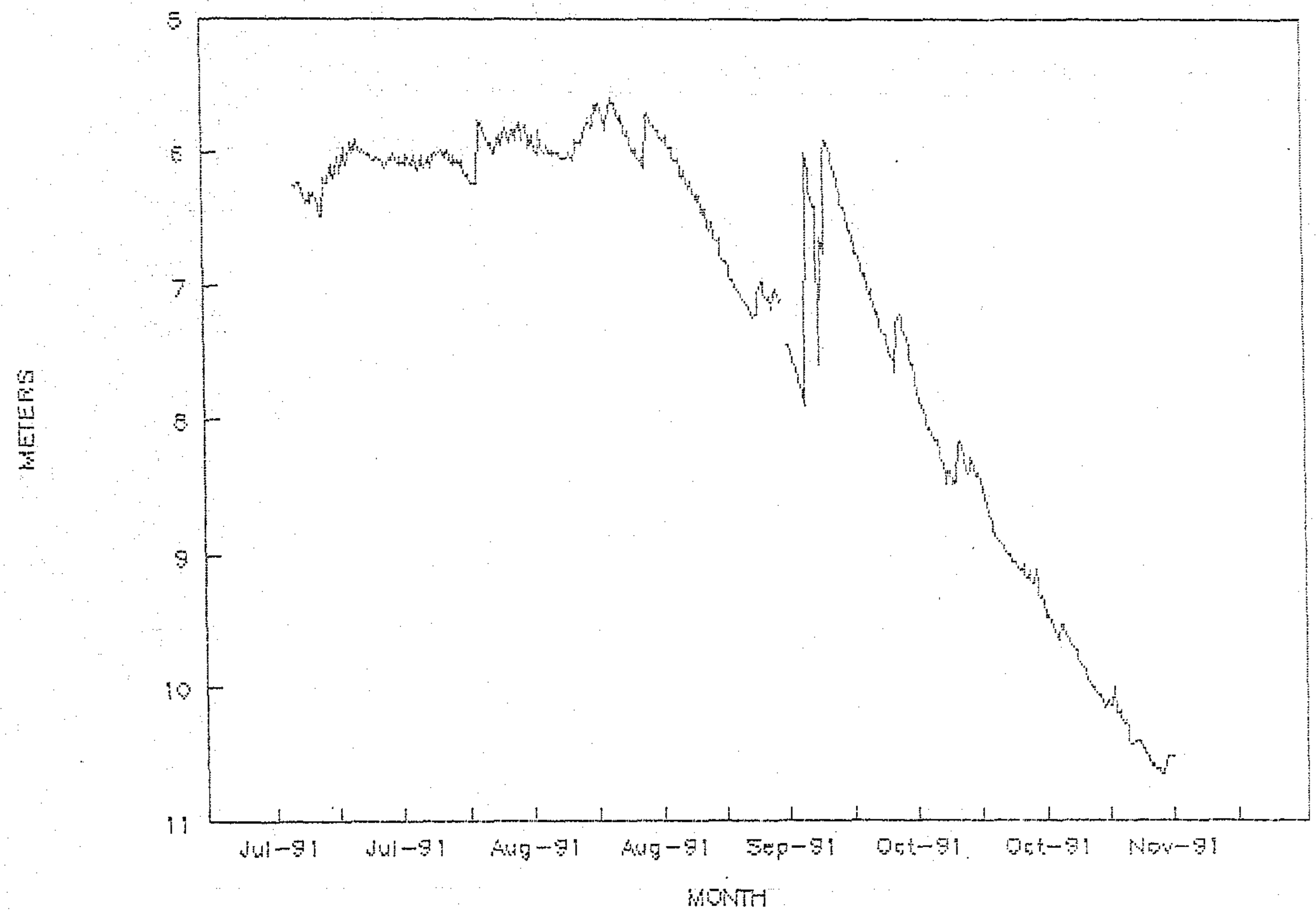


FIGURE 5.2.9 (CONTINUATION)
WELL HYDROGRAPH
WELL NO.1, SITE NO. 2, LAS PIÑAS

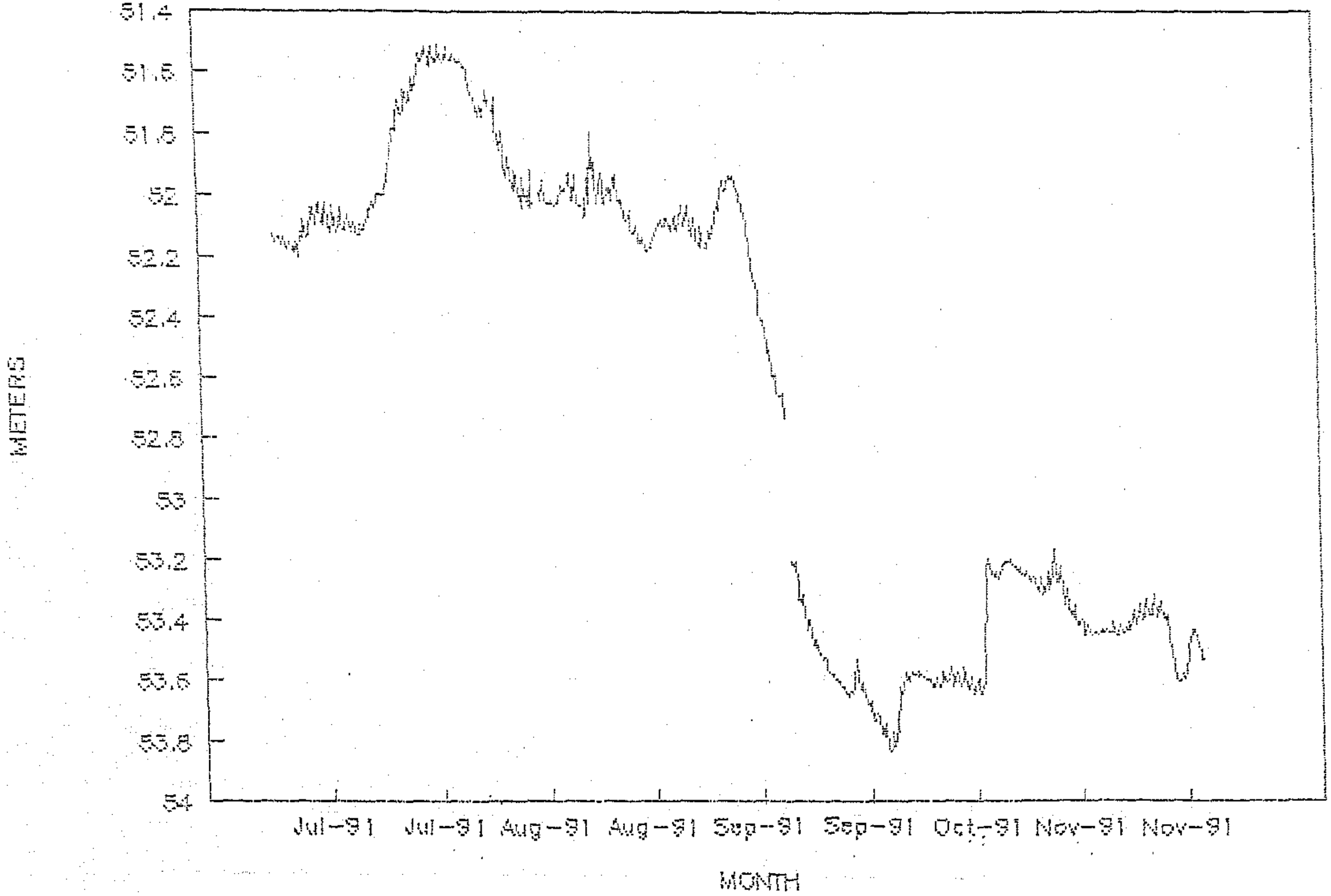


