5.7 EXAMINATION OF FUTURE GROUNDWATER USE AND GROUNDWATER LEVEL FLUCTUATION

5.7.1 Future Pumping Schemes

The future piezometric levels could be predicted by using the calibrated simulation model. Based on the water demand projections in year–2005 as shown in **Table 9.2–7** and the year–1993 pumpage estimates as presented in **Table 4.2–7**, three (3) future pumping schemes were prepared as input to the model. A 12–year prediction period from year–1994 to year–2005 was considered.

Using the PGDB database, the year–1993–pumpage database files were prepared by *x* and *y* coordinates, by type of users, and by municipalities. In preparing the schemes, it was assumed that the present well locations by grid will not change in the future.

(1) **Scheme 1**

Table 5.7–1 gives the 12–year (1994–2005) pumpage estimates in the Study Area by municipality and by type of use. The pumpage increases 225% from 28.428 MCM in year–1993 to 63.912 MCM in year–2005. The municipality with the highest increase in domestic, institutional and industrial uses is Dasmarinas with 280%, 458% and 246%, respectively. Dasmarinas (229%) also is second to Tagaytay (235%) in the commercial use of groundwater. No increase in pumpage for agricultural use is assumed from its 1993 level. **Fig. 5.7–1** shows the distribution of groundwater pumpage in the Study Area in year–2005 in scheme 1.

(2) **Scheme 2**

This scheme 2 is the same as scheme 1 for the domestic, institutional, and commercial uses, but it assumes that there is no more increase in industrial use from year–1996 to year–2005, with the industrial pumpage remaining constant at year–1995 level. **Fig. 5.7–2** shows the distribution of groundwater pumpage in the Study Area in year–2005 in scheme 2.

(3) **Scheme 3**

This scheme is the same as scheme 1 for the domestic, institutional, and commercial uses of groundwater, but it assumes that the increases in industrial pumpage after 1995 are moved to Trece Martirez, in the industrial zone along the Carmona–Trece Martirez–Naic Road. The yearly increases in industrial pumpage were considered spatial and not temporal. **Fig. 5.7–3** shows the distribution of groundwater pumpage in the Study Area in year–2005 in scheme 3. Row 20, columns 4–10 and column 7, rows 17–20 show the spatial distribution of the annual increase in industrial pumpage.

5.7.2 Evaluation of Model Response

The three (3) future pumping schemes were input to the 3–D model. The 3–D model covering the entire San Juan River Basin approximates the natural conditions of the aquifer system such as the

TABLE 5.7-1 PROJECTED GROUNDWATER PUMPAGE IN THE STUDY AREA (1994-2005)

COMMERCIAL

municipality	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
das	100	130	160	190	219	249	279	309	339	369	398	428	458
ind	23	26	30	33	36	39	43	46	49	52	56	59	62
gen	40	47	54	62	69	76	83	90	97	105	112	119	126
men	10	11	13	14	15	16	18	19	20	21	23	24	25
sil	57	66	75	84	93	102	111	119	128	137	146	155	164
tan	38	44	51	57	63	70	76	82	89	95	101	108	114
tag	15	18	20	23	25	28	30	33	36	38	41	43	46
ama	12	14	16	18	19	21	23	25	27	28	30	32	34
mag	7	8	9	10	11	12	14	15	16	17	18	19	20
mar	13	15	17	19	21	23	25	26	28	30	32	34	36
ter	7	8	9	10	11	12	13	13	14	15	16	17	18
alf	17	20	22	25	27	30	33	35	38	40	43	45	48
nai	31	36	41	46	50	55	60	65	70	75	79	84	89
agu	6	7	8	8	9	10	11	11	12	13	14	14	15
car	17	20	24	27	30	33	37	40	43	46	50	53	56
tre	10	12	15	17	19	21	24	26	28	30	33	35	37
tri	32	37	42	46	51	56	61	65	70	75	80	84	89
total	435	519	602	686	769	853	936	1,020	1,103	1,187	1,270	1,354	1,437

INDUSTRIAL

municipality	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
das	2,556	2,868	3,179	3,491	3,802	4,114	4,425	4,737	5,048	5,360	5,671	5,983	6,294
ind													
gen	1,499	1,511	1,523	1,535	1,546	1,558	1,570	1,582	1,594	1,605	1,617	1,629	1,641
men													
sil	181	181	182	182	183	183	183	184	184	185	185	186	186
tan	271	271	271	271	271	271	271	271	271	271	271	271	271
tag	113	113	113	113	113	113	113	113	113	113	113	113	113
ama													
mag	34	34	34	34	34	34	34	34	34	34	34	34	34
mar													
ter													
alf	118	118	118	118	118	118	118	118	118	118	118	118	118
nai	16	16	16	16	16	16	16	16	16	16	16	16	16
agu													
car	794	847	899	952	1,005	1,057	1,110	1,163	1,215	1,268	1,321	1,373	1,426
tre	881	881	881	881	881	881	881	881	881	881	881	881	881
tri	530	1,035	1,540	2,044	2,549	3,054	3,559	4,063	4,568	5,073	5,578	6,082	6,587
total	6,993	7,874	8,755	9,637	10,518	11,399	12,280	13,161	14,042	14,924	15,805	16,686	17,567
GRAND TOTAL	28,426	31,384	34,342	37,299	40,257	43,215	46,173	49,130	52,088	55,046	58,004	60,961	63,919

TABLE 5.7-1 PROJECTED GROUNDWATER PUMPAGE IN THE STUDY AREA (1994-2005)

DOMESTIC

municipality	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
das	6,142	7,065	7,988	8,911	9,834	10,757	11,681	12,604	13,527	14,450	15,373	16,296	17,219
ind	1,038	1,098	1,158	1,218	1,278	1,338	1,398	1,459	1,519	1,579	1,639	1,699	1,759
gen	1,921	2,110	2,299	2,489	2,678	2,867	3,056	3,245	3,434	3,623	3,813	4,002	4,191
men	465	492	519	545	572	599	626	652	679	706	733	759	786
sil	2,530	2,673	2,816	2,959	3,102	3,245	3,389	3,532	3,675	3,818	3,961	4,104	4,247
tan	711	833	955	1,077	1,199	1,321	1,443	1,564	1,686	1,808	1,930	2,052	2,174
tag	911	979	1,046	1,114	1,181	1,249	1,316	1,384	1,451	1,519	1,586	1,654	1,721
ama	509	534	559	585	610	635	660	685	710	735	761	786	811
mag	212	225	239	252	266	279	293	306	319	333	346	360	373
mar	461	488	516	543	570	598	625	652	680	707	734	762	789
ter	132	135	138	142	145	148	151	154	157	160	164	167	170
alf	853	902	951	1,000	1,049	1,098	1,147	1,195	1,244	1,293	1,342	1,391	1,440
nai	669	760	852	943	1,035	1,126	1,218	1,309	1,400	1,492	1,583	1,675	1,766
agu	231	239	247	255	263	271	280	288	296	304	312	320	328
car	329	346	362	379	396	412	429	446	462	479	496	512	529
tre	348	391	434	478	521	564	607	650	693	737	780	823	866
tri	625	647	670	692	715	737	759	782	804	827	849	872	894
total	18,087	19,918	21,750	23,581	25,412	27,244	29,075	30,906	32,738	34,569	36,400	38,232	40,063

INSTITUTIONAL

municipality	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
das	666	738	809	881	953	1,024	1,096	1,168	1,239	1,311	1,383	1,454	1,526
ind	154	158	163	167	171	175	180	184	188	192	197	201	205
gen	269	282	294	307	319	332	344	357	369	382	394	407	419
men	68	69	70	72	73	74	75	76	77	79	80	81	82
sil	380	394	408	421	435	449	463	476	490	504	518	531	545
tan	250	261	272	282	293	304	315	325	336	347	358	368	379
tag	97	108	119	130	141	152	163	173	184	195	206	217	228
ama	83	86	88	91	93	96	98	101	103	106	108	111	113
mag	50	52	53	55	56	58	59	61	62	64	65	67	68
mar	89	92	94	97	99	102	104	107	109	112	114	117	119
ter	47	48	49	50	51	52	54	55	56	57	58	59	60
alf	115	119	123	126	130	134	138	141	145	149	153	156	160
nai	206	213	221	228	236	243	250	258	265	273	280	288	295
agu	42	43	43	44	44	45	46	46	47	47	48	48	49
car	116	122	128	134	139	145	151	157	163	169	174	180	186
tre	69	73	78	82	87	91	96	100	104	109	113	118	122
tri	210	217	224	232	239	246	253	260	267	275	282	289	296
total	2,911	3,073	3,235	3,396	3,558	3,720	3,882	4,043	4,205	4,367	4,529	4,690	4,852

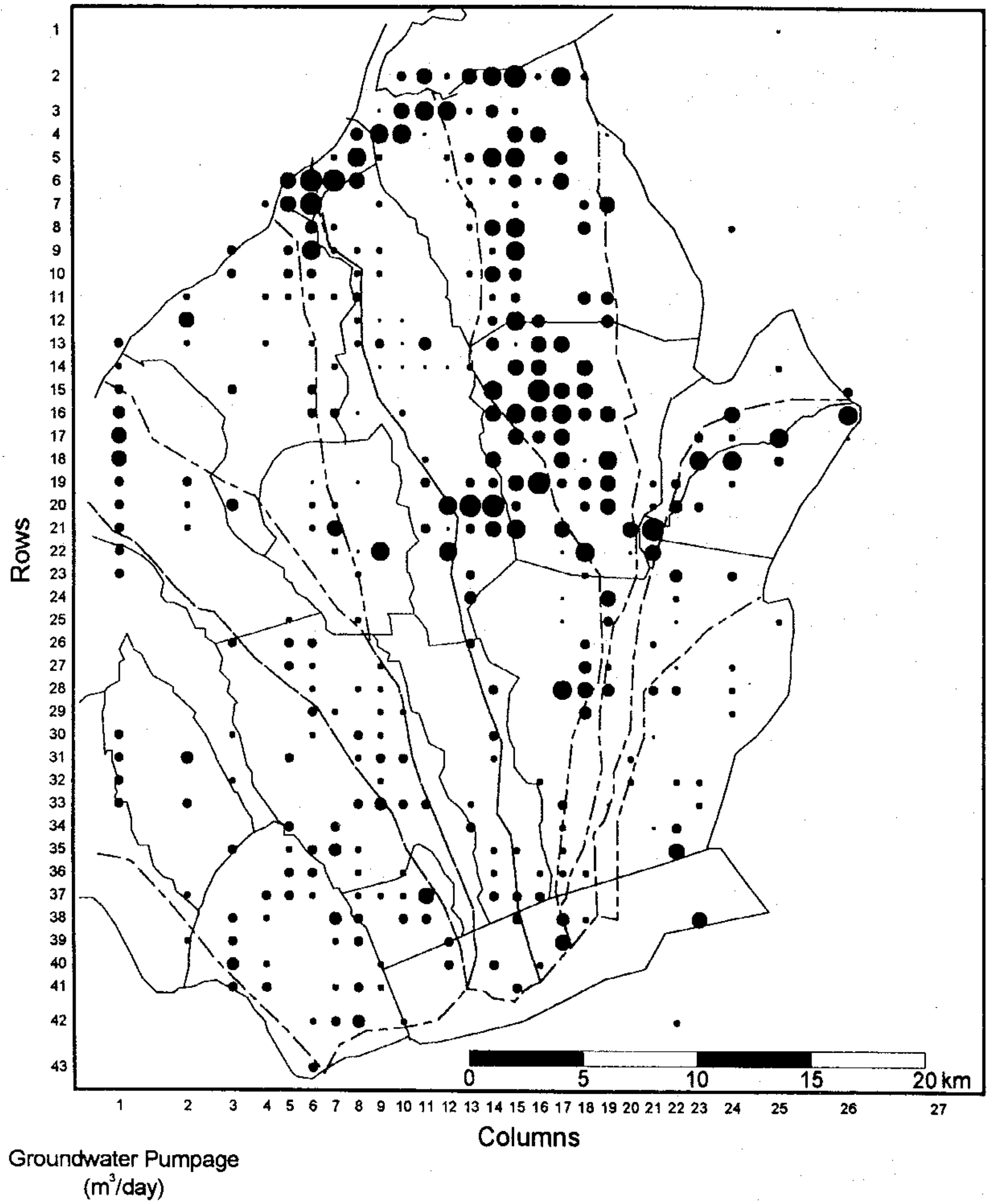
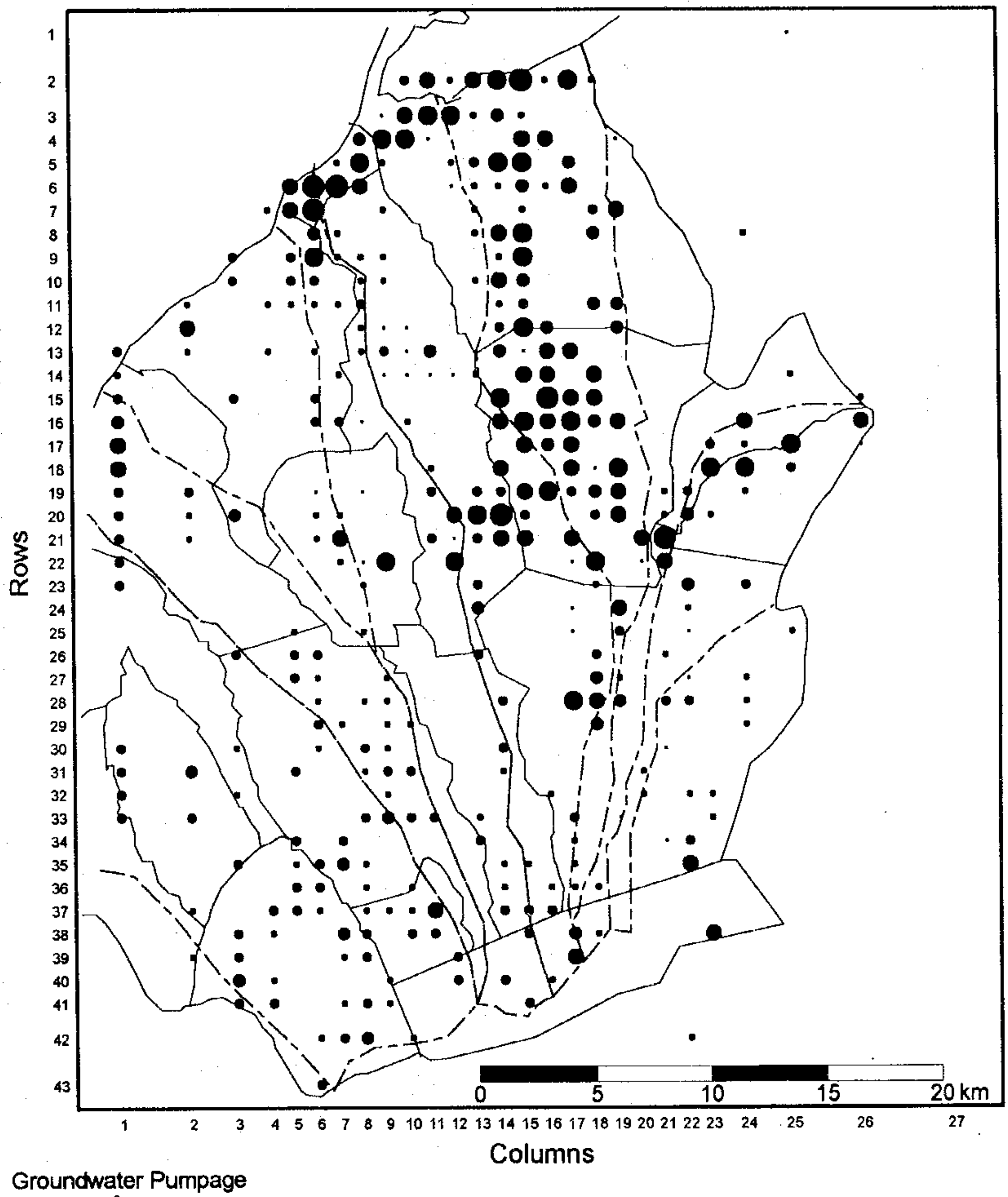


Fig. 5.7-1	DISTRIBUTION OF GROUNDWATER PUMPAGE IN 2005 BY PUMPING SCHEME 1

CAVITE WATER SUPPLY DEVELOPMENT STUDY

JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)	KOKUSAI KOGYO CO., LTD.



Groundwater Pumpage (m^3/day)

- 1.0 to 9.9
- 10 to 99
- 100 to 499
- 500 to 999
- 1,000 to 1,999
- 2,000 to 4,999
- 5,000 to 9,999

Fig. 5.7-2	DISTRIBUTION OF GROUNDWATER PUMPAGE IN 2005 BY PUMPING SCHEME 2
CAVITE WATER SUPPLY DEVELOPMENT STUDY	
JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)	KOKUSAI KOGYO CO., LTD.

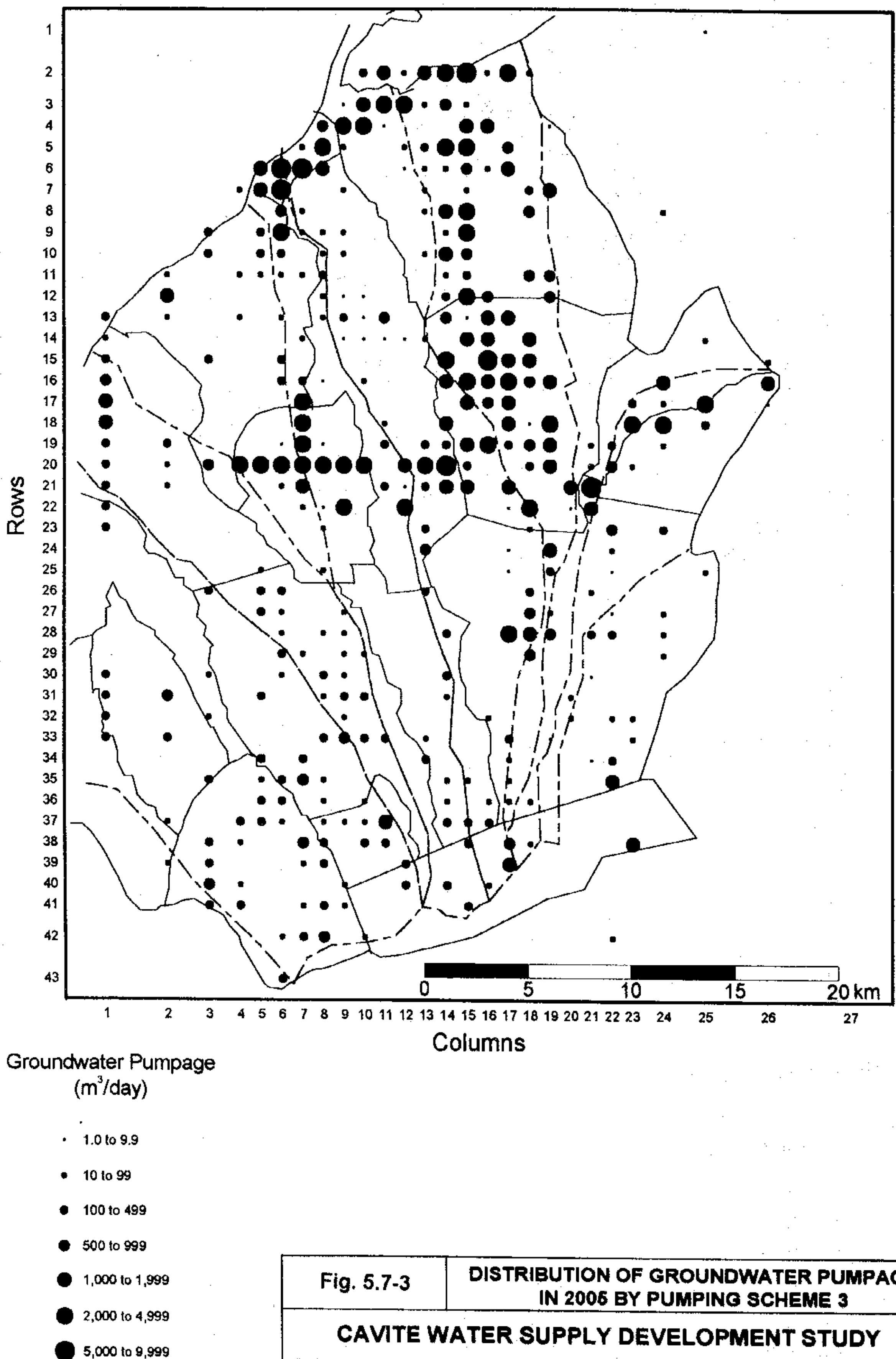


Fig. 5.7-3	DISTRIBUTION OF GROUNDWATER PUMPAGE IN 2005 BY PUMPING SCHEME 3
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structures of the groundwater basin and the hydrogeologic characteristics of each aquifer unit. Also it considers the present groundwater flow system in the historical calibration. The present groundwater flow regime is formed not only by the natural hydrogeological characteristics but also by the groundwater pumpage which reflects human activities. Therefore, evaluation of model response could suggest the future groundwater management options in the Study Area in general and in the SJRB in particular.

(1) **Scheme 1**

In **Fig. 5.7-4**, the absence of contours below the 100-m contour indicates that this downstream portion of the upper aquifer has dried up. **Fig. 5.7-5** shows a 10-meter decline of groundwater level in the upper aquifer inside the simulation area in the span of 10 years from 1995 to 2005.

In **Fig. 5.7-6**, a depression of 50 meters is shown at the downstream portion of the middle aquifer. **Fig. 5.7-7** illustrates that, if the pumpage in Dasmarinas increases to 25.497 MCM in year-2005 from the 1993 pumpage level of 9.464 MCM, the piezometric levels of the middle aquifer will drop 50 meters in ten years (1995-2005). This result is similarly shown in **Figs. 5.7-8** and **5.7-9** for the lower aquifer. This rate of 5 meters per year is worst compared to the present highest recorded rate of 2.84 meters annually in Dasmarinas. This 50-meter drop could already create a negative impact to the physical, social, and economic environments.

In the coastal area of Noveleta-Kawit at the downstream of the SJRB, a 45-meter lowering of water level is shown in the middle and lower aquifers. This would surely result in saltwater intrusion, and if this is already occurring, a wider area would be affected.

Fig. 5.7-10 shows the simulated groundwater levels at the JICA monitoring stations. At Brgy. San Juan, the groundwater level will be around 35 meters below sea level in both lower and middle aquifers in 2005. In the same year, the declines of water levels will be 34 m, more than 50m, less than 3 m, and around 5 m in Brgys. Santiago, Langkaan, Sabutan and Lalaan, respectively. At Brgy. Langkaan, the upper aquifer will dry up after 1997.