FIGURE 5.2.9 (CONTINUATION)
WELL HYDROGRAPH
WELL NO.3, SITE NO. 2, LAS PIÑAS

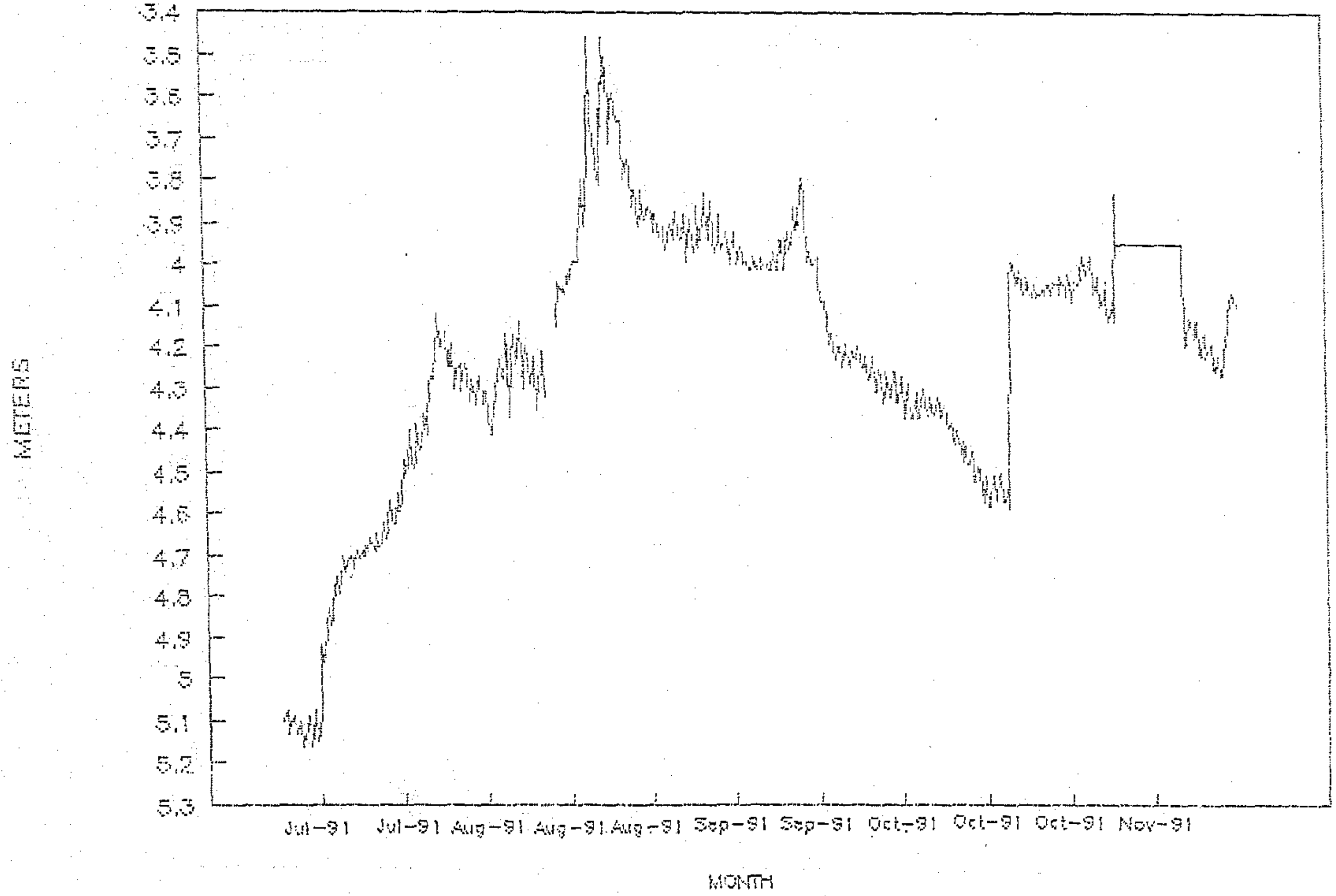


FIGURE 5.2.9 (CONTINUATION)
WELL HYDROGRAPH
WELL NO.1, SITE NO. 3, LAS PIÑAS

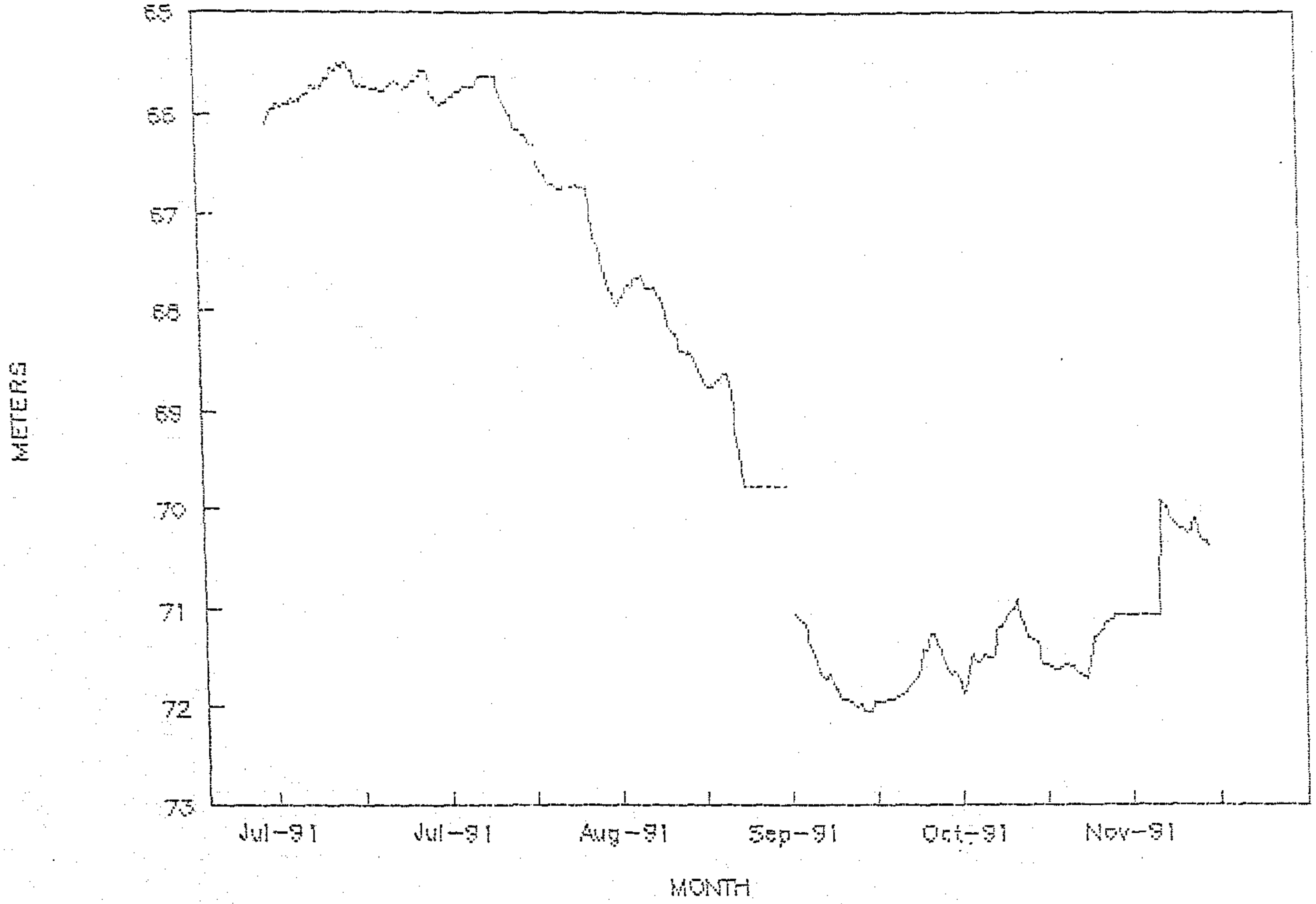


FIGURE 5.2.9 (CONTINUATION)