(2) **Scheme 2**

As shown in **Figs. 5.7-11 and 5.7-12**, the response of the upper aquifer to this pumping scheme 2 is the same as in scheme 1.

Figs. 5.7-13 to 5.7-16 show the behavior of the middle and lower aquifers to this scheme, and **Fig. 5.7-17** is almost similar to that of scheme 1 except that the lowering of water level is shallower in all the JICA monitoring stations..

In scheme 2, industrial pumpage in the Study Area is neglected, giving priorities to domestic, institutional and commercial users of groundwater. The simulation results suggest that groundwater level could be controlled if pumpage is reduced. If the pumpage in Dasmarinas increases to only 19.203 MCM in year-2005, the piezometric levels of both the middle and lower aquifers in SJRB will drop by 15 to 35 meters in ten years (1995-2005). Still the rate of 3.5 meters per year is high.

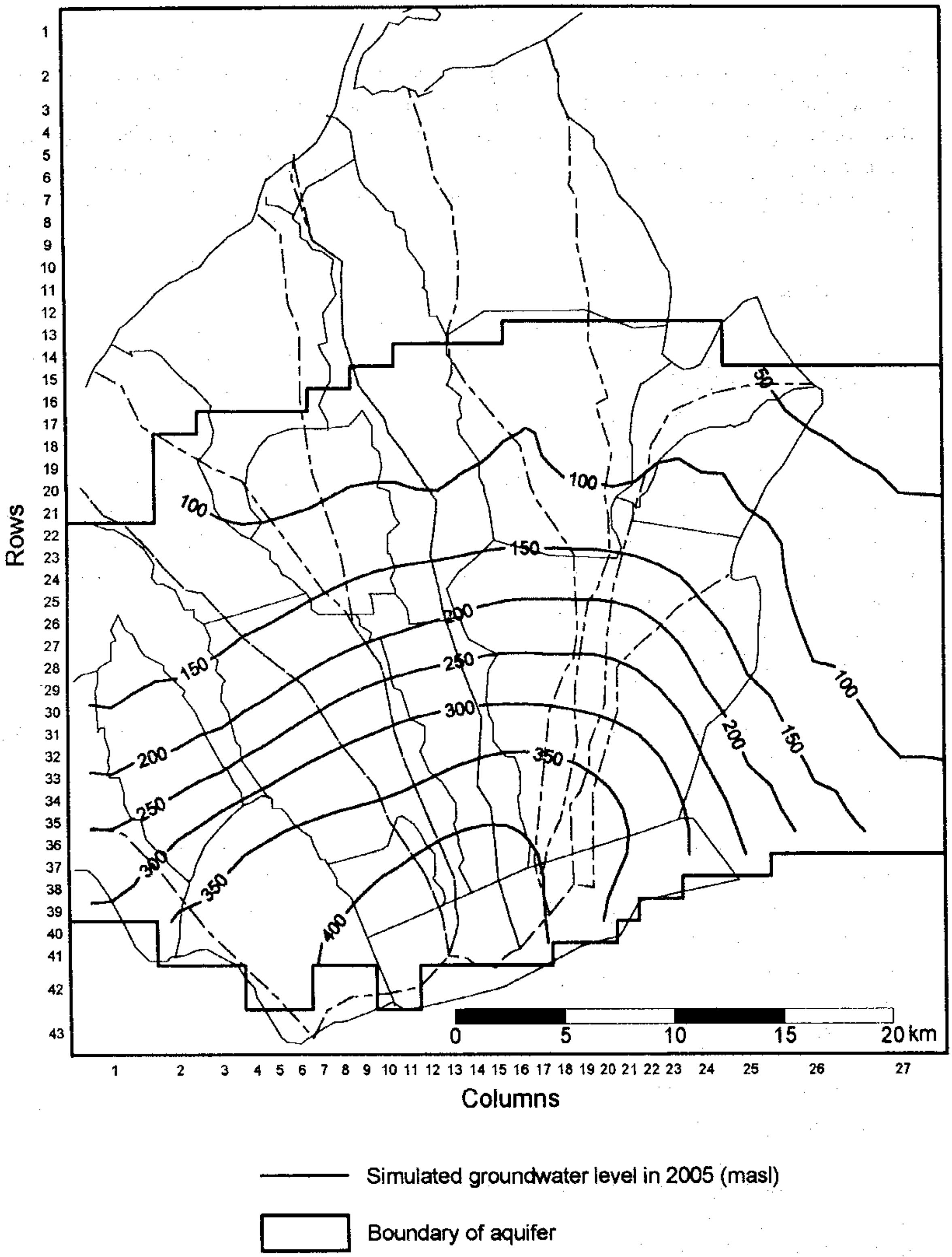

Fig. 5.7-4	SIMULATED GROUNDWATER LEVEL OF UPPER AQUIFER BY PUMPING SCHEME 1
CAVITE WATER SUPPLY DEVELOPMENT STUDY	
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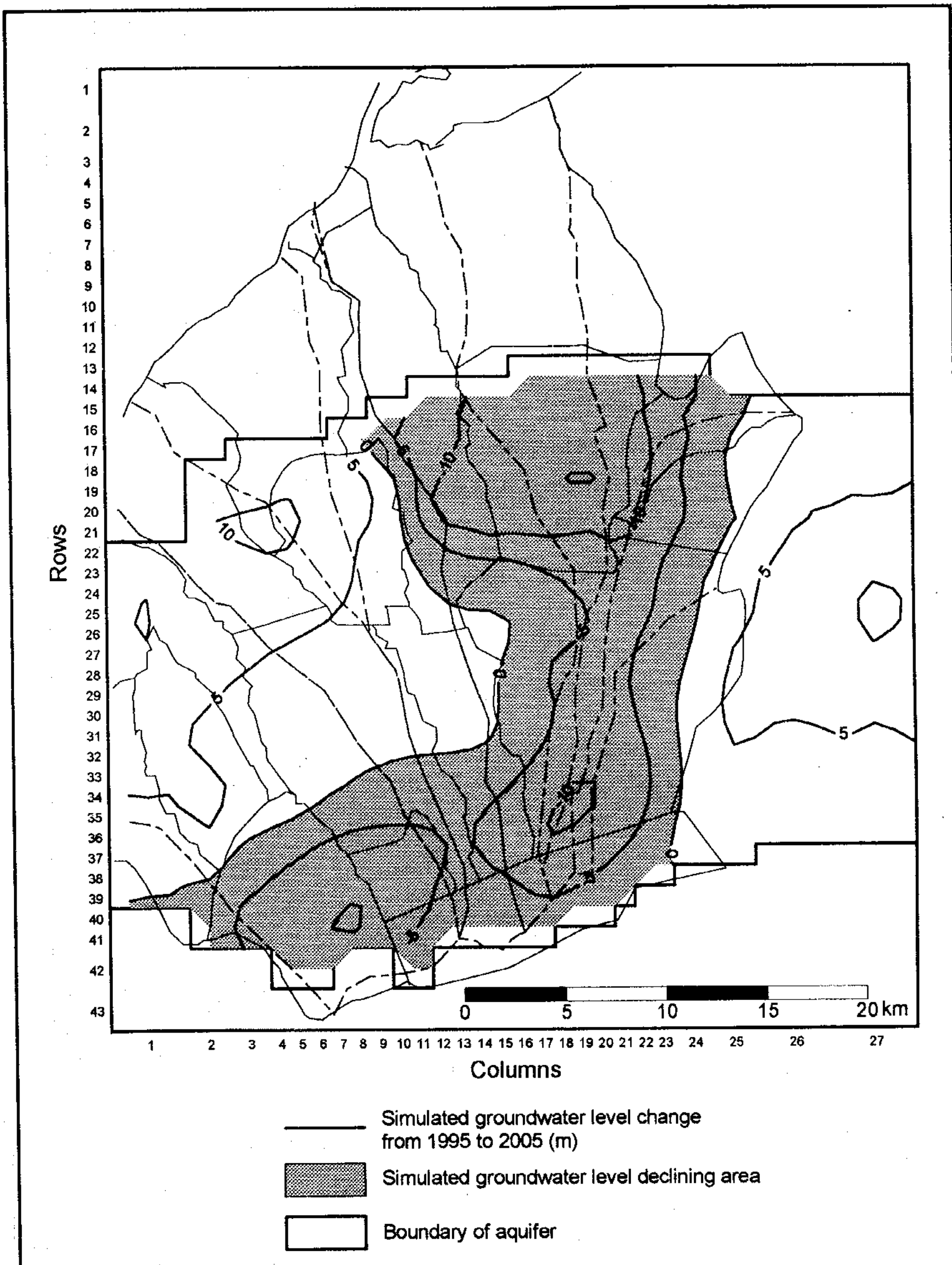

Fig. 5.7-5	SIMULATED GROUNDWATER LEVEL CHANGE IN UPPER AQUIFER BY PUMPING SCHEME 1
CAVITE WATER SUPPLY DEVELOPMENT STUDY	
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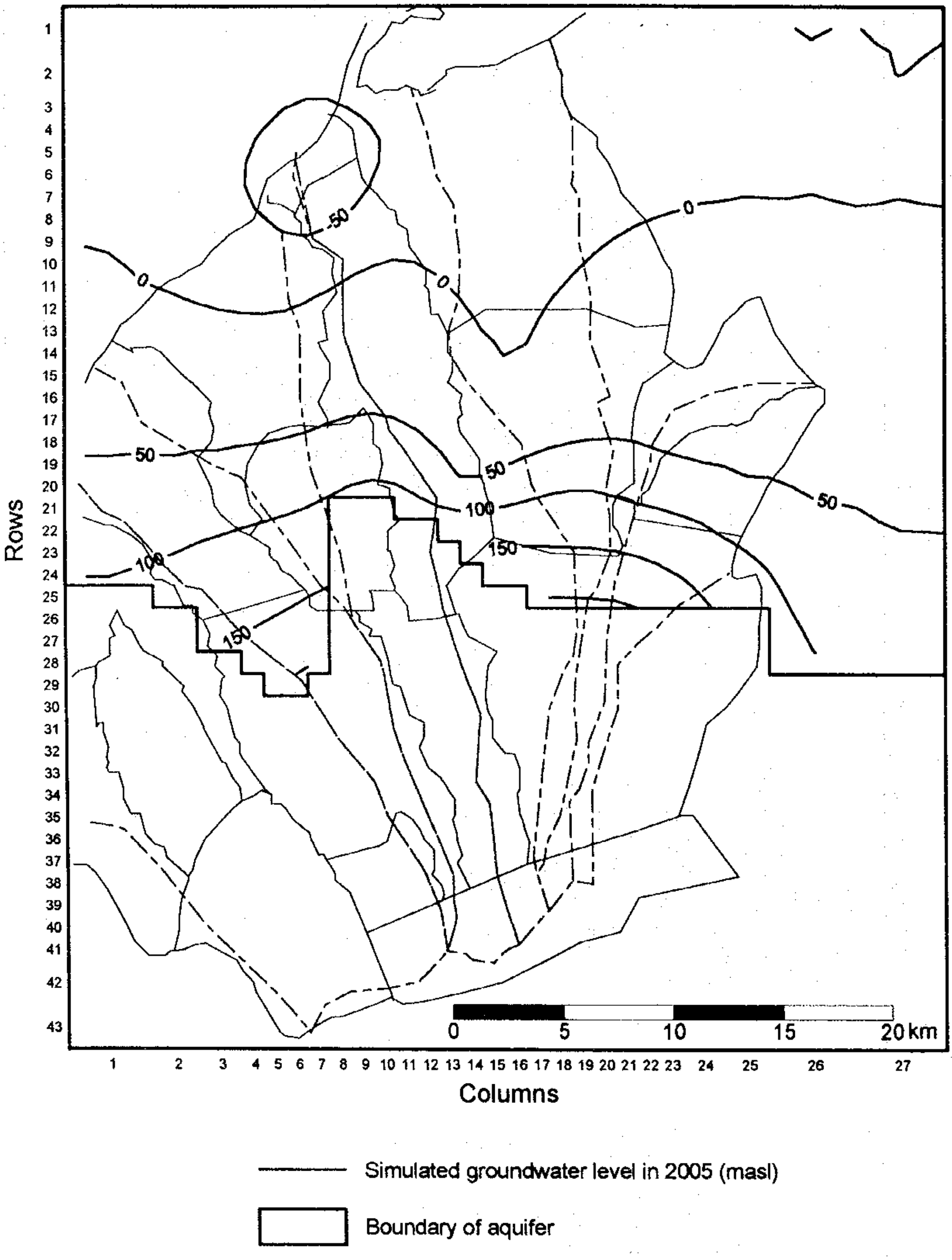

Fig. 5.7-6	SIMULATED GROUNDWATER LEVEL OF MIDDLE AQUIFER BY PUMPING SCHEME 1
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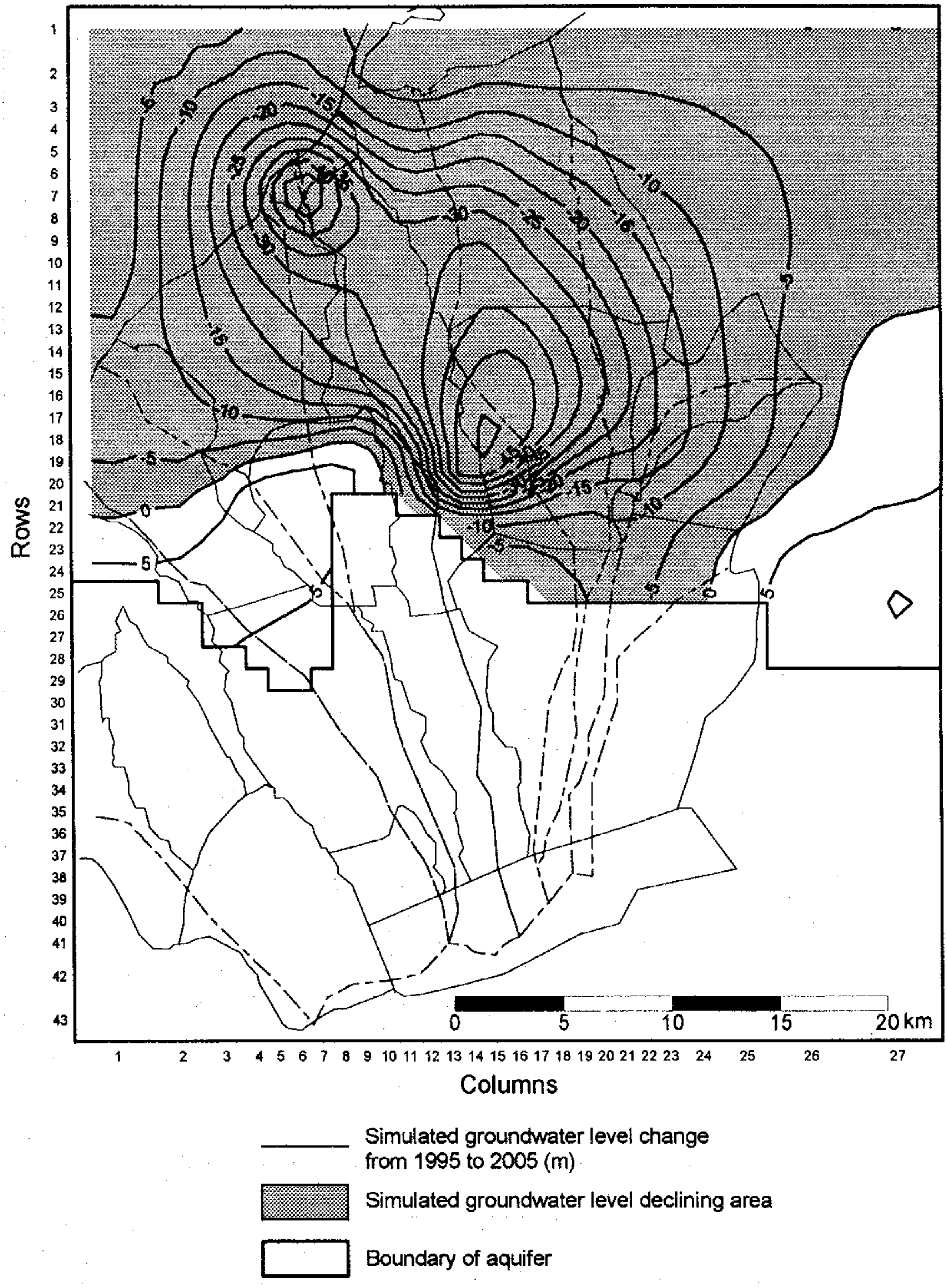

Fig. 5.7-7	SIMULATED GROUNDWATER LEVEL CHANGE IN MIDDLE AQUIFER BY PUMPING SCHEME 1
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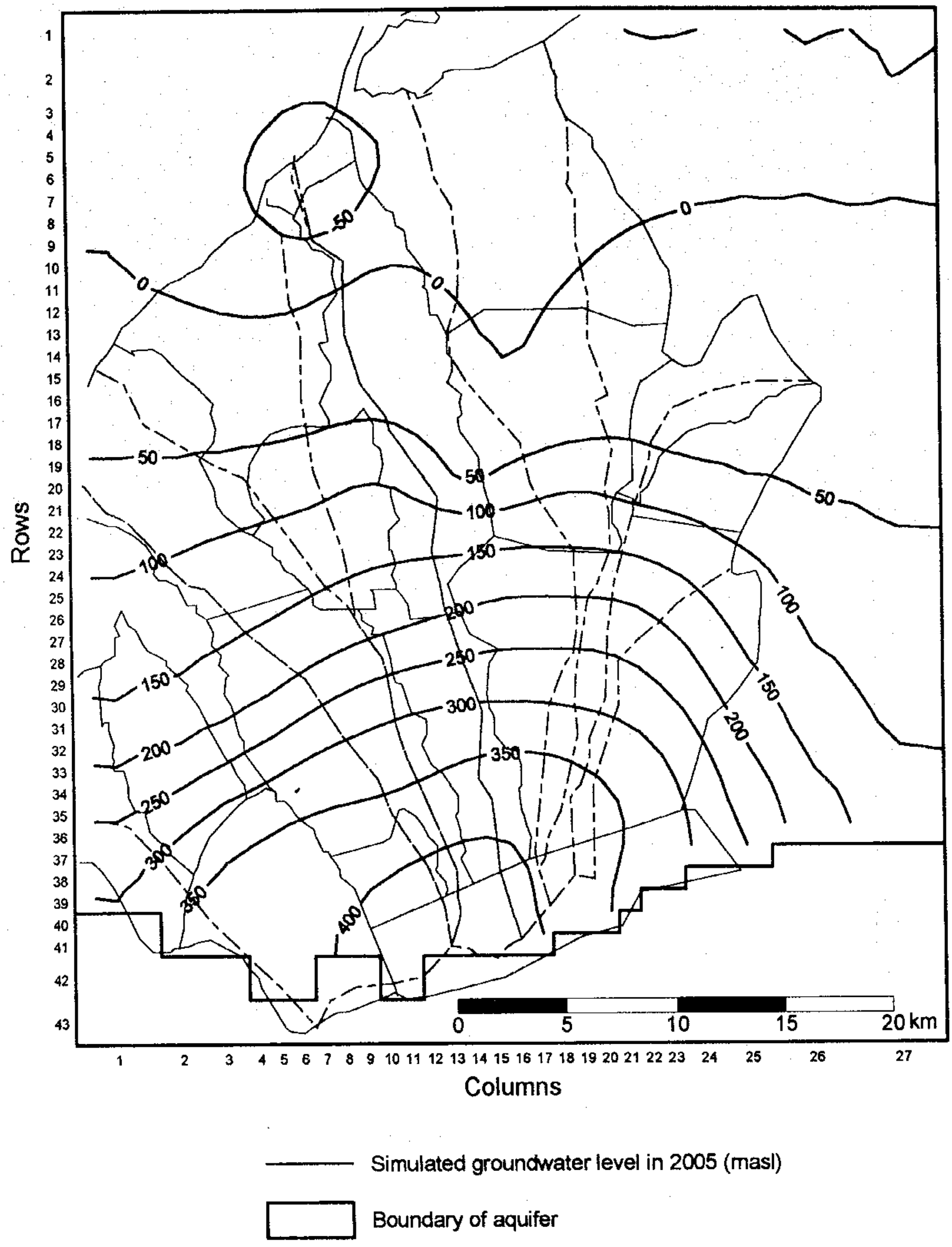

Fig. 5.7-8	SIMULATED GROUNDWATER LEVEL OF LOWER AQUIFER BY PUMPING SCHEME 1

CAVITE WATER SUPPLY DEVELOPMENT STUDY

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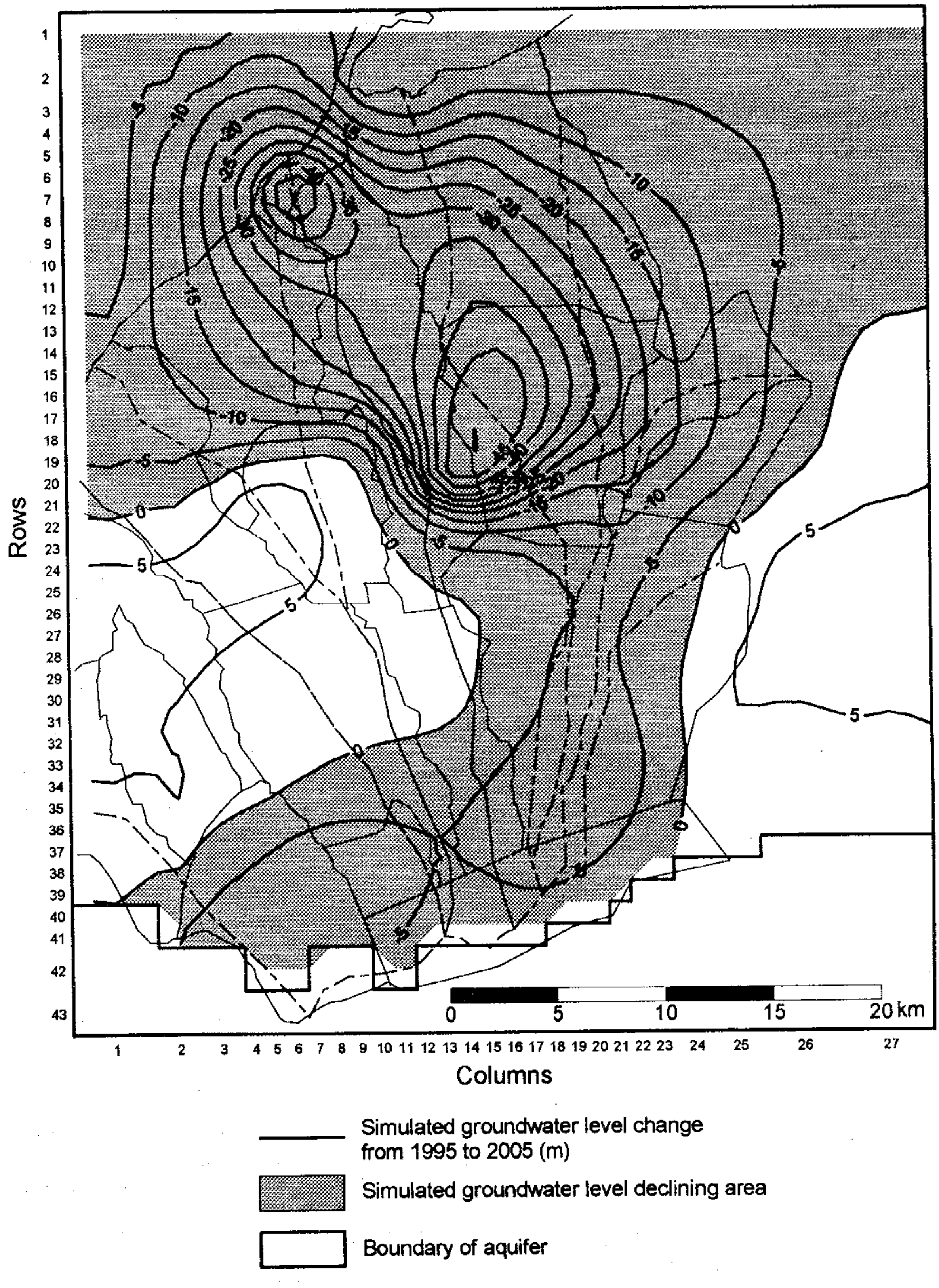

Fig. 5.7-9	SIMULATED GROUNDWATER LEVEL CHANGE IN LOWER AQUIFER BY PUMPING SCHEME 1
CAVITE WATER SUPPLY DEVELOPMENT STUDY	
JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)	KOKUSAI KOGYO CO., LTD.