WELL HYDROGRAPH
MARULAS ELEM. SCHOOL, VALENZUELA

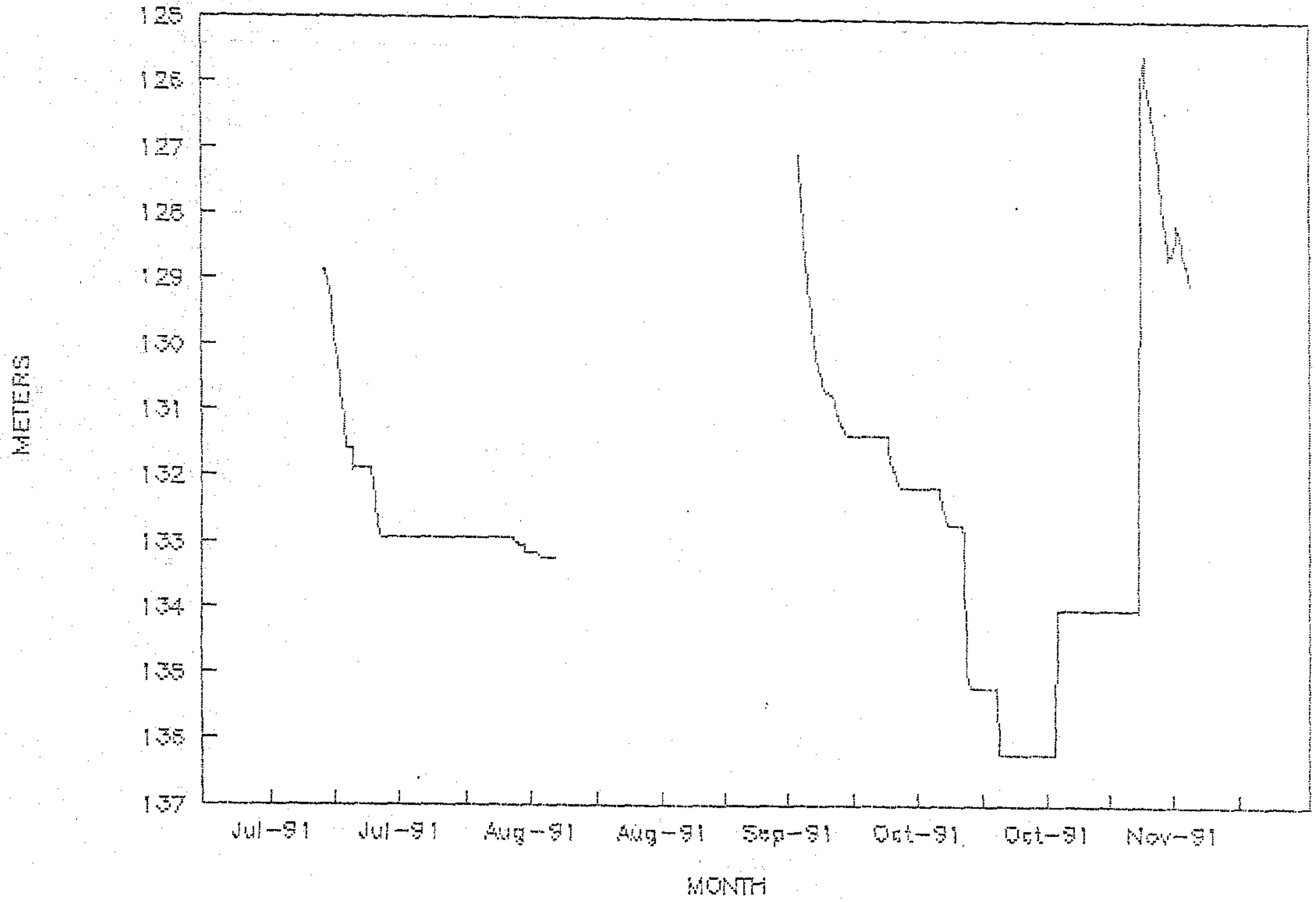


FIGURE 5.2.9 (CONTINUATION)
WELL HYDROGRAPH
TUAZON

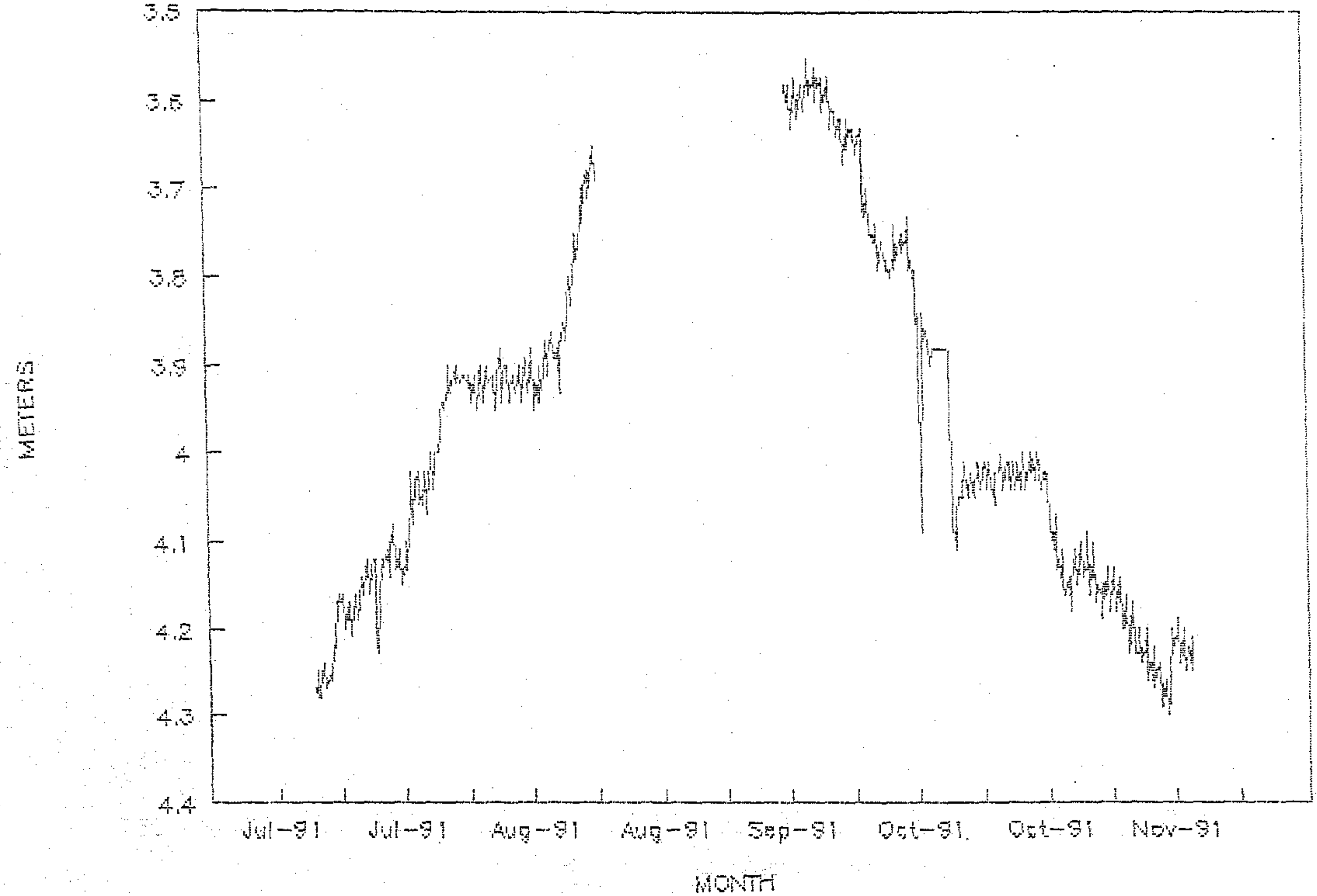


FIGURE 5.2.9 (CONTINUATION)
WELL HYDROGRAPH
MAGALLANES VILLAGE

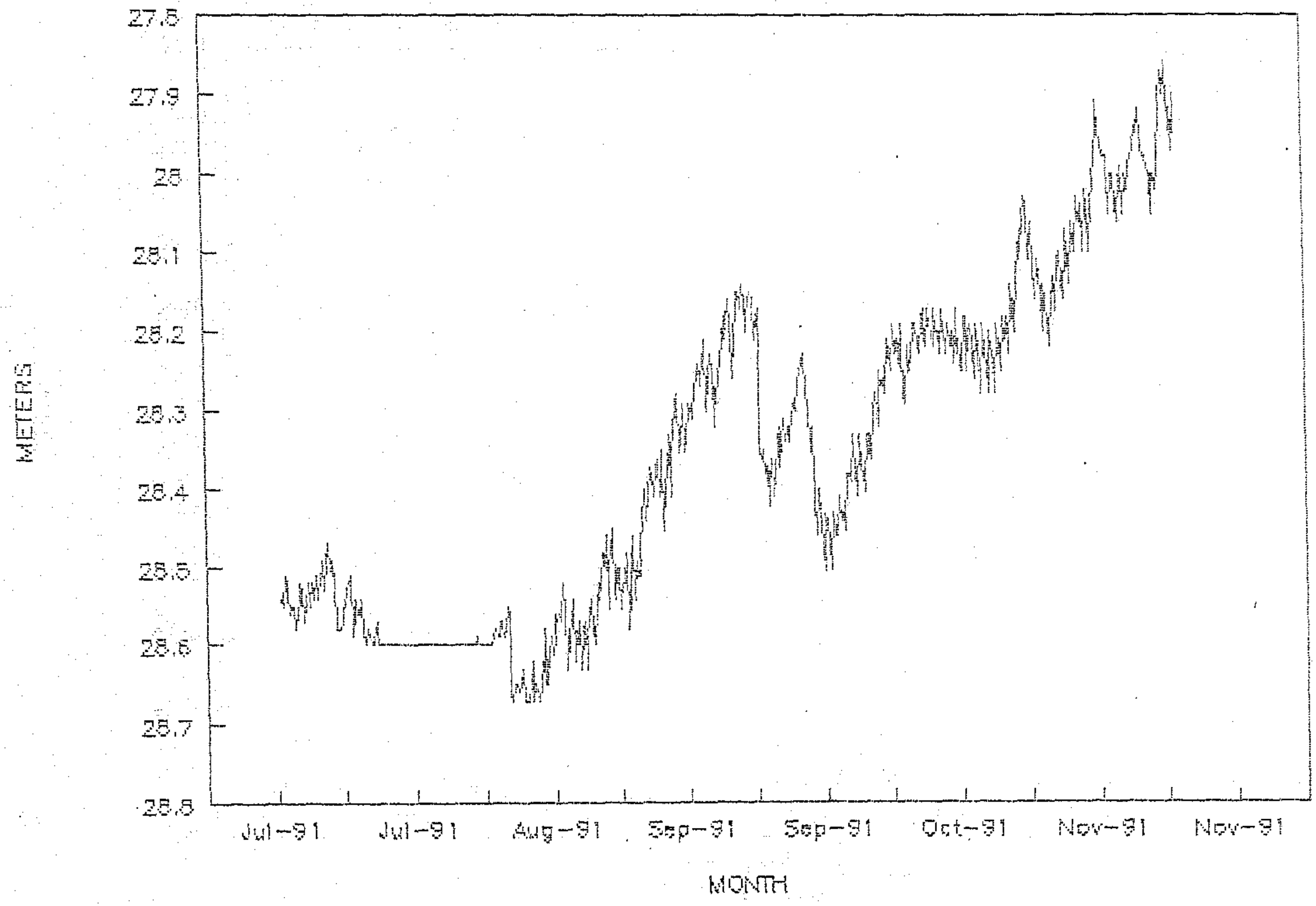