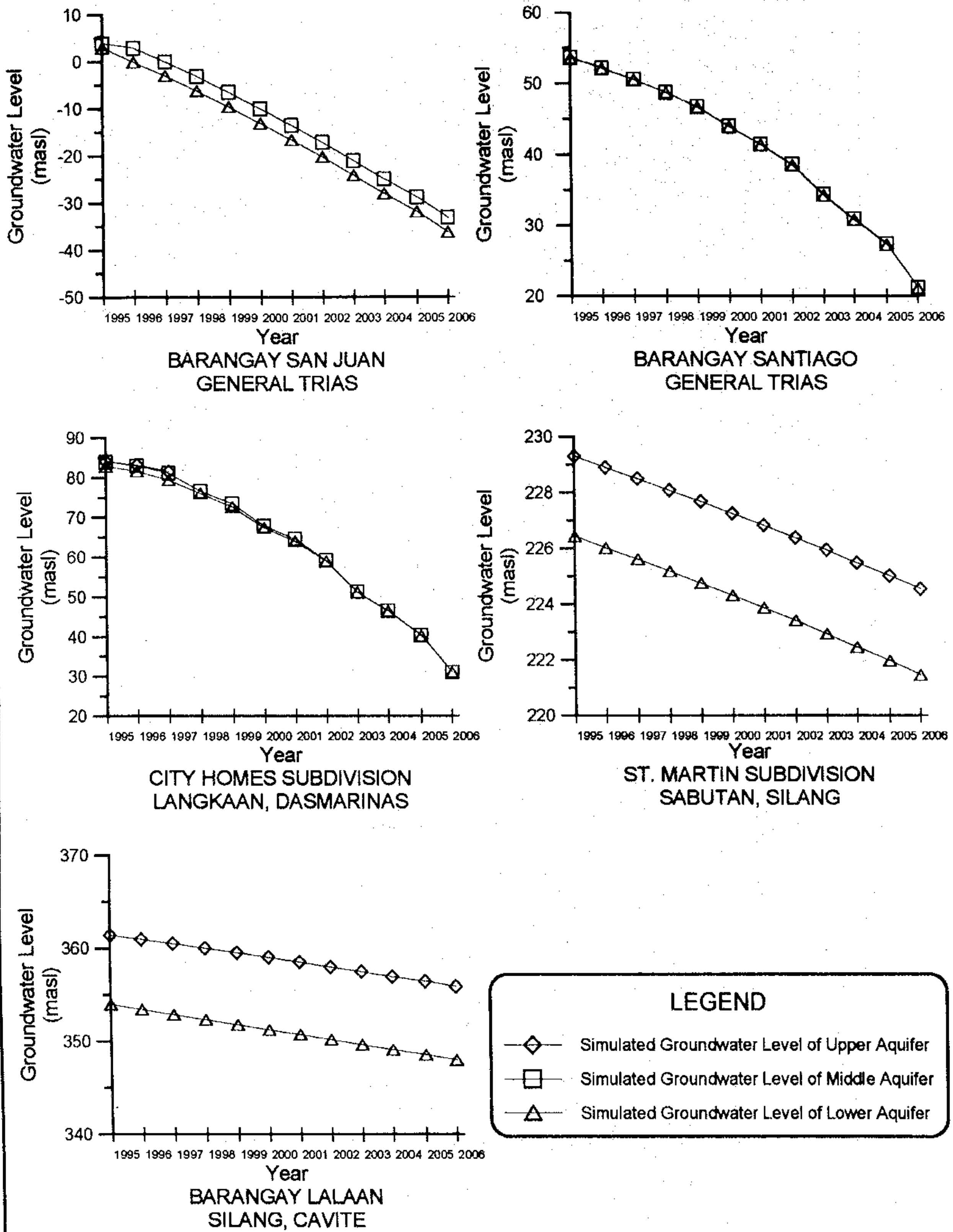

Fig. 5.7-10	SIMULATED GROUNDWATER LEVELS BY PUMPING SCHEME 1
CAVITE WATER SUPPLY DEVELOPMENT STUDY	
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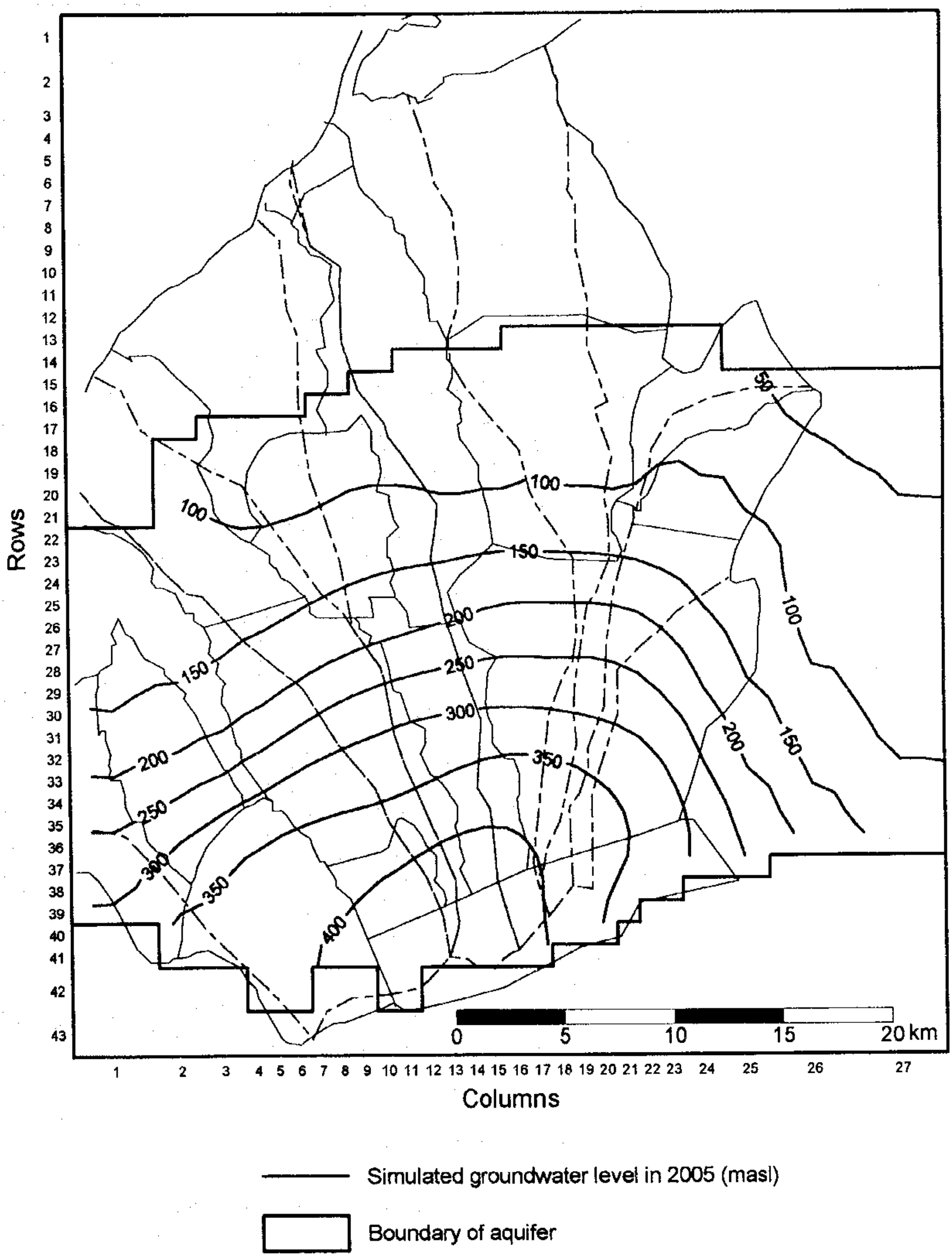

Fig. 5.7-11	SIMULATED GROUNDWATER LEVEL OF UPPER AQUIFER BY PUMPING SCHEME 2
CAVITE WATER SUPPLY DEVELOPMENT STUDY	
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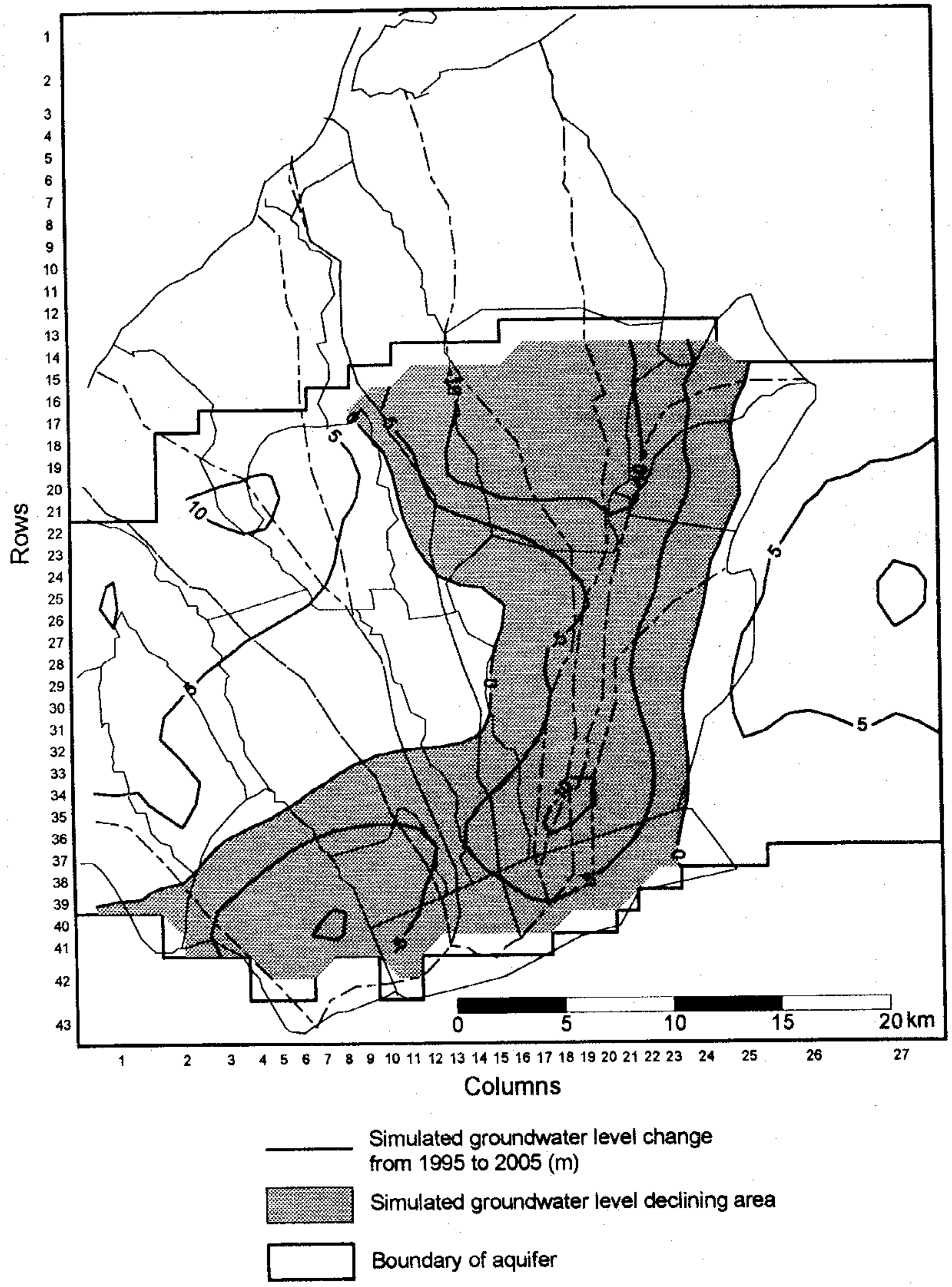

Fig. 5.7-12	SIMULATED GROUNDWATER LEVEL CHANGE IN UPPER AQUIFER BY PUMPING SCHEME 2
CAVITE WATER SUPPLY DEVELOPMENT STUDY	
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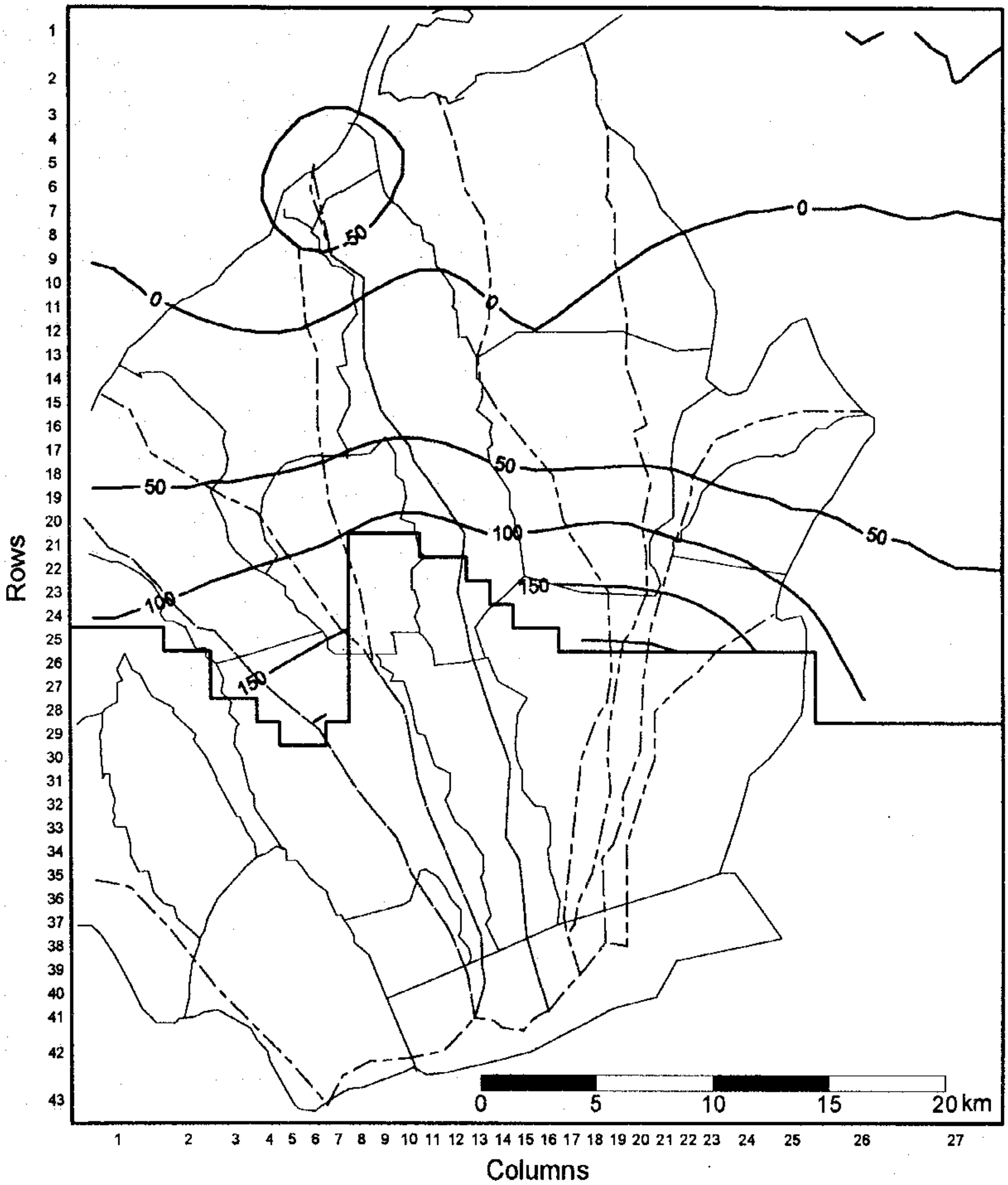

——— Simulated groundwater level in 2005 (masl)

Boundary of aquifer

Fig. 5.7-13	SIMULATED GROUNDWATER LEVEL OF MIDDLE AQUIFER BY PUMPING SCHEME 2
CAVITE WATER SUPPLY DEVELOPMENT STUDY	
JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)	KOKUSAI KOGYO CO., LTD.

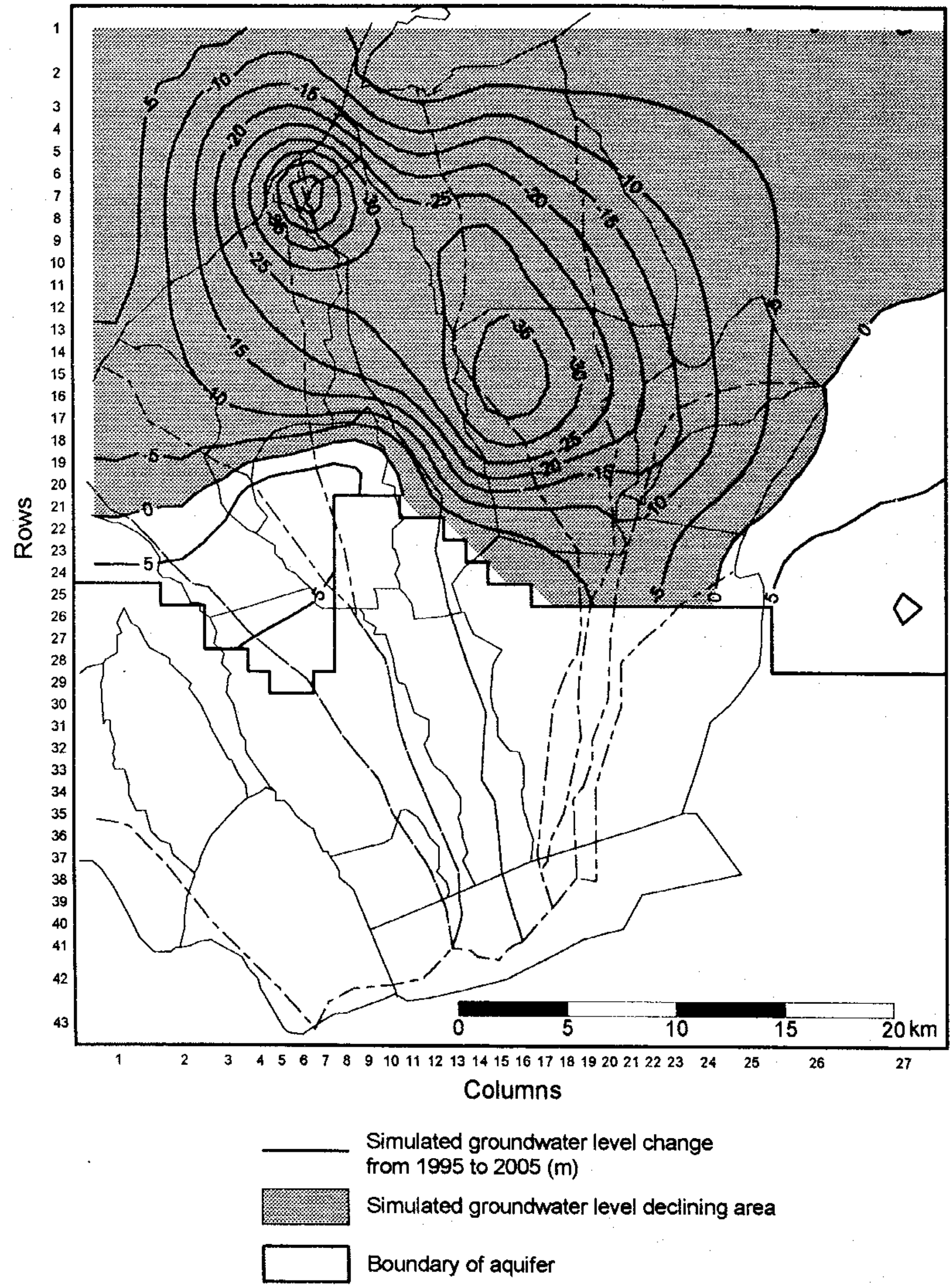

Fig. 5.7-14	SIMULATED GROUNDWATER LEVEL CHANGE IN MIDDLE AQUIFER BY PUMPING SCHEME 2

CAVITE WATER SUPPLY DEVELOPMENT STUDY

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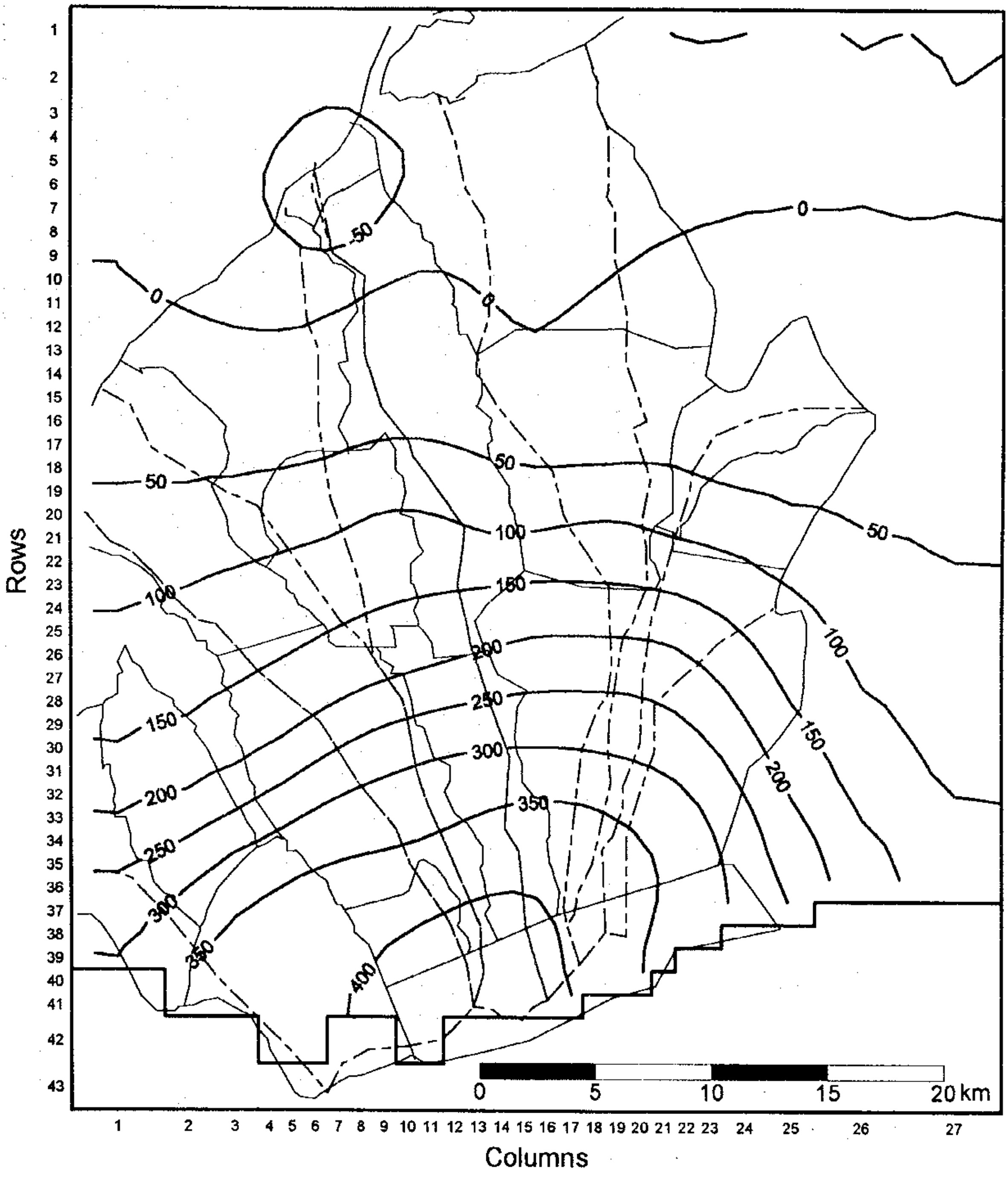


Simulated groundwater level in 2005 (masl)

Boundary of aquifer

Fig. 5.7-15	SIMULATED GROUNDWATER LEVEL OF LOWER AQUIFER BY PUMPING SCHEME 2
CAVITE WATER SUPPLY DEVELOPMENT STUDY	
JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)	KOKUSAI KOGYO CO., LTD.

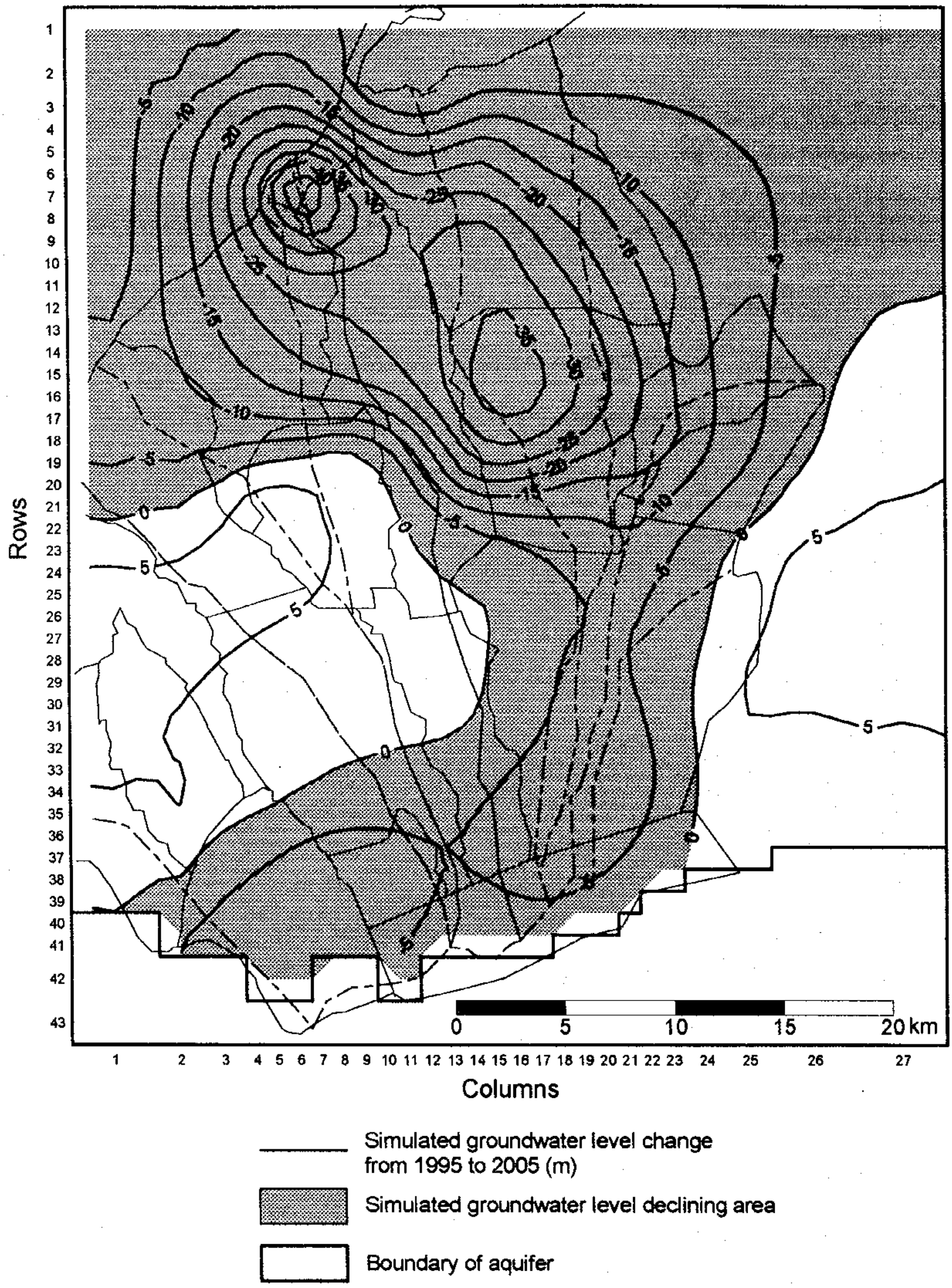


Fig. 5.7-16	SIMULATED GROUNDWATER LEVEL CHANGE IN LOWER AQUIFER BY PUMPING SCHEME 2
CAVITE WATER SUPPLY DEVELOPMENT STUDY	
JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)	KOKUSAI KOGYO CO., LTD.

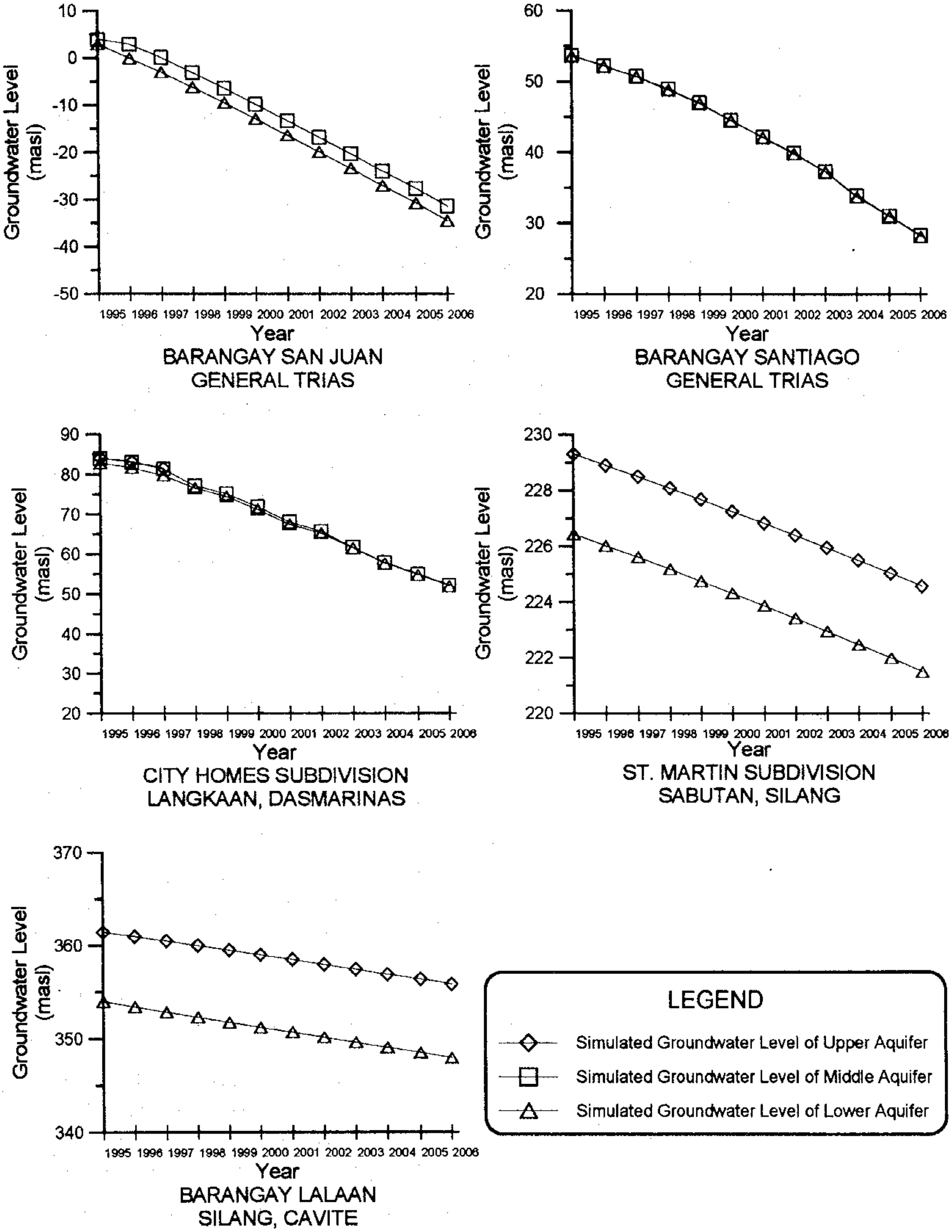


Fig. 5.7-17	SIMULATED GROUNDWATER LEVELS BY PUMPING SCHEME 2
CAVITE WATER SUPPLY DEVELOPMENT STUDY	
JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)	KOKUSAI KOGYO CO., LTD.

(3) **Scheme 3**

As shown in **Figs. 5.7-18 and 5.7-19**, the response of the upper aquifer to this pumping scheme 3 is similar to schemes 1 and 2.

Figs. 5.7-20 to 5.7-23 show the response of the middle and lower aquifers to this scheme; a new but shallow depression will occur in Trece Martirez. As shown in **Fig. 5.7-24**, the response of the water level in all JICA monitoring stations is almost similar to that of scheme 2.

The simulation results using scheme 3 suggest that the increase in industrial pumpage between 1996 and 2005, which is excluded in scheme 2, could be moved to less developed groundwater areas like in the industrial zones of Trece Martirez, and the yearly incremental increase distributed spatially and not concentrated in one place could result in a drop of 5 to 10 meters only in ten years.

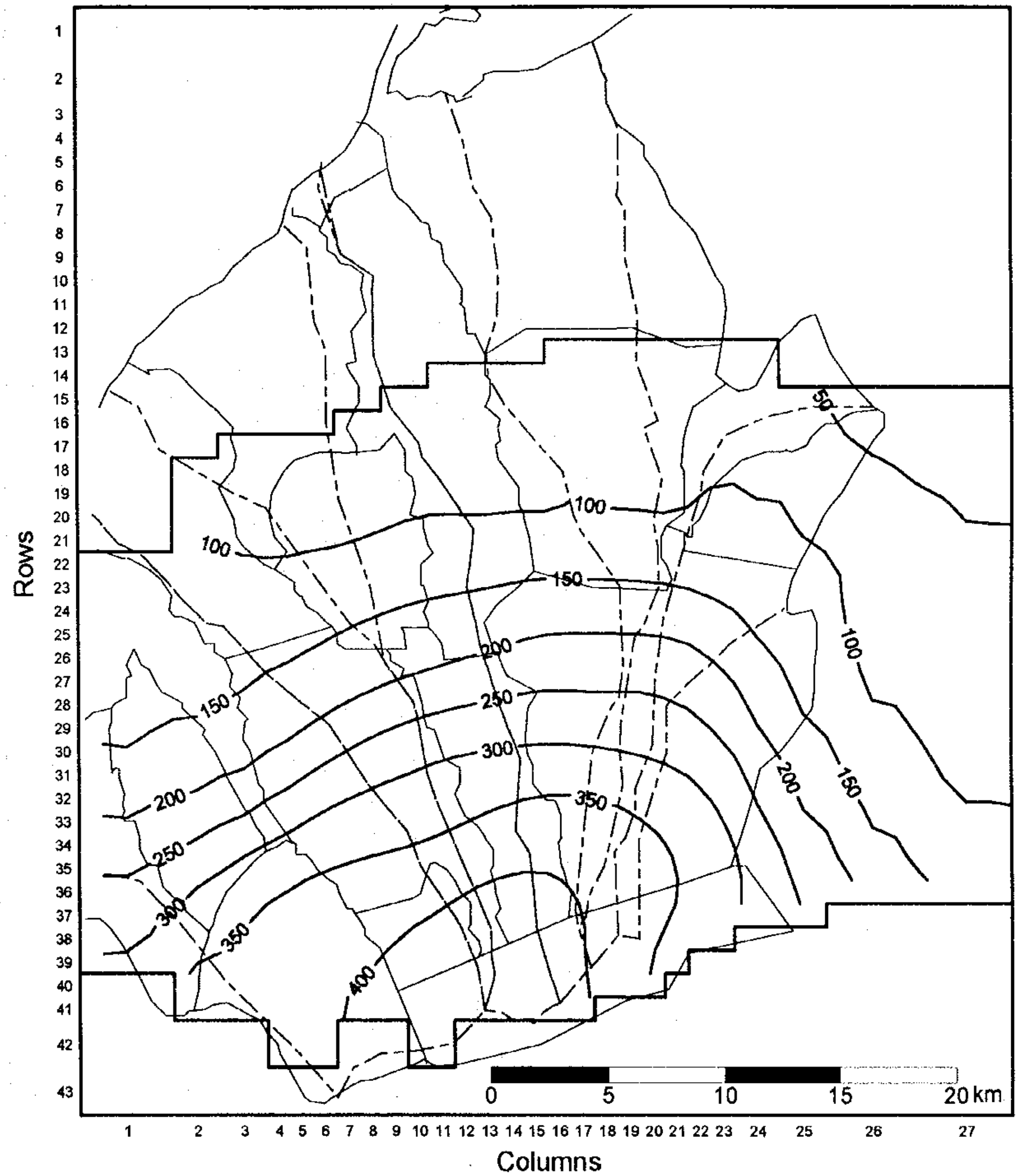
If a certain rate of water decline is to be maintained in a particular municipality to avoid, for instance, a negative environmental impact such as drying up of wells and springs, land subsidence, and sea water intrusion, pumpage can then be distributed outside in less developed groundwater areas and piped to supply the water demand of the municipality, of course with the technical and economic feasibilities being considered. As shown in this scheme 3, the redistribution of pumpage can be analyzed using the groundwater model installed at LWUA.

The accuracy and reliability of groundwater model installed at LWUA must be improved in the future. This may be achieved by a more accurate and updated pumpage estimates, by a more accurate aquifer parameter estimates, and by a continuous monitoring of groundwater levels.

Groundwater level has been rapidly declining in some areas of Cavite, as shown by present observed data, and it will be more rapid in the future, as indicated by the above results of the simulation. It is therefore crucial to establish a critical groundwater zone that covers these heavily pumped areas. However, objectives and priorities of groundwater use must be clearly defined and established first, in which every sector must be involved in the process. If possible, the cost-benefit analysis of groundwater utilization has to be carried out in setting up the priorities.

In the case of the priority being given to the domestic use of groundwater, groundwater tariff can be collected and water rights can be limited to 10 years to discourage other users.

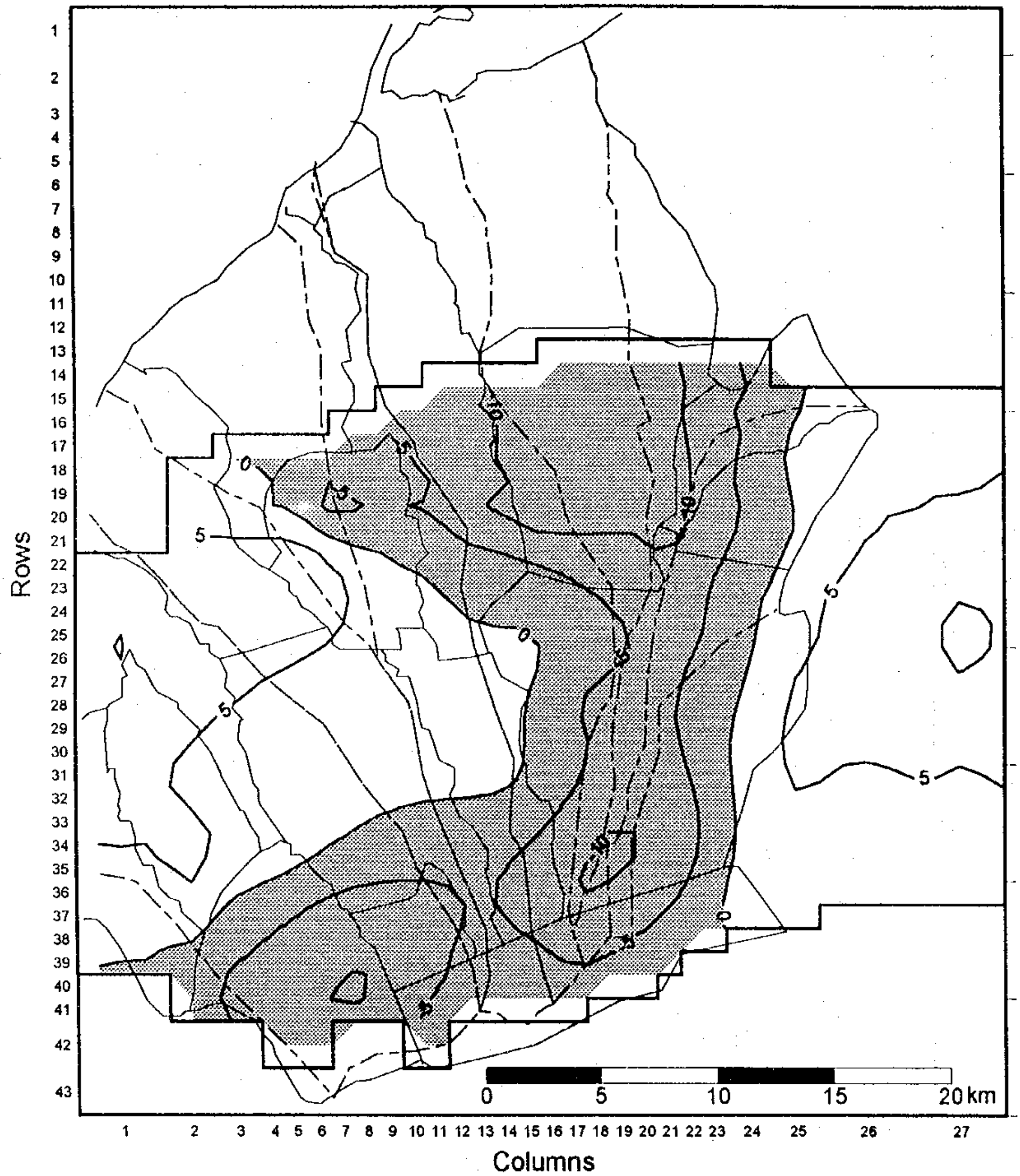
Monitoring of groundwater levels and pumpage would be vital in the critical groundwater zone and should be implemented at once. Coupled to the monitoring system is the use of database and simulation model, which are prerequisite to an effective evaluation of the existing and future groundwater conditions not only in the critical groundwater zone but also in the whole Study Area.



Simulated groundwater level in 2005 (masl)

Boundary of aquifer

Fig. 5.7-18	SIMULATED GROUNDWATER LEVEL OF UPPER AQUIFER BY PUMPING SCHEME 3
CAVITE WATER SUPPLY DEVELOPMENT STUDY	
JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)	KOKUSAI KOGYO CO., LTD.



Simulated groundwater level change from 1995 to 2005 (m)

Simulated groundwater level declining area

Boundary of aquifer

Fig. 5.7-19	SIMULATED GROUNDWATER LEVEL CHANGE IN UPPER AQUIFER BY PUMPING SCHEME 3

CAVITE WATER SUPPLY DEVELOPMENT STUDY

JAPAN INTERNATIONAL COOPERATION AGENCY (JICA) | KOKUSAI KOGYO CO., LTD.