FIGURE 5.2.9 (CONTINUATION)
WELL HYDROGRAPH
WELL NO.2, ANTIPOLO

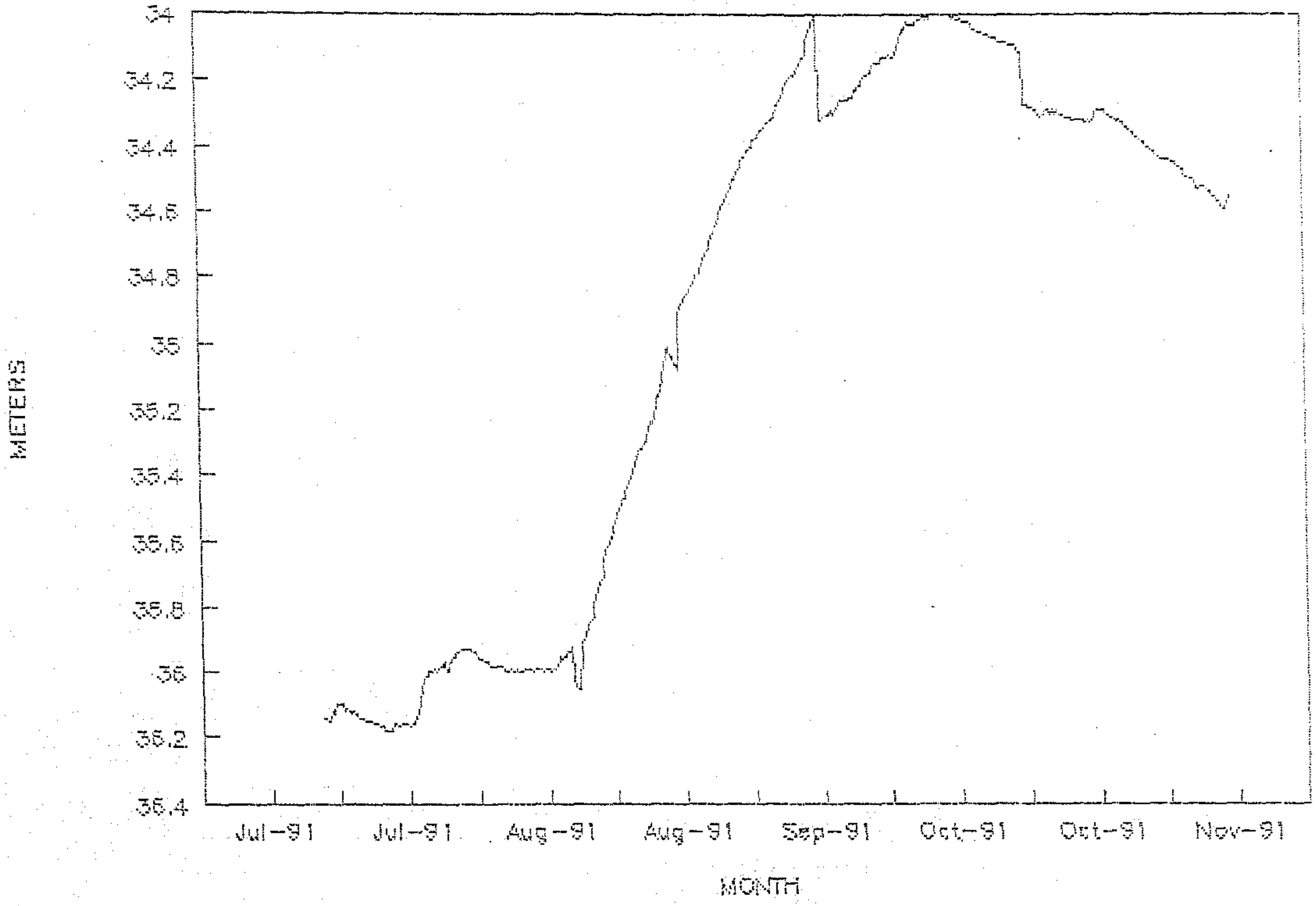
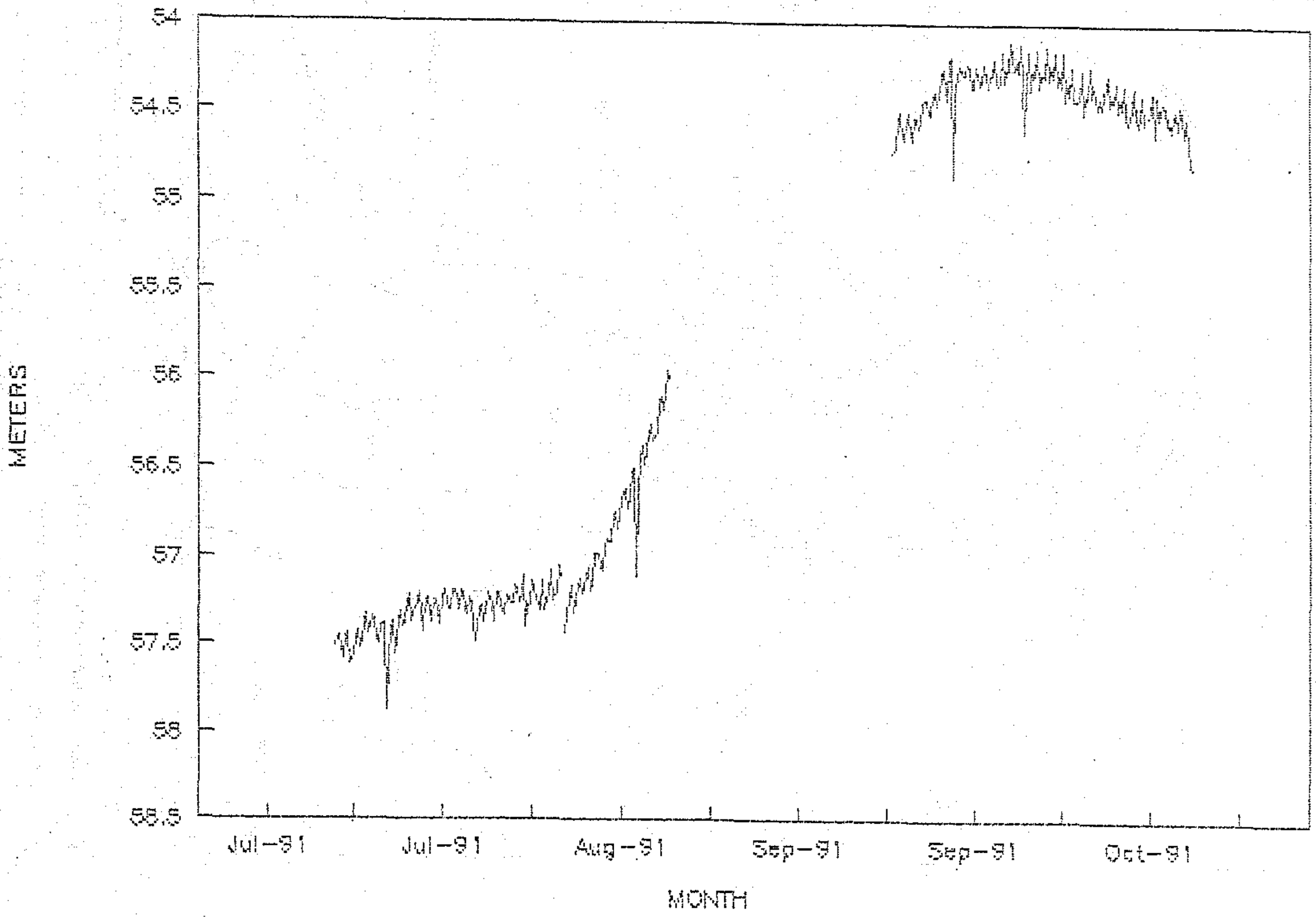