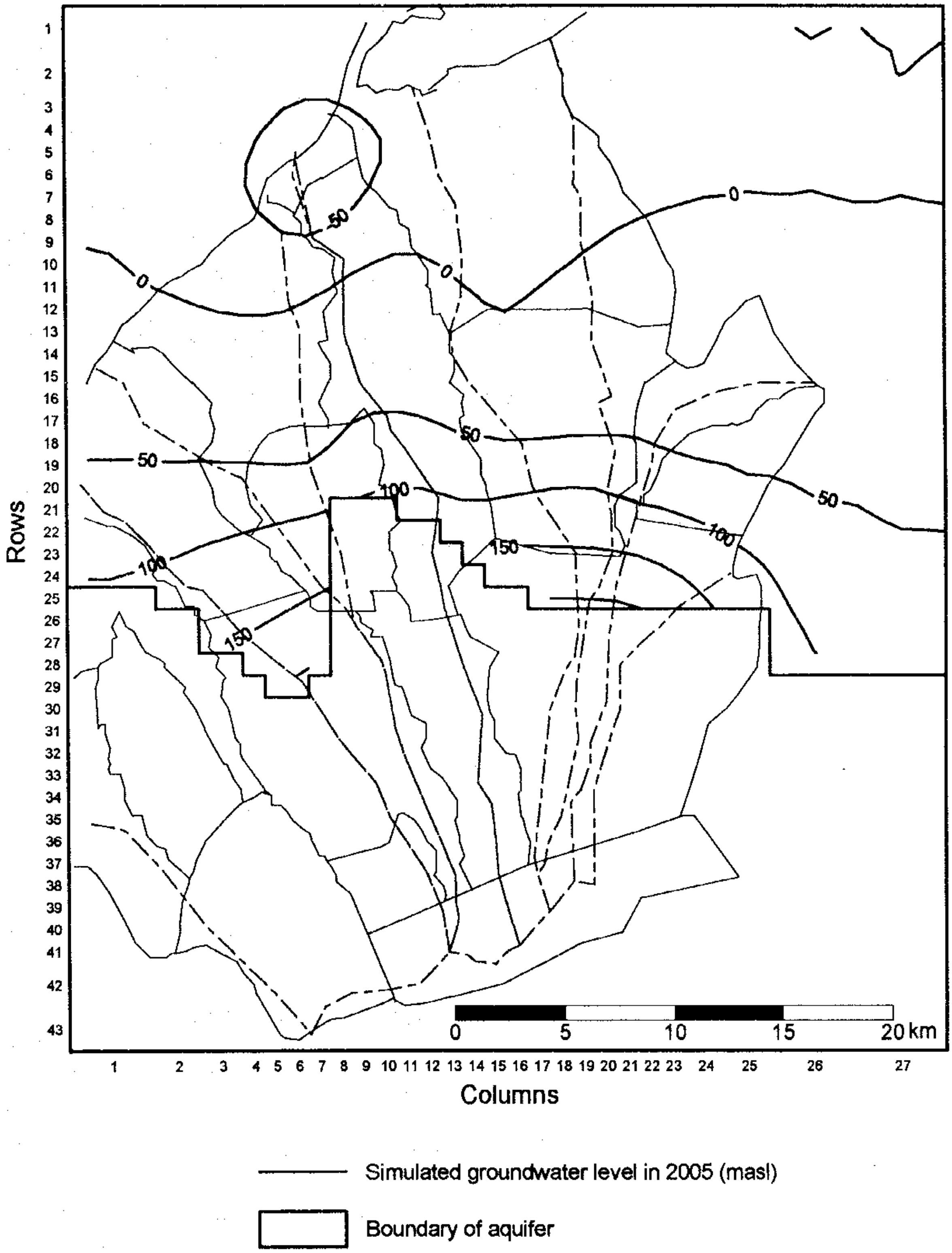
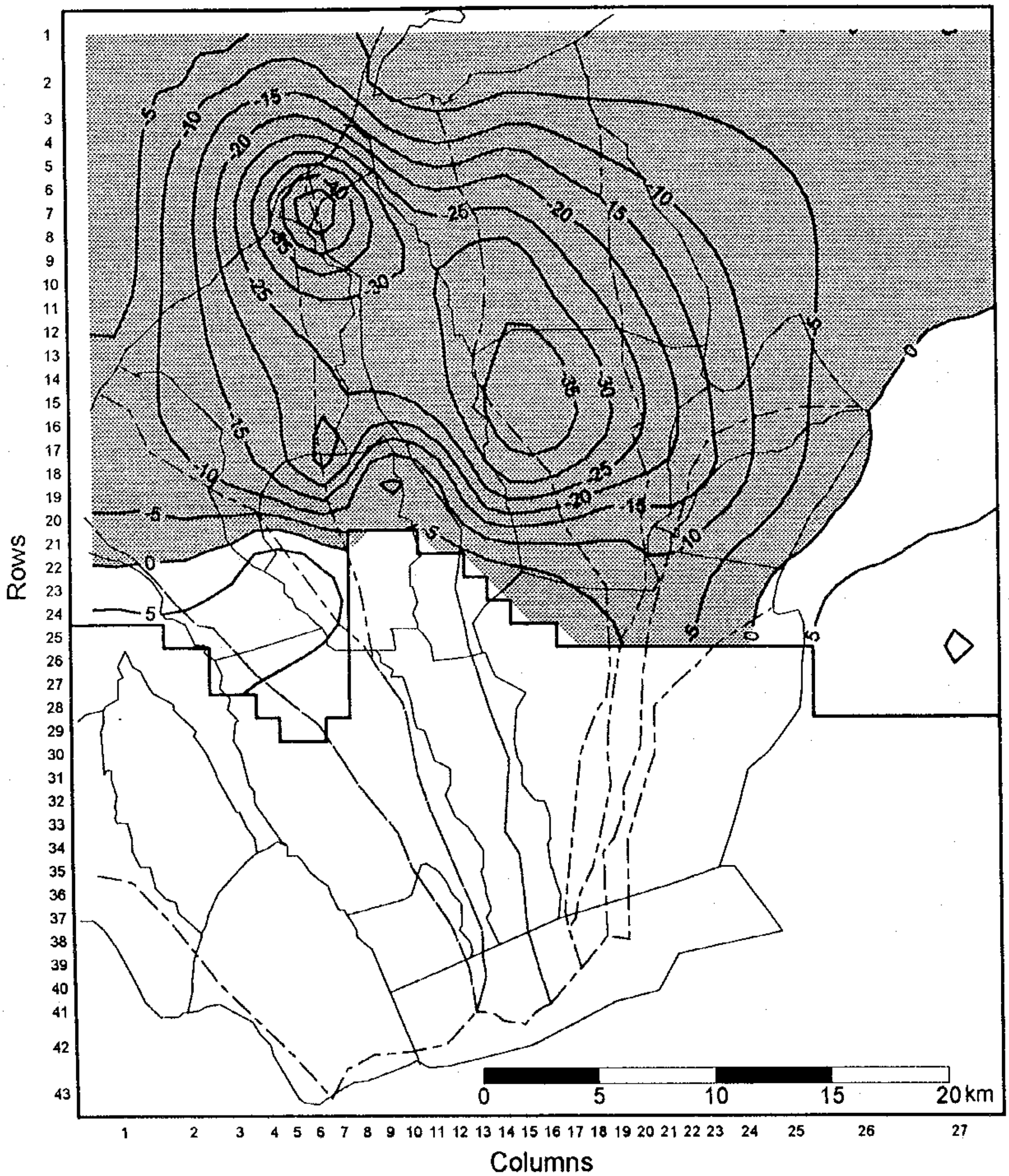


Fig. 5.7-20	SIMULATED GROUNDWATER LEVEL OF MIDDLE AQUIFER BY PUMPING SCHEME 3
CAVITE WATER SUPPLY DEVELOPMENT STUDY	
JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)	KOKUSAI KOGYO CO., LTD.

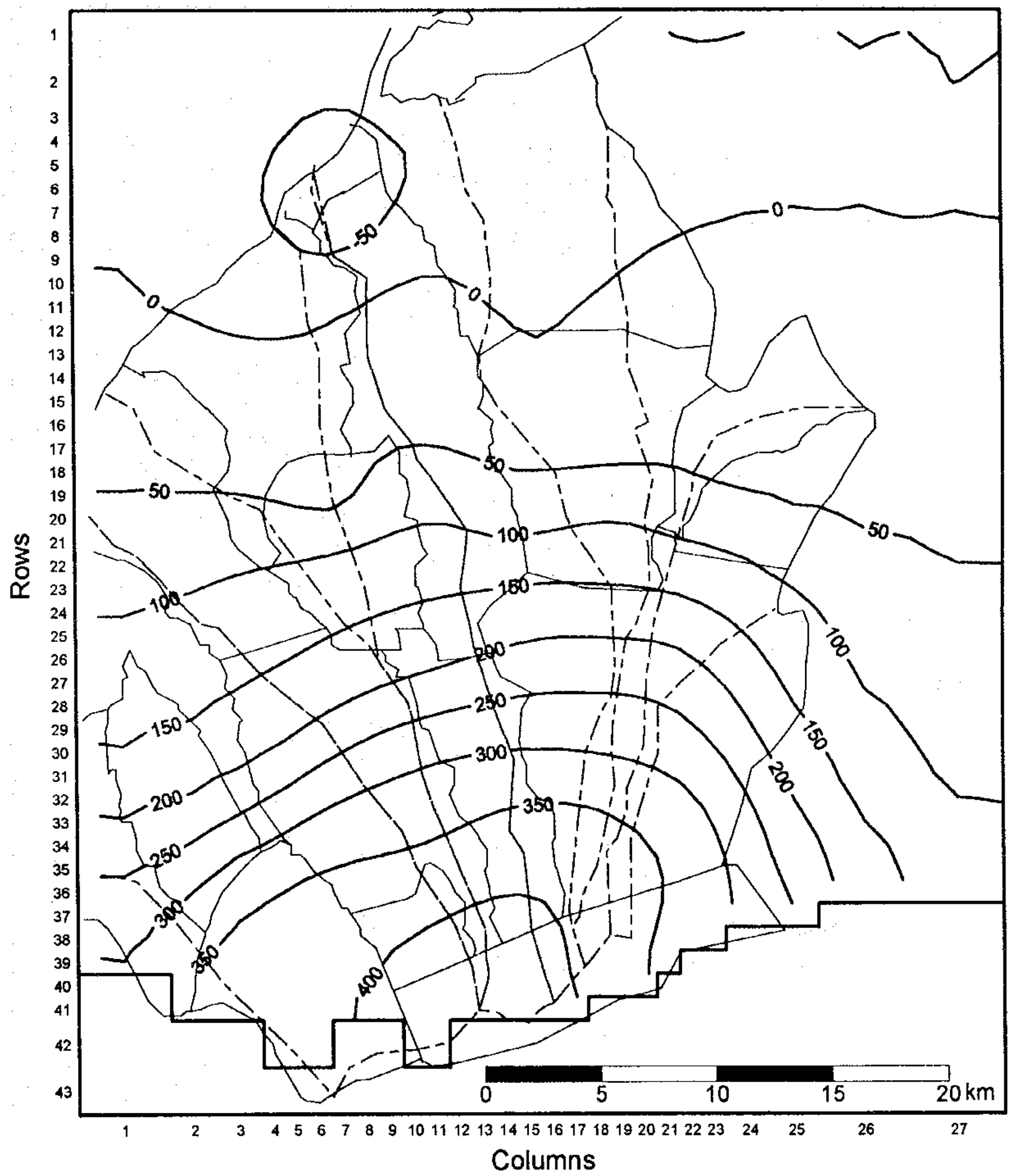


Simulated groundwater level change from 1995 to 2005 (m)

Simulated groundwater level declining area

Boundary of aquifer

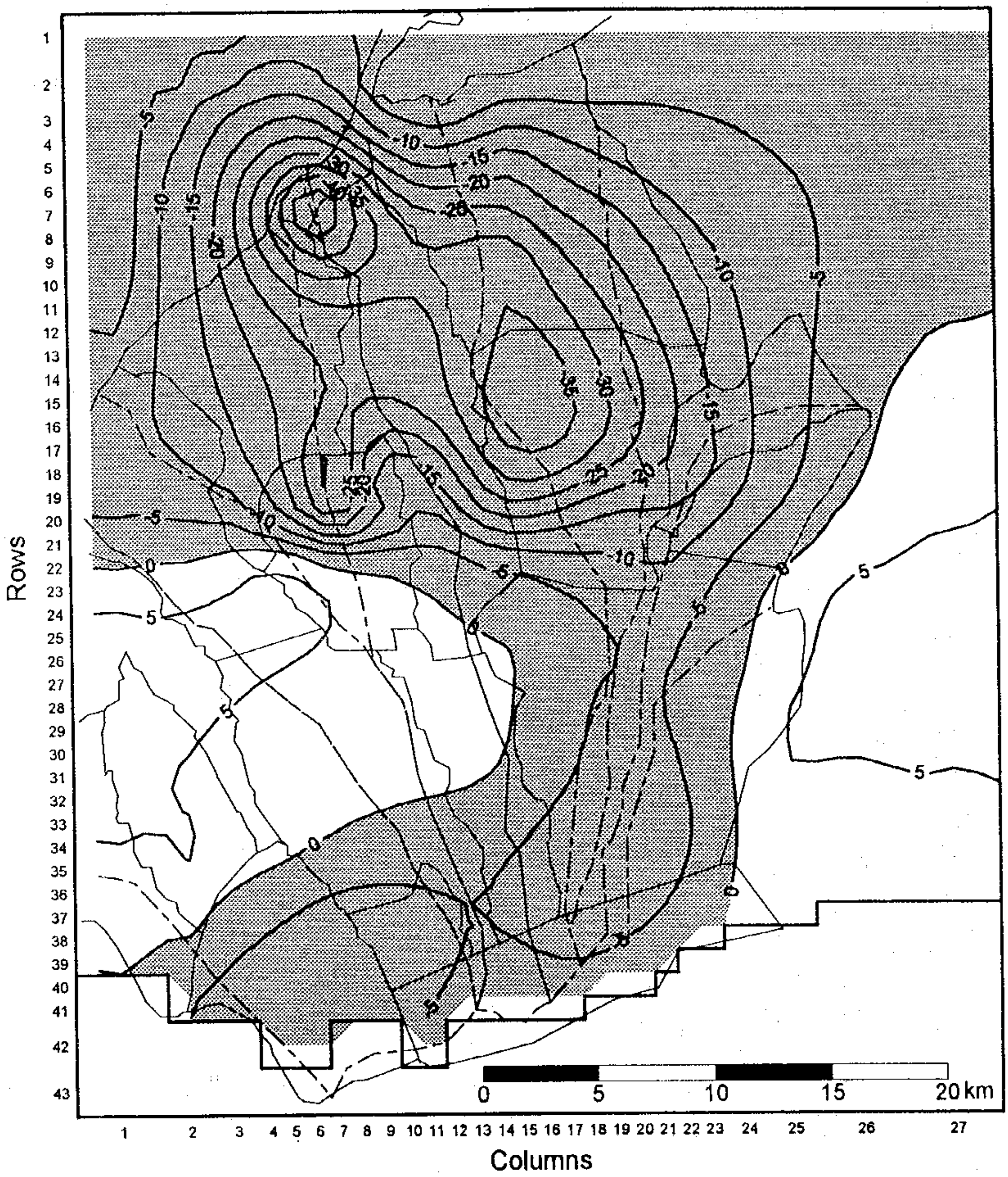
Fig. 5.7-21	SIMULATED GROUNDWATER LEVEL CHANGE IN MIDDLE AQUIFER BY PUMPING SCHEME 3
CAVITE WATER SUPPLY DEVELOPMENT STUDY	
JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)	KOKUSAI KOGYO CO., LTD.



——— Simulated groundwater level in 2005 (masl)

☐ Boundary of aquifer

Fig. 5.7-22	SIMULATED GROUNDWATER LEVEL OF LOWER AQUIFER BY PUMPING SCHEME 3
CAVITE WATER SUPPLY DEVELOPMENT STUDY	
JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)	KOKUSAI KOGYO CO., LTD.



Simulated groundwater level change from 1995 to 2005 (m)

Simulated groundwater level declining area

Boundary of aquifer

Fig. 5.7-23	SIMULATED GROUNDWATER LEVEL CHANGE IN LOWER AQUIFER BY PUMPING SCHEME 3
CAVITE WATER SUPPLY DEVELOPMENT STUDY	
JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)	KOKUSAI KOGYO CO., LTD.

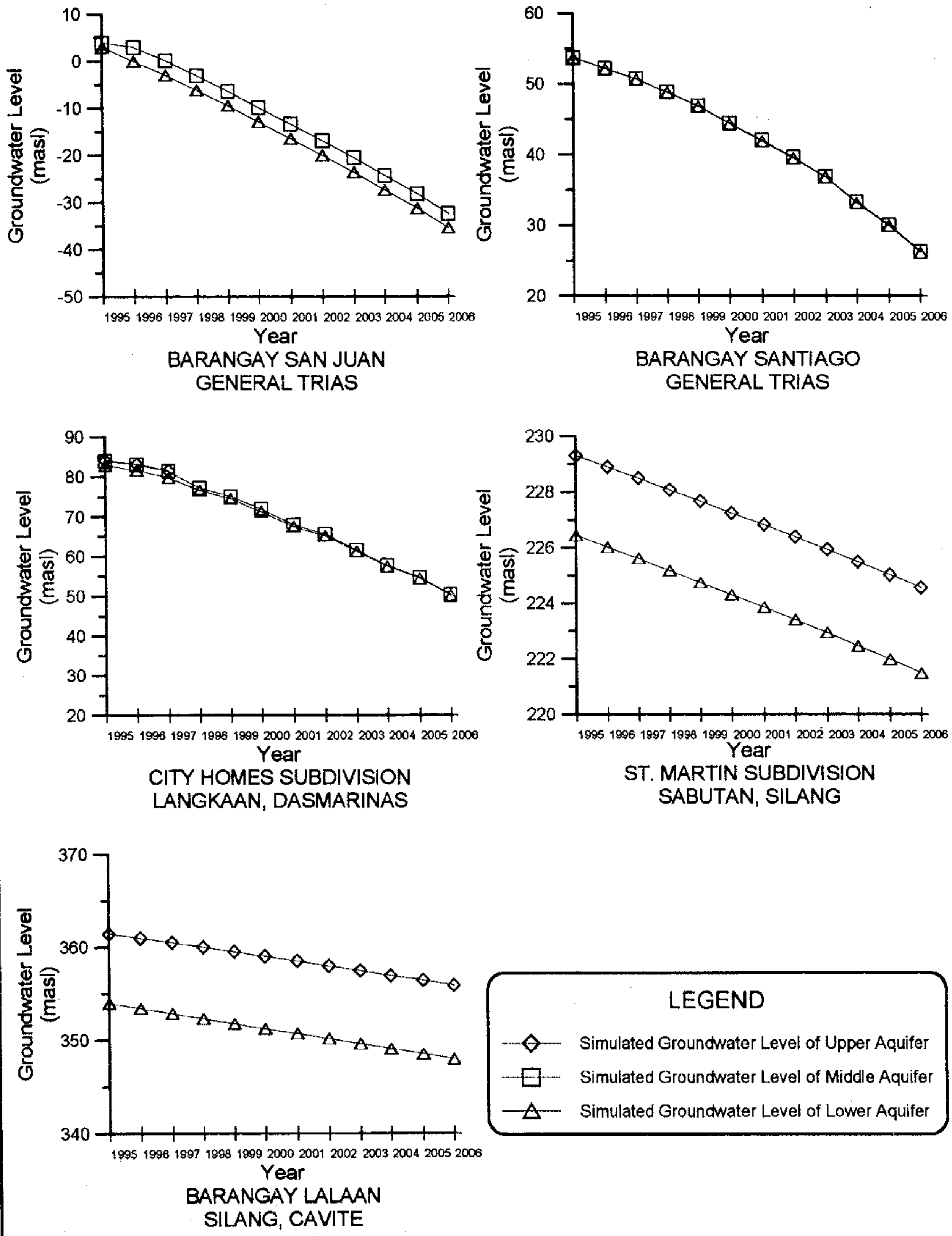


Fig. 5.7-24	SIMULATED GROUNDWATER LEVELS BY PUMPING SCHEME 3
CAVITE WATER SUPPLY DEVELOPMENT STUDY	
JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)	KOKUSAI KOGYO CO., LTD.

CHAPTER 6

QUALITY OF WATER RESOURCES

CHAPTER 6

QUALITY OF WATER RESOURCES

The quality of spring water sampled in the Study Area meets the National Water Quality Standard for Drinking Water (NSDW) for all the items.

In case of deep well water, about 90% of the water quality items meet the class AA, public water supply class I in the Water Quality Standards for Public Water Area of the Philippines, but in a few samples, Phenols, NO_3-N, Total Coliforms and Fecal Coliforms did not meet the Class AA. According to the field survey and existing data, river water is widely polluted.

Due to the water quality type represented by hexa-diagram, groundwater or spring water in the recharge area is similar to that of rainwater in quality.

Groundwater sampled in lowland or from deep wells has high concentration of HCO_3^- reflecting a long storage period.

In the Study Area, 66% of potential industrial polluters are equipped with some wastewater treatment facilities, but most of them are inefficient.

Thiodan (Endosulfan) and Cymbush (Cypermethrin) are the most popular pesticide and usage of them in lowland is prevalent compared to the upland area. While, fertilizers have been used extensively in both upland and lowland areas.

Domestic wastewater in the poblacions are channeled through or treated by septic tanks, but the efficiency of such septic tanks are very low due to their poor function and scarce maintenance.

Of the 17 poblacions, twelve have their own dumpsites, but all of them have no provision for leachate control and monitoring. In addition, at least about 18 creeks and 6 rivers are used as illegal dumpsites.

The river waters in the Study Area are deteriorated by wastewater discharged from the above mentioned various sources. While the deterioration of deep well water is attributed to the insufficient well structure or the well's nearness to pollution sources.

6.1 OBJECTIVES OF WATER QUALITY ANALYSIS

The objectives of water quality analysis are to determine the water quality characteristics of the different water resources in the Study Area, to grasp the groundwater flow system from the viewpoint of water quality and to evaluate deterioration of water resources.

6.2 SAMPLES COLLECTED

A total of 40 samples were taken for analysis: 20 from existing deep wells, 10 from rivers and 10 from springs. The sampling locations were determined to have a better distribution over the Study Area.

Groundwater samples were taken twice, in June and in October, simultaneously with groundwater level measurements to find the typical water quality in dry season and wet season. Four (4) samples were also taken from JICA test wells in October and in December when the wells were completed.

Operating deep wells with lithologic log, well design, construction and other pertinent data were given priority as sampling points. Second priority sampling points were those having at least lithologic logs and well depths.

As for the analysis of pesticides, samples were collected form two deep wells located upland in Silang and Indang, three deep wells situated lowland in Maragondon, Naic and Tanza and five shallow wells situated near paddy fields in Naic, Maragondon, Gen. Trias and Tanza.

The sampling points are plotted in **Fig. 6.2-1.**

6.3 ANALYTICAL ITEMS AND ANALYTICAL METHOD

Samples were analyzed on the following water quality items: Coliform and Bacteria, Color, Odor, Taste, Turbidity as SiO_2, pH, TDS, Hardness, EC, Na, K, Ca, Mg, Zn, Cu, Fe, Mn, As, Pb, Se, Phenols, HCO_3^-, Cl^-, SO_4^{2-}, NO_2-N, NO_3-N and NH_3-N.

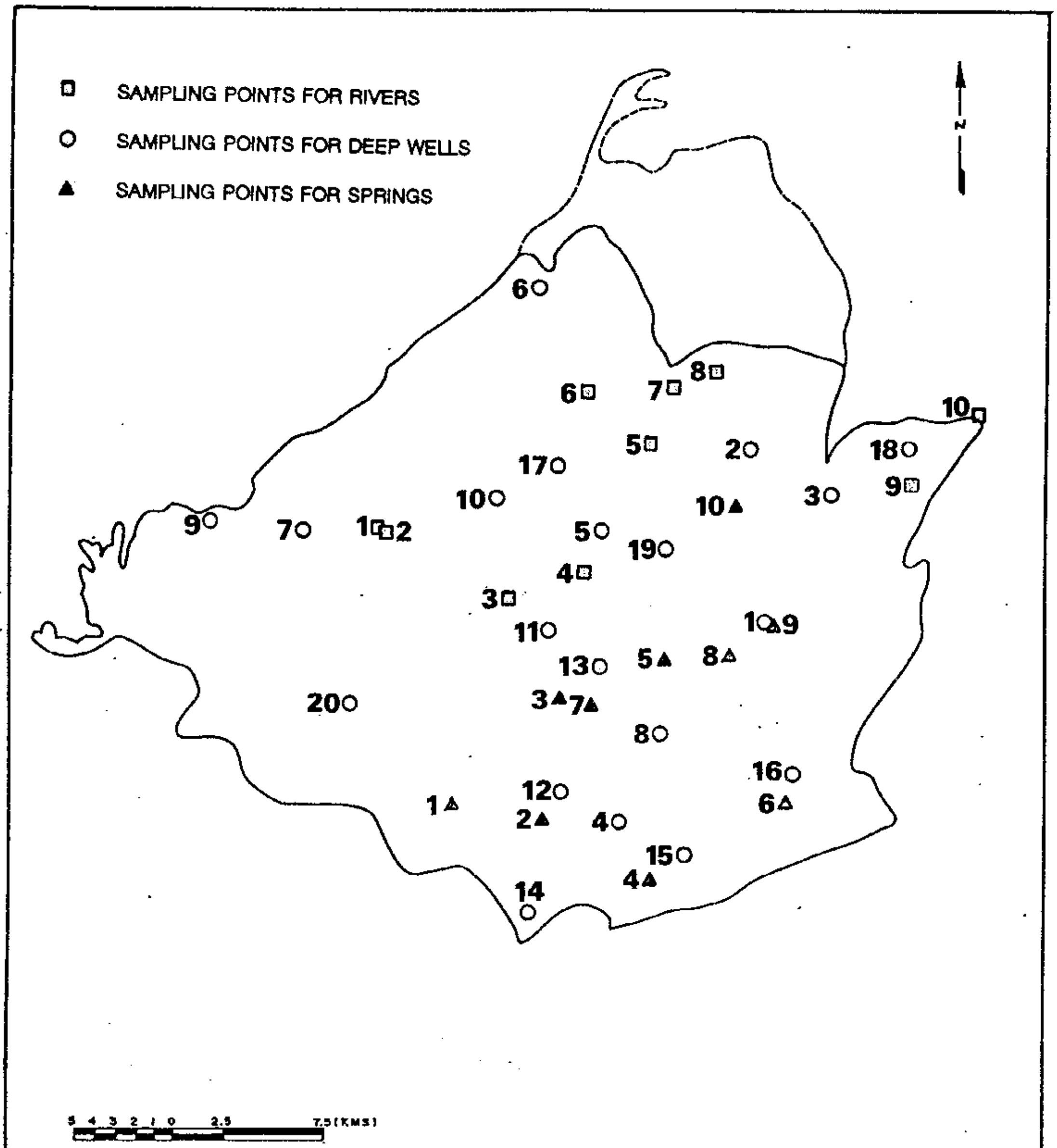
Of these items, color, odor, pH and EC were measured on site during sampling.

Na, K, Ca, Mg, HCO_3, Cl, SO_4, Fe and Mn were selected to determine the chemical characteristics of water from the hydrogeological point of view.

While, Phenol, NH_4-N, NO_2-N, NO_3-N, As, Cu, Pb, Se, Zn, Coliform, Bacteria and Pesticide were selected as indicators of water quality deterioration.

As for pesticides, Thiodan 35 EC (brand name: Endosulfan) and Azodrin 202R (brand name: Monocrotophos) were analyzed. Though both pesticides are recently banned in the Philippines by the Fertilizer and Pesticide Authority (FPA), they have been popularly used for quite a long time in the Study Area.

The water quality analysis were mostly done in LWUA Laboratory; other parameters including pesticides which could not be analyzed in LWUA were entrusted to a local private laboratory. The analytical method was the one adopted by the Environmental Protection Agency (EPA) of the USA.



CAVITE WATER SUPPLY DEVELOPMENT STUDY	Fig. 6.2-1
JAPAN INTERNATIONAL COOPERATION AGENCY	SAMPLING POINTS FOR WATER QUALITY ANALYSIS

6.4 ANALYTICAL RESULTS AND FITNESS FOR BENEFICIAL USE

Analytical results of water samples collected from deep wells, springs, and rivers are shown in **S/R.**

Based on the National Water Quality Standard for Drinking Water (NSDW) and the Water Quality Standards for Public Water Area of the Philippines (WSPWA) (refer to **Table 7.2-3**), beneficial use of various water sources in the Study Area are discussed hereafter.

6.4.1 Spring Water

Water quality of the 10 spring samples complies not only with Class AA of WSPWA, but also with the NSDW which is stricter than WSPWA. Consequently, spring water can be used as the best drinking water source not requiring treatment.

6.4.2 Deep Well Water

Deep well water has the same origin as springs, but the quality is not as good as that of spring water because of the effect of polluted shallow groundwater entering from the upper part of the well.

Table 6.4-1 shows the fitness for beneficial use of deep well water. About ninety (90) percent of the parameters are in compliance with class AA, however, quite a few samples have one or more parameters over the limit of class AA especially in wet season. Non-conformance with Class AA is attributed to high Phenols, NO_3-N, Total Coliforms or Fecal Coliforms.

As the wells scarcely have certain parameter with a constant deteriorated quality, the deterioration is not attributed to the pollution of aquifers, but to well construction and its facilities. Therefore, water quality deterioration of deep well can be prevented by sufficient well construction and its maintenance.

In both dry and wet seasons, samples were taken from five (5) deep wells for pesticide analysis and the results are N.D. (not detectable).

6.4.3 River Water

Most of the river water samples failed in the NSDW in terms of color and Ph. Even if color and pH are excluded, less than half of the samples comply with the NSDW. This means that the majority of the rivers in the Study Area cannot be considered as a safe source for drinking water supply.

Because most parameters are not listed in WSPWA, the data obtained from DENR are used in the assessment. The results are shown in **Table 6.4-2**. General evaluation or classification is difficult as only a few items could be used as basis, however, the results of water quality analyses show that river

Table 6.4-1 FITNESS FOR BENEFICIAL USE OF DEEP WELL WATER

NO.	COLOR	TEMP.	TDS	Cl	As	Pb	Cu	PHENO.	NO3-N	T. COL.	F. COL.
1	AA/AA	AA/AA	AA/AA	AA/AA	AA/AA	AA/AA	AA/--	B/AA	A/A	AA/AA	AA/AA
2	AA/AA	AA/AA	AA/AA	AA/AA	AA/AA	AA/AA	AA/--	A/AA	AA/AA	AA/AA	AA/AA
3	AA/AA	AA/AA	AA/AA	AA/AA	AA/AA	AA/AA	AA/--	AA/AA	AA/A	AA/AA	AA/AA
4	AA/AA	AA/AA	AA/AA	AA/AA	AA/AA	AA/AA	AA/--	A/AA	A/A	AA/A	AA/C
5	AA/AA	AA/AA	AA/AA	AA/AA	AA/AA	AA/AA	AA/--	AA/AA	AA/AA	AA/AA	AA/AA
6	AA/AA	AA/AA	AA/AA	AA/AA	AA/AA	AA/AA	AA/--	B/C	AA/AA	AA/AA	AA/AA
7	AA/AA	AA/AA	AA/AA	AA/AA	AA/AA	AA/AA	AA/--	AA/AA	AA/AA	AA/AA	AA/A
8	AA/AA	AA/AA	AA/AA	AA/AA	AA/AA	AA/AA	AA/--	AA/C	A/A	AA/A	AA/A
9	AA/AA	AA/AA	AA/AA	AA/AA	AA/AA	AA/AA	AA/--	A/AA	AA/AA	AA/AA	AA/AA
10	AA/C	AA/AA	AA/AA	AA/AA	AA/AA	AA/AA	AA/--	A/C	AA/AA	AA/AA	AA/AA
11	AA/AA	AA/AA	AA/AA	AA/AA	AA/AA	AA/AA	AA/--	AA/C	AA/A	AA/A	AA/A
12	AA/AA	AA/AA	AA/AA	AA/AA	AA/AA	AA/AA	AA/--	AA/B	A/A	AA/AA	AA/AA
13	AA/AA	AA/AA	AA/AA	AA/AA	AA/AA	AA/AA	AA/--	AA/B	AA/A	AA/AA	AA/AA
14	AA/AA	AA/AA	AA/AA	AA/AA	AA/AA	AA/AA	AA/--	AA/AA	A/AA	AA/A	AA/B
15	AA/AA	AA/AA	AA/AA	AA/AA	AA/AA	AA/AA	AA/--	AA/B	A/A	AA/A	AA/B
16	AA/AA	AA/AA	AA/AA	AA/AA	AA/AA	AA/AA	AA/--	AA/B	A/A	AA/AA	AA/AA
17	AA/AA	AA/AA	AA/AA	AA/AA	AA/AA	AA/AA	AA/--	AA/AA	AA/AA	AA/AA	AA/AA
18	AA/AA	AA/AA	AA/AA	AA/AA	AA/AA	AA/AA	AA/--	AA/AA	AA/AA	AA/AA	AA/AA
19	AA/AA	AA/AA	AA/AA	AA/AA	AA/AA	AA/AA	AA/--	AA/AA	AA/AA	C/AA	C/AA
20	AA/AA	AA/AA	AA/AA	AA/AA	AA/AA	AA/AA	AA/--	AA/AA	AA/A	A/AA	AA/AA

Source : JICA Study Team

TEMP. : Temperature
PHENO. : PHENOLS
T. COL : Total Coliforms
F. COL : Fecal Coliforms
TDS : Total Dissolved Solids

Left : Dry Season
Right : Rainy Season

Table 6.4-2 FITNESS FOR BENEFICIAL USE OF RIVER WATER

SOURCE	ADDRESS	DATE	COLOR	DO	BOD	SS	TS
ZAPOTE-BACOOR RIVER	BRGY. LIGAS, BACOOR	93, 10	B	AA	A	B	--
DITTO	LAS PINAS BACOOR BRGY.	93, 10	B	D	D	B	--
DITTO	LAS PONAS ZAPOTE BRGY.	93, 10	B	D	D	B	--
DITTO	COASTAL ROAD BRGY.	93, 10	B	D	D	B	--
ZAPOTE RIVER	DOWNSTREAM, HIGHWAY KM 14.8	92, 02	B	D	D	D	D
DITTO	UPSTREAM, BOUNDRY OF SAN	92, 02	B	AA	D	A	D
DITTO	ZAPOTE BRGY.	92, 11	B	D	D	AA	D
DITTO	UPSTREAM ELIZA HOMES BRGY.	92, 11	B	A	A	D	A
DITTO	SOLDIER HILLS, HANGING BRGY.	92, 11	A	D	A	D	AA
DITTO	CUTFALL, MOLINA DAM	92, 11	D	AA	A	D	A
DITTO	BAN NIICALAS VOUDARY	92, 11	A	D	D	A	D
ILANG ILANG RIVER	FCTE SEWER DISCHARGE POINT	92, 05	D	D	D	D	D
DITTO	NEAR KPI; UPSTREAM OF DAM	92, 05	A	AA	AA	AA	AA
DITTO	DASMARINAS RIVER BRGY.	92, 11	AA	D	--	A	AA
DITTO	MALAGASANG BRGY.	92, 11	B	D	--	A	AA
DITTO	ASN SEBASTIAN HANGING BRGY.	92, 11	C	AA	--	D	AA
DITTO	HANGING BRGY. JAM FARM	92, 11	AA	D	--	AA	AA
DITTO	KAWIT BRGY.	92, 11	A	D	--	AA	D
DITTO	*	92, 11	C	D	--	D	A
DITTO	**	92, 11	C	D	--	D	D
PALICO RIVER	DOWNSTREAM, NASUGBU-LIAN BRGY.	92, 10	D	D	--	D	AA
DITTO	BILARAN PALICO BRGY.	92, 10	A	AA	--	D	AA
DITTO	UPSTREAM SABANG BRGY.	92, 10	A	D	--	AA	AA
IMUS RIVER	POBLACION II-A	92, 11	A	--	--	D	AA
DITTO	BACOOR BRGY.	92, 11	A	--	--	D	AA
DITTO	PASONG BUAYA	92, 11	AA	--	--	AA	B
DITTO	TANZA LUMA 6-UPSTREAM	92, 11	AA	--	--	AA	AA
DITTO	TANZA LUMA 5-UPSTREAM	92, 11	B	--	--	AA	AA
DITTO	TOLL BRGY. AGUINALDO HIGHWAY	92, 11	A	--	--	AA	AA

Source : DENR Region IV Office.

* : DOWNSTREAM 400 M EFFLUENT OF MONTERE WTF

** : DOWNSTREAM 300 M FROM EFFLUENT OF MOTEREY SLAUGHERHOUSE water is often classified as B, C or D, rather than as A or AA. According to the classification of DENR, the two (2) main rivers in the Study Area, Ilang Ilang River and Imus River, belong to class B and C, respectively. Based on these results, it seems reasonable to consider that other rivers like Zapote River and Palico River do not belong to class A or AA.

6.5 GROUNDWATER FLOW SYSTEM

The groundwater flow system in the Study Area was investigated by interpreting the results of the analysis of groundwater and river water quality, considering their origin and mutual relationship.

Fig. 6.5-1 shows the water quality type of groundwater, spring, and river water in the Study Area. The water quality is expressed in equivalents per million (epm), and its value is the average of the dry and wet seasons' values.

(1) Most springs are distributed in the higher elevations from 310 m to 530 m and their water quality types are similar. But, the water quality type of Bukal Spring (No.10) located at 130 m in elevation is different from those of other springs.

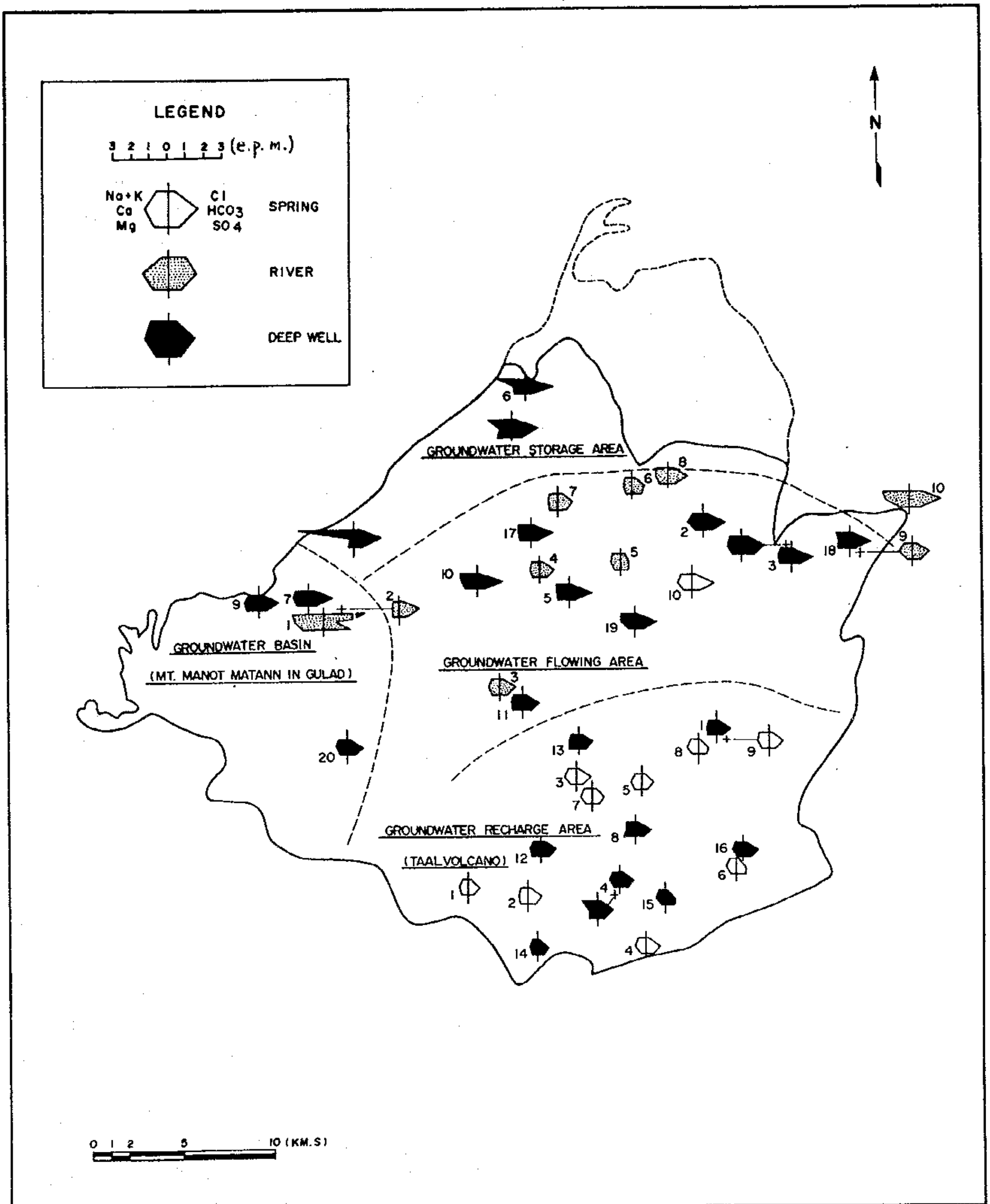
Usually, groundwater or spring water in the recharge area is similar to that of rainwater in quality and shows a balanced hexa-diagram. Bukal Spring water, however, has been stored for a longer period in the aquifer, and its concentrations of HCO_3, Na+K and Ca, especially HCO_3 are higher than those of the other springs.

(2) The water quality types of the deep well waters located above 300 m in elevation are very similar to those of springs and have a balanced rhombus. Thus, deep well waters have conditions similar to most springs, i.e., with short storage period in the aquifer.

On the other hand, the groundwater quality of the wells located from 70 m to 300 m in elevation is different from those of the wells located higher than 300 m. Water type of these wells shows a high concentration of HCO_3 as well as the other components. This fact suggests that the storage period is longer and the chemical components are added through the process of groundwater flowing from high to low elevation areas. The middle elevations where groundwater show high concentration of HCO_3 is defined here as the Groundwater Flowing Area.

The water quality type of deep well water in Tanza is very different from those in other areas. The concentration of HCO_3 is the highest and the Na+K component is also very high, while the Ca component is low. This indicates that the storage period of groundwater in Tanza is very long, and ion exchange between Na+K and Ca has occurred during this period. Thus, the low elevation area is named here the Groundwater Storage Area.

Though the wells in Maragondon (No.7) and Camandag (No.9) are located in the Groundwater Storage Area, their water quality types are very different from that of Tanza well. Thus, it is considered that they have different recharge areas. The groundwater in Maragondon and



CAVITE WATER SUPPLY DEVELOPMENT STUDY	Fig. 6.5-1 WATER QUALITY TYPE OF WATER RESOURCES IN THE STUDY AREA
JAPAN INTERNATIONAL COOPERATION AGENCY	

Camandag may be recharged in Mt. Manot Mataan in Gulad an old volcano located westward. The groundwater of the Magallanes (No.20) is also recharged in the same area

(3) Most river waters show a water quality type similar to that of spring and deep well waters located above 300 m. Thus, the origin of the river water is considered to be springs. However, the water of the Maragondon River (No.1) indicates high concentration of chloride (804 mg/lit in average) as well as the other components. The water of Maragondon River is considered to be affected by sea water since the elevation of the sampling point (No.1) is almost the same as MSL.

In **Fig. 6.5-2**, hexa-diagram of deep well water is plotted on the cross section along A-A' line of the electric resistivity survey. This figure indicates the same relationship between water quality type and the storage period in the aquifer described above. In addition, the difference in water quality type between upper and lower aquifers is not so large.

Fig. 6.5-3A, 3B and **3C** are the hexa-diagrams of deep well water, spring water and river water, respectively. On the key-diagram, most waters are lined in the narrow zone with 30 - 40% of Na^{+}+K^{+}, but the ratio of HCO_3^- changes widely from 40% to 80% reflecting the storage period.

6.6 POLLUTION OF WATER RESOURCES

6.6.1 Pollution Sources

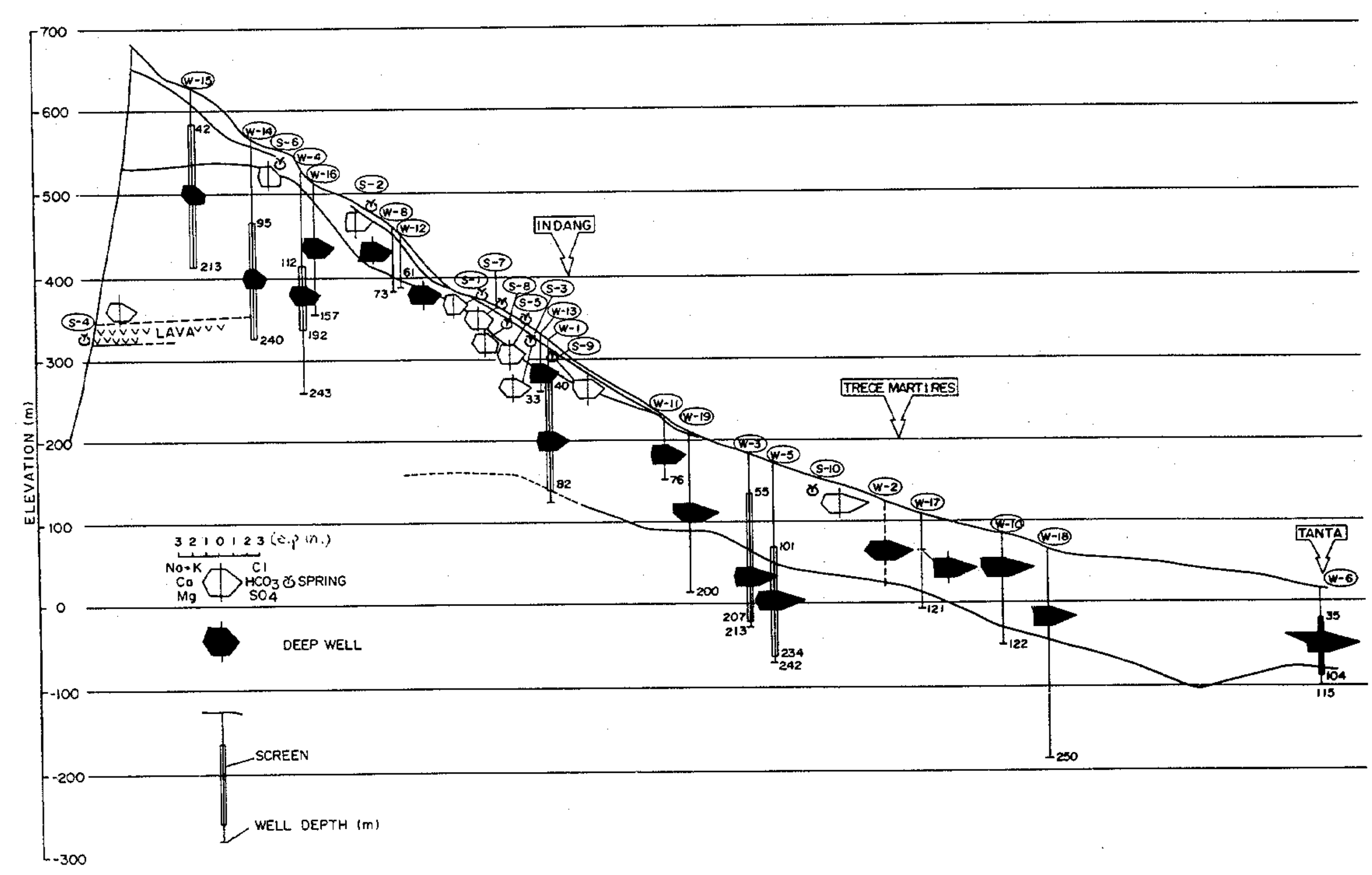
Industrial effluent, fertilizers and pesticides, domestic wastewater and solid wastes are identified as pollution sources in the Study Area.