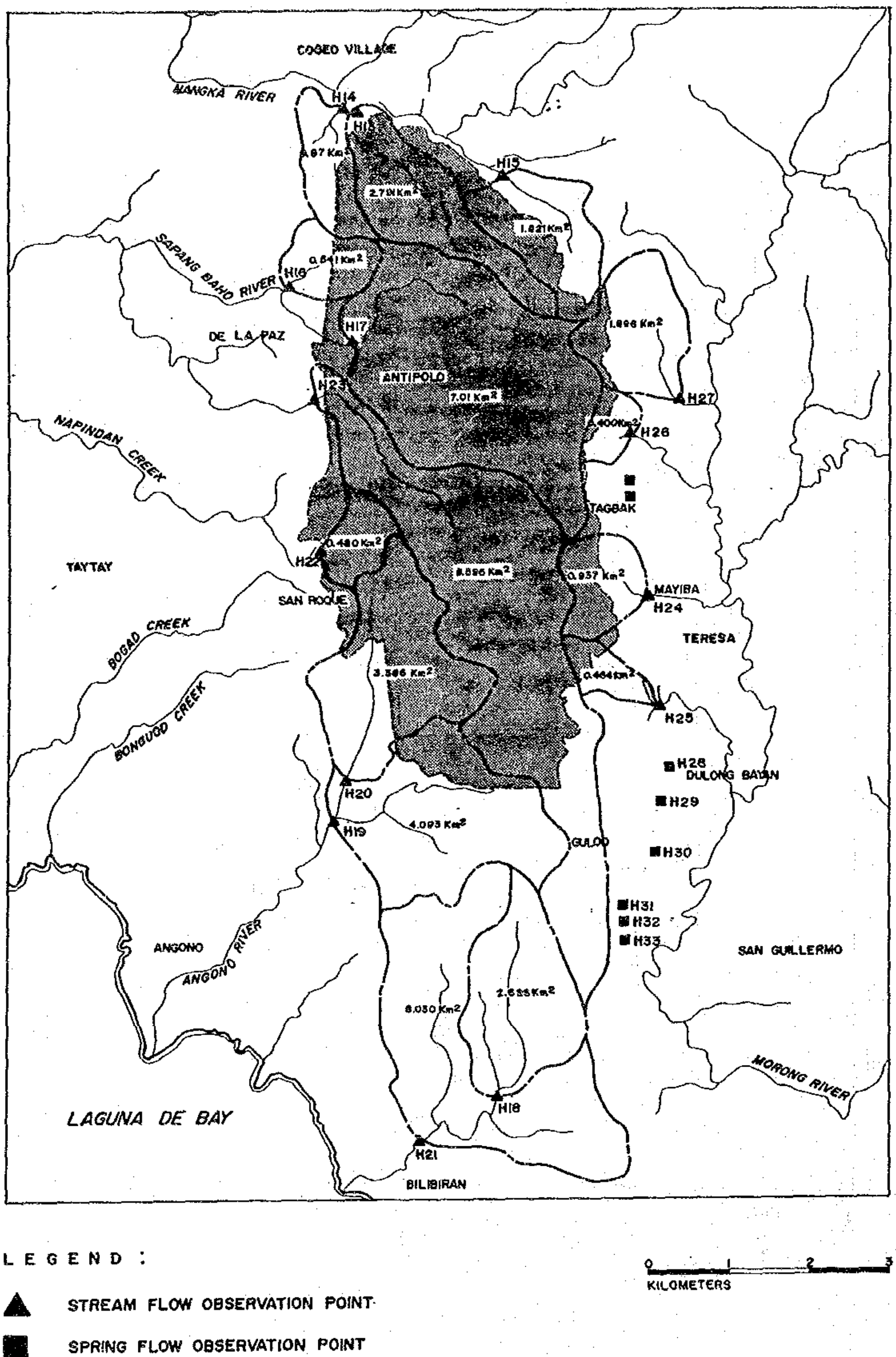


FIGURE 5.2.9 (CONTINUATION)
WELL HYDROGRAPH
BULIRAN ROAD, ANTIPOLO





STUDY FOR THE GROUNDWATER DEVELOPMENT IN METRO MANILA	FIGURE 5.2.10
JAPAN INTERNATIONAL COOPERATION AGENCY	LOCATION MAP OF SPRING & STREAM FLOW MEASUREMENTS