(1) Industrial Effluent

A total of 181 industrial establishments are in operation and some new plants are currently being constructed in the Study Area. A plot of these industries is presented in **Fig. 6.6-1**. Location, water source, operation patter, products and other data are presented in S/R.

About 20 percent of total industrial wastewater generated in the Study Area (approximately 5.730 x 10^6 cum) is discharged in open spaces and 80 percent is discharged to canals or creeks. The ratio of treated effluent to wastewater is estimated as low as about 30 percent. Particularly in G.M.A., Carmona and Silang almost all wastewaters are disposed without treatment.

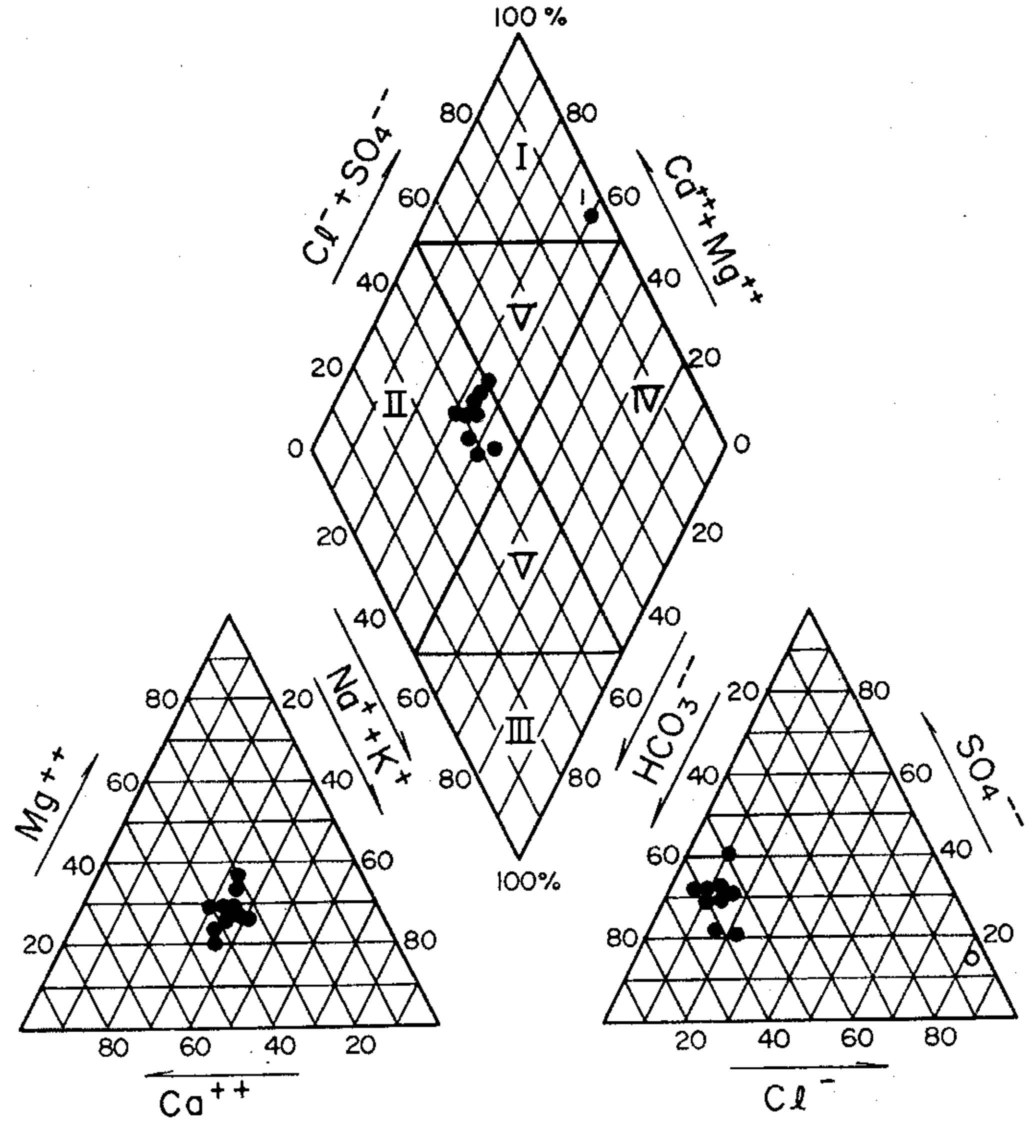
Thirty five (35) of the 181 industries located in the Study Area are considered as potential polluters because a lot of water is consumed during operation and/or toxic or harmful elements are released in wastewater of these industries.



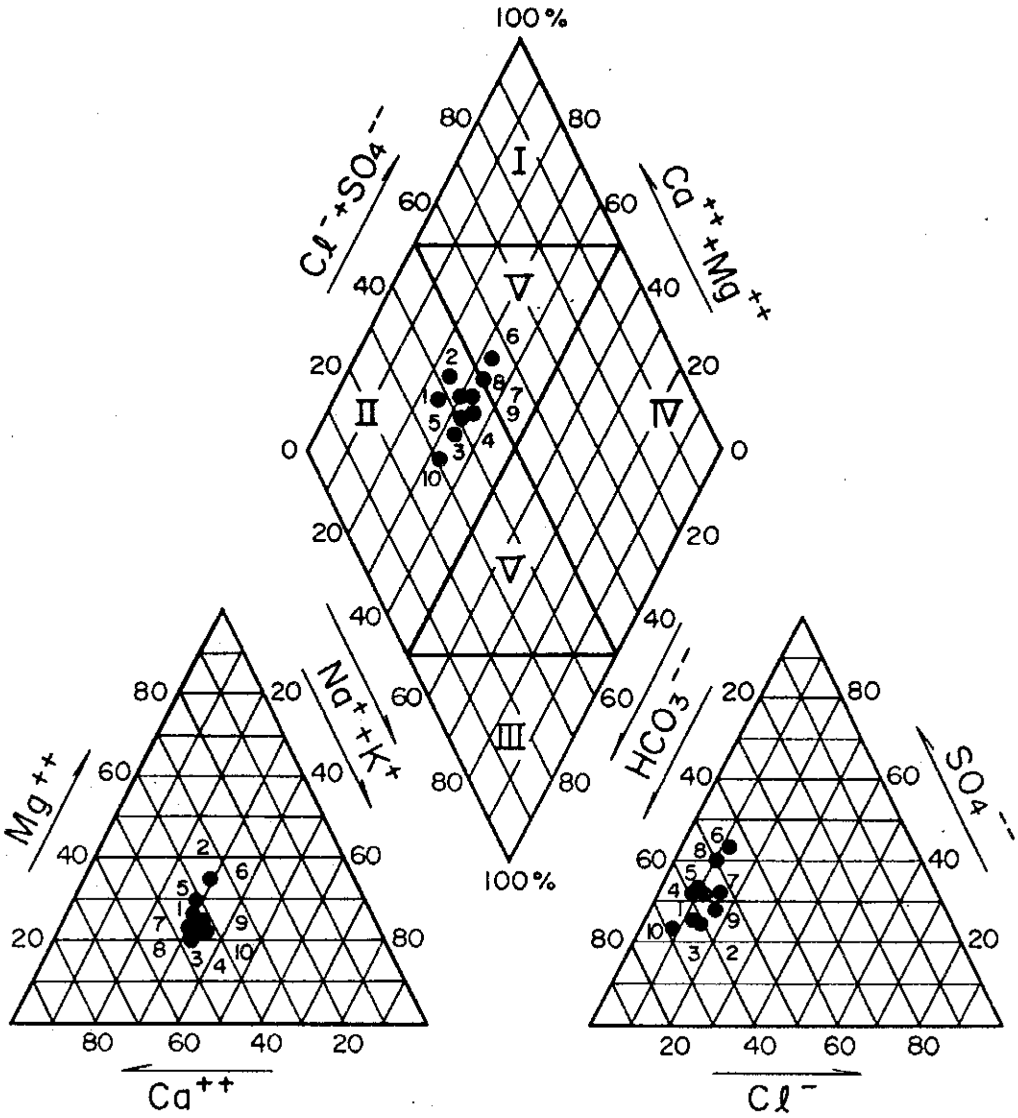
CAVITE WATER SUPPLY DEVELOPMENT STUDY

JAPAN INTERNATIONAL COOPERATION AGENCY

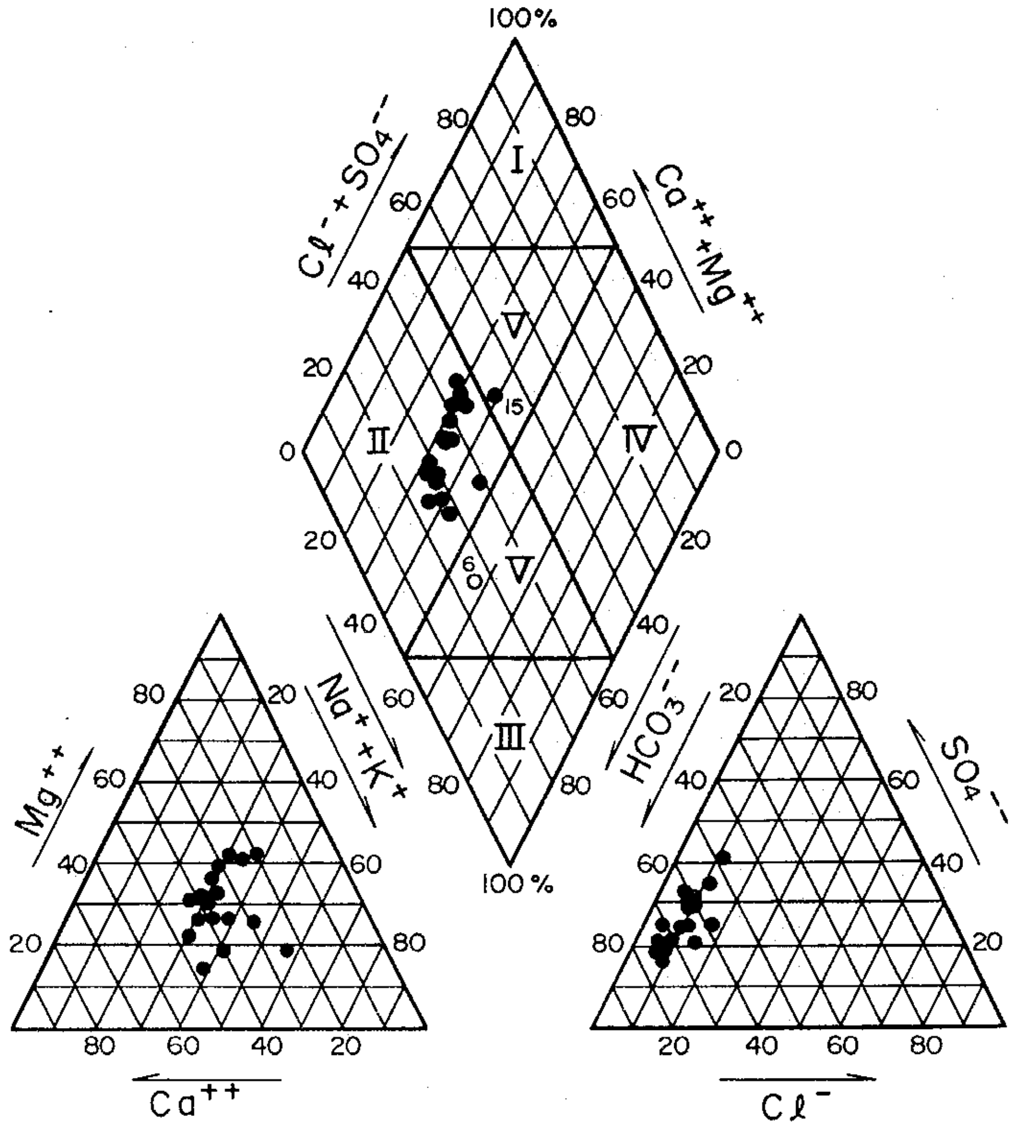
Fig. 6.5-2
RELATIONSHIP BETWEEN WATER QUALITY TYPE AND DEPTH



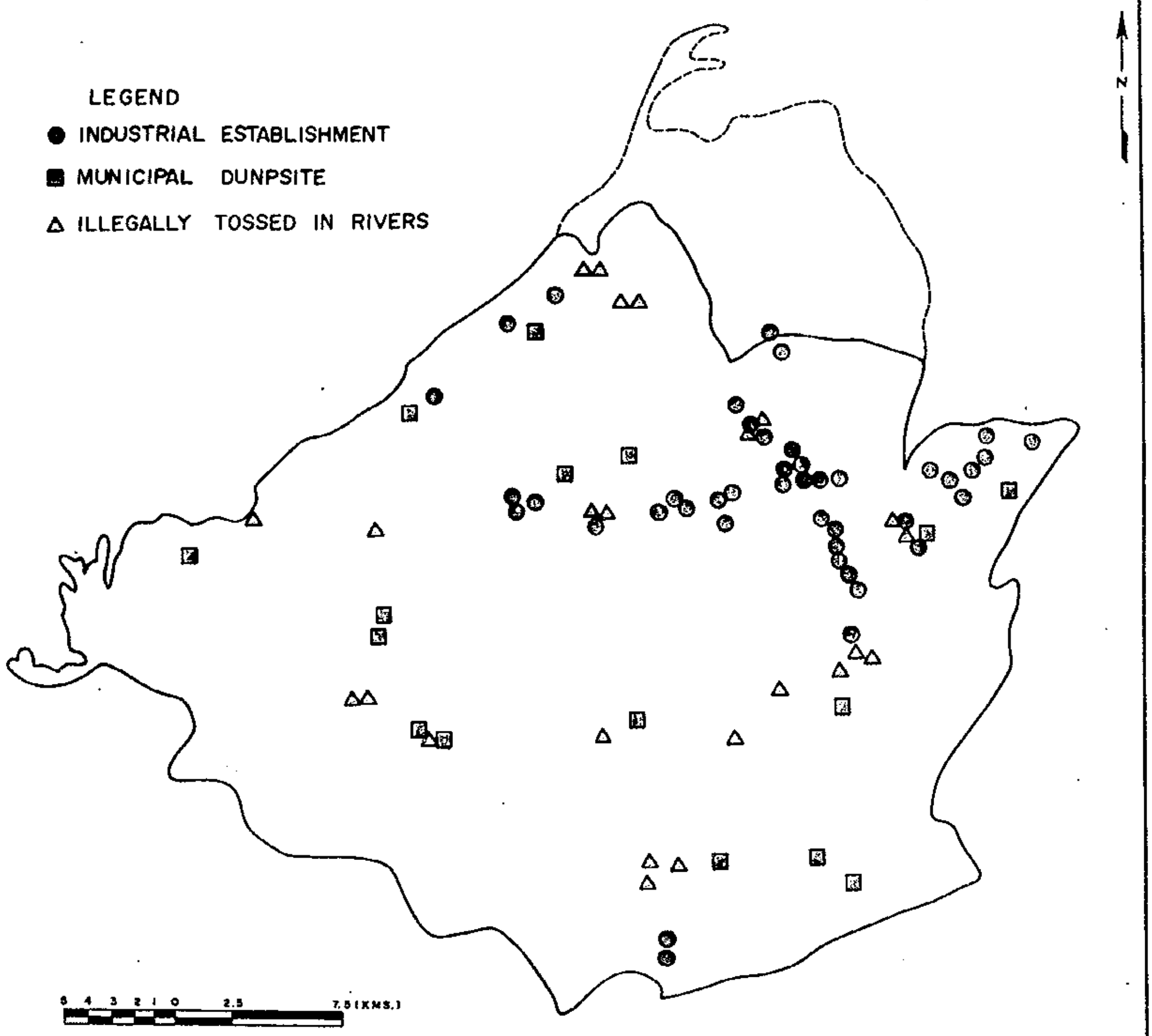
CAVITE WATER SUPPLY DEVELOPMENT STUDY	Fig. 6.5-3 (A) KEY-DIAGRAM OF WATER RESOURCES (A) RIVER WATER
JAPAN INTERNATIONAL COOPERATION AGENCY	



CAVITE WATER SUPPLY DEVELOPMENT STUDY	Fig 6.5-3 (B) KEY-DIAGRAM OF WATER RESOURCES (B) SPRING WATER
JAPAN INTERNATIONAL COOPERATION AGENCY	



CAVITE WATER SUPPLY DEVELOPMENT STUDY	Fig. 6.5-3 (C) KEY-DIAGRAM OF WATER RESOURCES (C) DEEP WELL WATER
JAPAN INTERNATIONAL COOPERATION AGENCY	



CAVITE WATER SUPPLY DEVELOPMENT STUDY	Fig. 6.6-1
JAPAN INTERNATIONAL COOPERATION AGENCY	DISTRIBUTION OF POLLUTION SOURCES

The majority (66 percent) of potential polluters are equipped with WTP (Wastewater Treatment Plant), but the DENR compliance monitoring records show that many of these systems are inefficient.

In 1992–1993, the DENR Office of Region IV collected forty-five (45) effluent samples from twenty-one (21) industries in Cavite Province and analyzed 5–7 items, that is Color, pH, Total Solids, Suspended Solids, DO and BOD. As a result, it was made clear that more than 50 percent of the potential polluters are making genuine efforts to treat their effluent, and some have been successful. The other half of the industries discharge effluent in violation of the effluent standards. About 10% of the samples have a BOD value equal or greater than 3000 ml/L.

(2) Pesticides and Fertilizers

There is no government agency in charge of monitoring the quantity of pesticides produced or consumed in the Philippines. The FPA only monitors the total quantity imported by the country.

Based on the results of farm and shop surveys conducted in one upland area (Mendez), and two lowland areas (Naic and Tanza), usage of pesticides in lowlands is prevalent compared to the upland area. In Mendez, where coffee and fruits are grown, none of the interviewed farmers is using pesticides. While in Tanza, pesticides are widely used in irrigated paddy fields.

Thiodan (Endosulfan) and Cymbush (Cypermethrin) are the most popular brands. Cymbush is used during the wet months, while Thiodan is used during the dry months. The decrease in users of Thiodan is possibly due to the restriction on its use issued last year by the FPA.

Use of pesticides in the Study Area started about 45 years ago. However, the pesticides are being used for a period of 10 and 20 years by 50 percent and 14 percent of the interviewed farmers, respectively.

Water samples were taken from shallow wells adjacent to rice field for the analysis of popular pesticides. The result is N.D. (not detectable).

Fertilizers have been used extensively in both upland and lowland areas. Eighty (80) percent of the interviewed farmers were using urea. This fertilizer contains 46 percent of nitrogen. Other commercial fertilizers used by the farmers are also of nitrogen type without phosphorus and potassium. Complete type of fertilizers are used occasionally by very few farmers. Data on fertilizers use are summarized as follows:

MUNICIPALITY	APPLICATION SEASON	APPLICATION FREQUENCY (times/yr)	AMOUNT APPLIED (Kg/ha/yr)	CROP
LOWLAND:				
Naic	dry & wet	4	950	rice
Tanza	dry & wet	4	750	rice
UPLAND:				
Mendez	wet	1 or 2	1,150	coffee fruits

Both upland and lowland areas have started using fertilizers since the late 1940s. However, only 50 percent and 31 percent of the interviewed farmers have been using fertilizers for more than 13 and 20 years, respectively.

Contents of NO_3-N and NH_3-N in groundwater, presented in the later section, indicates that the degree of contamination of groundwater by fertilizers is relatively slight at present.

(3) Domestic Wastewater

As a part of EIA Survey, a domestic wastewater disposal survey was conducted in the lowland towns of Naic, Tanza, Cavite and the upland town of G.M.A.

Results of the survey are presented in S/R. Domestic wastewater in the poblacions are channeled through or treated by septic tanks. These septic tanks are not provided with a soil infiltration system and not regularly inspected. Effluents from the septic tanks are mostly discharged to the street canals and eventually flow into creeks or rivers.

(4) Solid Wastes

Of the 17 poblacions, twelve (12) have their own dump sites. These dump sites are all open dumps with no provisions for leachate control and monitoring. Location of the dump sites is presented in **Fig. 6.6-1**. Total solid wastes gathered to these dump sites amounts to 140,900 x 10^6 ton/year.

As in most municipalities, creeks and rivers are the common sites for illegal dumps. At least about 18 creeks and 6 rivers are used as illegal dumps in the Study Area. A total of about 222 x 10^6 ton of illegally disposed wastes were noted during the survey.

6.6.2 Groundwater Pollution Mechanism

(1) Identification

Groundwater in the Study Area, as already mentioned, is a safe source for drinking, but it is somewhat polluted in several wells.

Degree of groundwater pollution were measured by pollution index Ii defined as follows:

$$Ii = Ci/Co$$
$$Co = AVG(i) + 2STD$$

Ii : pollution index of a certain water quality item
Ci : concentration of i in groundwater
Co : concentration of i in spring water in the upland area
AVG(i) : average concentration of i in spring water in the upland area
STD : standard deviation

Since NH_3-N and NO_3-N are not detected from spring water, their Co's are determined as 2 mg/lit for NH_3-N and 1 mg/lit for NO_3-N. The calculation results are shown in **Table 6.6-1.**

(2) Distribution of Pollution Index

Fig. 6.6-2 shows the distribution of I_{TDS}, which represents the general tendency of pollution. Obviously, wells with high I_{TDS} are concentrated along the National Road crossing the Study Area and along the sea shore area. This indicates the relationship between groundwater pollution and urbanization. Particularly, wells 7 and 9 in Maragondon and Ternate are not only characterized by a high level of I_{TDS} but also by the highest I_{Cl}, which suggests the possibility of saline water intrusion.

It can be found in **Table 6.6-1** that the increase of I_{TDS} seems accompanied by the increase of nitrogen compounds.

In most wells, concentration of NH_3-N is higher than that of NO_3-N and the former in wet season is higher than that in dry season, while the latter is not so different between dry season and wet season.

As nitrogen compounds transfer from NH_3-N to NO_2-N via NO_3-N, the above mentioned facts suggest that the excremental pollution sources are near the wells. As a matter of fact, septic tanks sometimes are constructed less than 25 meters away from water supply sources and are generally insufficient in the Study Area.

Influence of excremental pollution sources to the wells is also reflected to the abnormal high content of coliform in wells No.19 (wet season) and No.4, 14, 15 (dry season).

Table 6.6-1 POLLUTION INDEX OF DEEP WELL WATER

WELL	TDS		Ca		Mg		Na+K		Zn		Cu		Fe		Mn		Pb		HCO3+CO3		SO4		CL		PHENOLS		NH3-N		NO3-N	
NO.	DRY	RAIN	DRY	RAIN	DRY	RAIN	DRY	RAIN	DRY	RAIN	DRY	RAIN	DRY	RAIN	DRY	RAIN	DRY	RAIN	DRY	RAIN	DRY	RAIN	DRY	RAIN	DRY	RAIN	DRY	RAIN	DRY	RAIN
1	0.80	0.75	0.6	0.8	0.9	0.9	0.7	0.8	0.4	1.1	0.78	--	1.6	0.2	0.0	0.9	ND	ND	0.8	0.7	0.4	0.3	0.8	0.6	3.0	0.0	1.7	2.5	1.7	1.8
2	1.07	0.99	1.2	1.1	0.6	1.2	1.0	0.9	1.6	0.5	1.03	--	1.3	0.8	0.3	0.9	ND	ND	1.1	1.1	0.7	0.4	0.9	0.7	2.0	0.0	1.5	2.7	0.6	0.2
3	1.03	0.96	0.8	1.0	1.3	1.2	1.0	0.9	1.1	0.1	0.99	--	1.6	0.6	0.0	1.7	ND	ND	1.1	1.1	0.7	0.4	0.5	0.3	0.9	0.0	3.5	2.6	0.6	1.0
4	0.71	0.64	0.6	0.8	0.7	0.7	0.7	0.7	0.3	0.1	0.68	--	1.4	0.2	0.1	0.9	ND	ND	0.7	0.7	0.7	0.5	0.8	0.4	0.9	0.0	0.7	2.5	1.9	2.0
5	1.27	0.97	1.1	1.0	1.4	1.2	1.1	1.1	3.1	6.1	1.12	--	0.9	0.6	0.1	1.0	ND	ND	1.3	1.1	0.8	0.3	0.6	0.4	0.9	0.0	0.7	2.3	0.5	0.2
6	1.43	1.34	0.7	1.0	1.1	0.9	2.4	2.6	0.7	0.1	1.39	--	1.4	0.7	0.2	1.8	ND	ND	1.5	1.4	0.6	0.4	0.7	0.9	4.0	10.0	2.9	2.5	0.1	0.0
7	1.35	1.22	1.0	1.2	1.7	1.4	1.2	1.2	2.3	7.1	1.29	--	0.9	0.6	0.1	0.9	ND	ND	1.2	1.2	0.5	0.6	1.6	1.3	0.9	0.0	1.2	2.5	0.6	0.6
8	0.98	0.85	0.6	0.7	1.3	1.5	0.8	0.8	0.4	0.6	0.92	--	1.0	0.3	0.0	0.8	ND	ND	0.8	0.7	0.7	0.4	0.8	0.5	0.9	10.0	1.4	2.3	3.0	3.0
9	1.14	1.03	0.9	1.0	1.4	1.2	0.9	0.9	2.7	0.3	1.09	--	1.0	0.6	0.1	0.3	ND	ND	1.0	1.0	0.7	0.5	1.6	1.4	2.0	0.0	0.0	2.4	0.0	0.5
10	1.27	1.22	1.0	1.2	1.2	1.5	1.3	1.5	6.1	2.0	1.25	--	0.7	1.6	0.7	2.1	ND	ND	1.4	1.1	0.5	0.4	0.8	0.5	1.0	6.0	1.5	2.4	0.0	0.2
11	0.85	0.79	0.6	0.9	1.2	1.0	0.8	0.8	0.7	1.9	0.82	--	1.0	0.2	0.1	0.9	ND	ND	0.8	0.8	0.5	0.5	0.9	0.6	0.9	6.0	1.5	2.5	0.6	1.2
12	0.91	0.84	0.7	1.0	1.3	0.9	0.7	0.7	8.6	1.1	0.88	--	0.6	0.2	0.0	0.9	ND	ND	0.7	0.7	0.5	0.6	0.7	0.7	0.9	5.0	1.7	2.6	2.9	3.0
13	0.70	0.68	0.5	0.7	1.1	1.0	0.6	0.7	5.2	1.0	0.69	--	2.1	0.2	0.1	0.8	ND	ND	0.7	0.7	0.6	0.5	0.5	0.4	0.9	3.0	1.1	2.5	0.1	1.9
14	0.63	0.54	0.6	0.5	0.9	0.5	0.5	0.5	0.4	0.0	0.59	--	1.5	0.3	0.0	0.3	ND	ND	0.6	0.5	0.6	0.4	0.5	0.4	0.9	0.0	1.2	2.5	2.7	0.5
15	0.80	0.69	0.5	0.7	0.0	0.6	0.7	0.7	11.7	6.3	0.75	--	1.4	0.3	0.0	0.3	ND	ND	0.5	0.5	0.8	0.5	0.7	0.6	0.9	3.0	1.8	2.5	2.6	2.9
16	0.99	0.74	0.0	0.7	0.0	1.0	0.7	0.7	0.5	0.4	0.87	--	1.0	0.3	0.0	0.8	ND	ND	0.9	0.7	0.9	0.3	0.7	0.4	0.9	5.0	0.0	2.4	2.5	3.0
17	1.09	1.03	0.7	1.0	1.3	1.2	1.1	1.1	24.2	3.1	1.06	--	1.5	0.7	0.0	0.8	ND	ND	1.1	1.2	0.7	0.3	0.7	0.6	0.9	0.0	1.8	2.5	0.3	0.3
18	1.10	0.99	0.8	0.8	1.3	1.4	1.1	1.2	16.6	0.3	1.05	--	1.2	0.3	0.0	0.2	ND	ND	1.1	1.1	0.4	0.3	0.7	0.5	0.9	0.0	2.8	2.4	0.5	0.4
19	1.10	0.98	0.8	1.0	0.0	1.2	1.2	1.2	0.4	0.4	1.04	--	1.6	0.1	0.0	0.8	ND	ND	1.1	1.2	0.6	0.4	0.6	0.3	0.9	0.0	3.3	2.6	0.4	0.0
20	0.92	0.81	0.7	0.8	1.0	0.8	0.9	0.8	2.7	0.5	0.87	--	3.5	0.3	2.3	0.2	ND	ND	0.9	0.7	0.6	0.5	0.9	0.8	0.9	0.0	2.9	2.5	0.1	1.6
Co(BV)	236	255	40.1	34.5	12.7	13.9	37.9	35.0	.016	0.1	0.04	--	0.22	0.3	0.22	0.2	ND	ND	170	163	66.1	128	18.3	18.1	0.001		2		1	

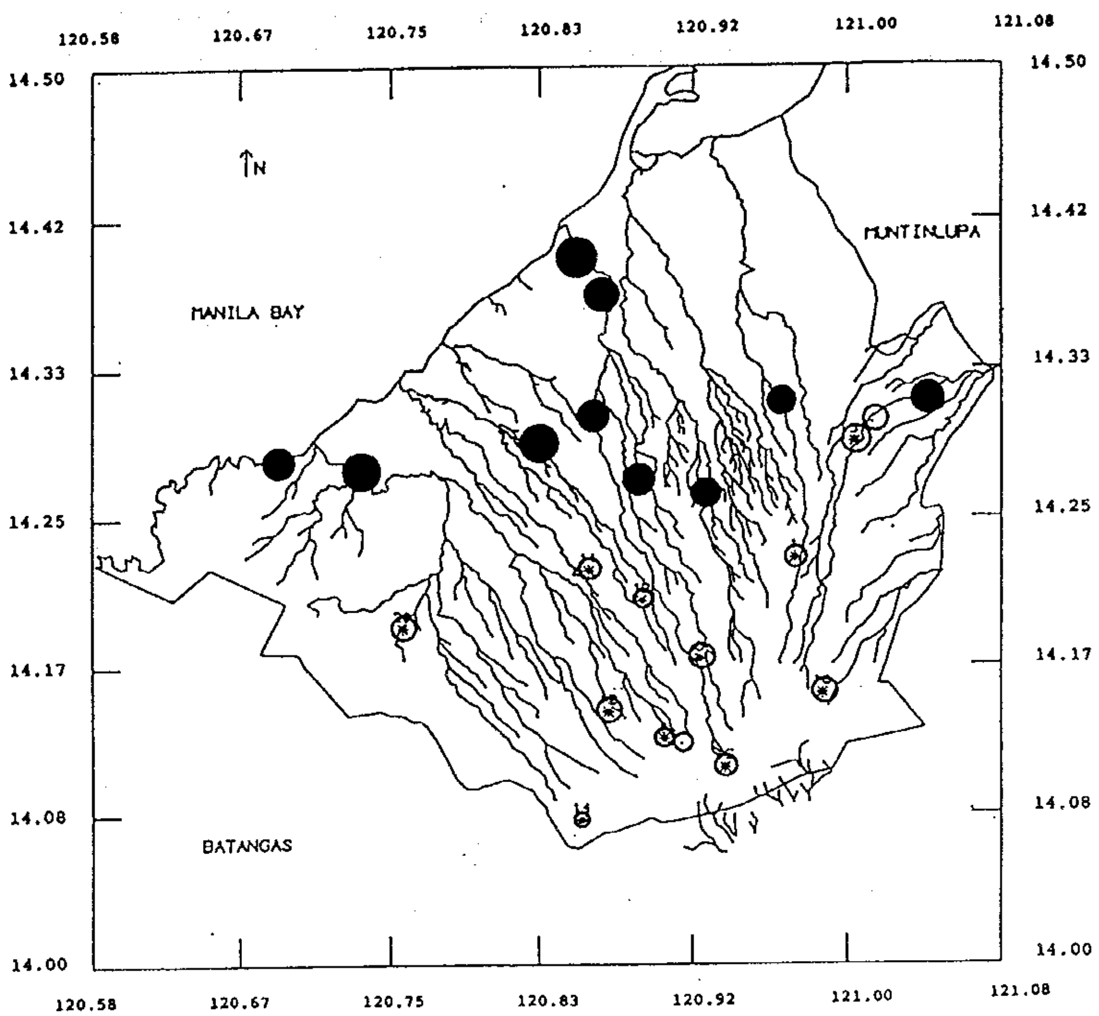
Source : JICA Study Team

TDS : Total Dissolved Solids

DRY : Dry Season

RAINY : Rainy Season

Co(BV) : Base Value calculated with the results of spring water quality analysis and the formulation Co=AVG+2*STD



Deep well with TDS pollution index equal or greater than 1.

Deep well with TDS pollution index less than 1.

CAVITE WATER SUPPLY DEVELOPMENT STUDY	Fig. 6.6-2
JAPAN INTERNATIONAL COOPERATION AGENCY	DISTRIBUTION OF TDS POLLUTION INDEX FOR DEEP WELL WATER

The other parameter that should be heeded is phenols, for it has degraded groundwater of some wells from class AA to class B and even C. As phenols pollution is usually attributed to industries, a thorough investigation was carried out in the EIA survey. Only one industry (a fabric/yarn knitting factory) was found near one of the problem wells (NO.10), but the test results showed that phenols in its wastewater is below the NSDW standard (0.001mg/l).

CHAPTER 7

SOCIAL SYSTEMS RELATED WITH DEVELOPMENT AND PRESERVATION OF WATER RESOURCES

CHAPTER 7

SOCIAL SYSTEMS RELATED WITH DEVELOPMENT AND PRESERVATION OF WATER RESOURCES

The promotion, development and financing of local water utilities had been devolved to LWUA, which was created in 1973.

NEDA Board Resolution No.4, 1994, however, restricted LWUA's affairs to the implementation of financially viable Level III water supply projects in areas outside the MWSS jurisdiction.

The other water supply projects in the local areas are devolved to LGUs such as PPDC or MPDC/CPDC in cooperation of the related agencies.

Operation and maintenance of completed water supply facilities are entrusted to WD or RWSA, which are non-profit organizations formed by LGU.

Water quality standards are established for drinking water, for beneficial water area use and for effluent, respectively.

The water rates are decided in consideration of (a) financial self sufficiency, (b) socialized pricing scheme, (c) ability-to-pay by the consumers, (d) discouragement of excessive use and water wastage and other factors. As for (c), LWUA recommends that the water rate should be within 5% of the family income in the low income class and should not be increased by more than 60% in a year.

Water districts in the Study Area are aiming to reduce the ratio of the unaccounted water to less than 20 - 25% by the year 2000.

7.1 LAW AND REGULATIONS

The Provincial Water Utilities Act of 1973 (PD No.198) authorizes the formation of local water districts in the provincial areas of the Philippines outside the Metropolitan Manila area and provides for their administration and operation. It also created the LWUA as a specialized lending institution for the promotion, development and financing of local water utilities. This act consists of three titles; (1) Preliminary Provisions, (2) Local Water District Law, and (3) Local Water Utilities Administration Law.

The Water Code of the Philippines of 1976 (PD No.1067) is a base for utilization, exploitation, development, conservation and protection of water resources. The control and regulation of the government are through the National Water Resources Board (NWRB) which is composed of DPWH, NEDA, DOA, DTI, DENR, DOH, MWSS, LWUA, NIA and NPC. The objectives of this Code are: (a) to establish the basic principles and framework relating to the appropriation, control and conservation of water resources to achieve the optimum development and rational utilization of these resources; (b) to define the extent of the rights and obligations of water users and owners including the protection and regulation of such rights; (c) to adopt a basic law governing the ownership, appropriation, utilization, exploitation, development, conservation and protection of water resources and rights to land related thereto; and (d) to identify the administrative agencies which will enforce this Code.

NEDA Board Resolution No.5, s. 1989, delineates the responsibilities of DILG, DPWH and LWUA. Level I (point sources) water supply projects will be implemented by DPWH with the participation of LGUs, and Level II (communal faucets) and III (individual connections) water supply projects will be implemented by LWUA. DILG's participation will be limited to general administration and institutional building.

The Local Government Code of 1991 (RA No.7160) provides for a more responsive and accountable local government structure through a more decentralized system of government, by which local government units (LGUs) shall enjoy more powers, authority, responsibilities and resources. Certain national government functions and responsibilities (especially for basic services including water supply) are to be devolved to LGUs.

NEDA Board Resolution No.4, s. 1994, provides the amendment of NEDA Board Resolution No.4, s. 1989 consistent with government's decentralization and devolution process. The proposed amendment is as follows: "Level I, Level II and Level III water supply projects may be implemented by the concerned LGUs within their jurisdiction. LWUA shall implement only financially viable Level III water supply projects in areas outside the MWSS jurisdiction. DILG participation will consist of general administration and institution building. MWSS will be responsible for Level III water systems in Metro Manila and adjacent areas. DPWH, together with DILG and DOH, will provide technical assistance to LGUs in the planning, implementation and operation & maintenance of water supply facilities".

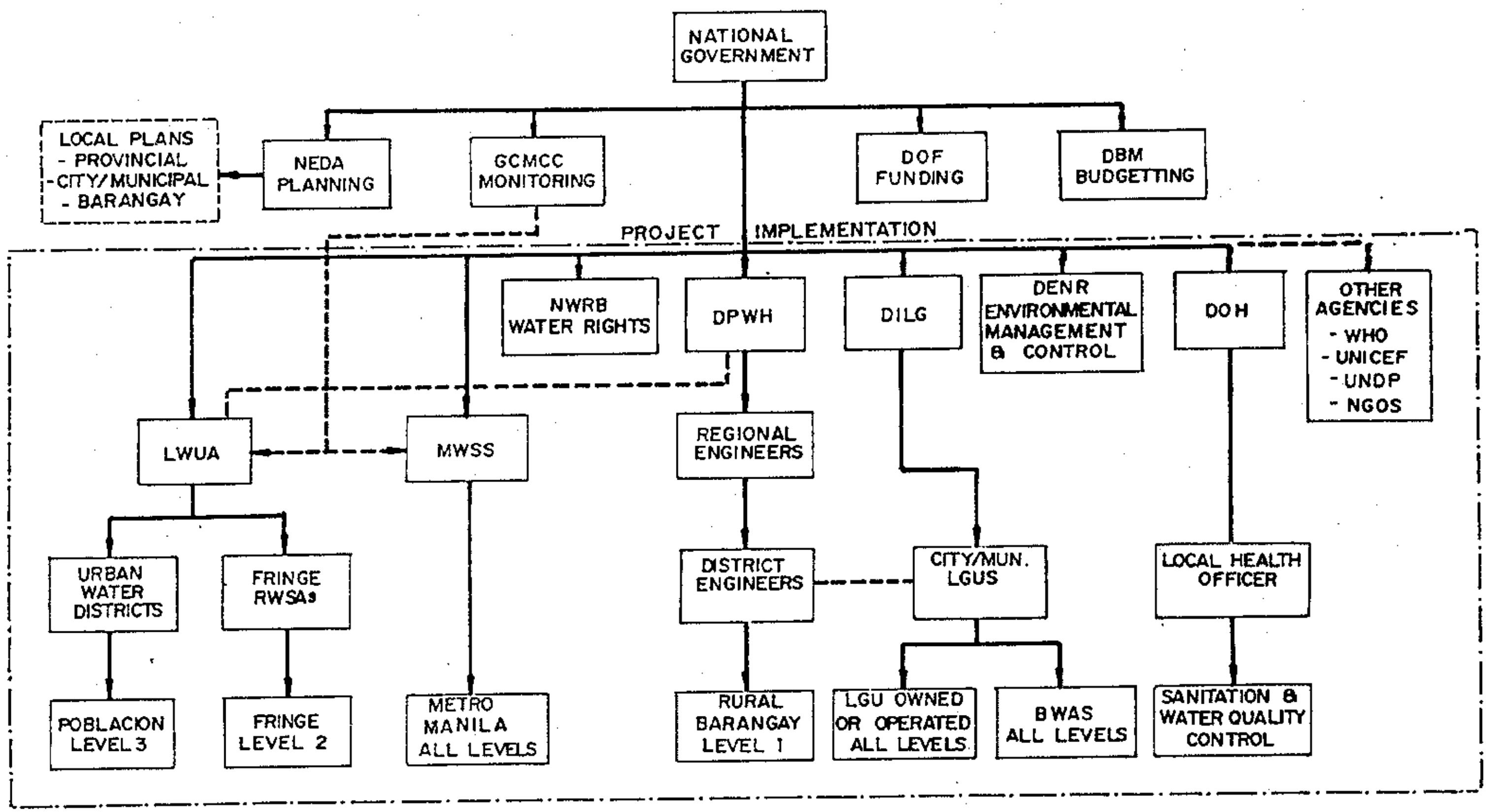
7.2 ADMINISTRATIVE ORGANIZATIONS

Several government agencies are involved in policy formulation, project planning, implementation and management related to water resources. The related agencies and institutions are shown in **Fig. 7.2.1**.

7.2.1 Central agencies

(1) NWRB

The National Water Resource Board (NWRB) is a high level body, which the NWRC was reorganized and renamed in 1987. It is responsible for coordinating and integrating all the activities related to water resources development and management. It formulates and coordinates water resources programs, regulates and controls the utilization, exploitation, development and conservation of the Country's water resources and the regulation of water



CAVITE WATER SUPPLY DEVELOPMENT STUDY

JAPAN INTERNATIONAL COOPERATION AGENCY

Fig. 7.2-1
ADMINISTRATIVE ORGANIZATIONS RELATED WATER RESOURCES FUNCTIONAL RELATIONSHIPS

utilities' operation. The Board is composed by DPWH, DOA, NEDA, DOH, DENR, DTI, MWSS, LWUA, NIA and NPC.

(2) DPWH

The Department of Public Works and Highways (DPWH) is responsible for the development of integrated water supply plans, mainly for source development of Level I water supply systems, in line with national plans and policies. DPWH performs engineering and construction functions such as drilling of wells and provision of technical assistance although these functions are being devolved to the LGUs according to the Local Government Code of 1991.

(3) DILG

The Department of Interior and Local Government (DILG) is responsible for administration and institution building such as assistance to the LGUs in the formation of Barangay Water Association (BWA).

(4) DOH

The Department of Health (DOH) is responsible for the formulation and implementation of sanitation programs and the administration of health education programs. It also promotes safe water supply and exercises surveillance of water quality.

(5) DENR

The Department of Environment and Natural Resources (DENR) is responsible for environmental management and control as a whole. As for water resources, it monitors the environmental conditions through the water quality criteria and effluent standards.

7.2.2 Local Agencies

(1) MWSS

The Metropolitan Waterworks and Sewerage System (MWSS) provides a potable water supply and sewerage requirements of Metro Manila and contiguous areas including 5 municipalities and one city in Cavite Province. It is responsible for the planning, design, construction, operation and maintenance of water supply and sewerage disposal systems for all level within its jurisdiction.

(2) LWUA

The Local Water Utilities Administration (LWUA) is responsible for water supply development in all areas not covered by MWSS in the country. Although it has provided water services through Level II and Level III, the NEDA Board Resolution No.4, s. 1994, delineates that LWUA shall implement only financially viable Level III water supply projects in areas outside the MWSS jurisdiction. LWUA provides loan to Water Districts (WD) for the development of water systems and extends engineering services as well.

(3) WD and RWSA

Water Districts and Rural Waterworks and Sanitation Associations are institutions to be established for the purpose of ensuring proper operation and maintenance of completed water supply, sewage and sanitation facilities.

A Water District is a non–profit, quasi–public and local entity. WDs are formed at the option of the local government concerned. RWSAs are non–stock, non–profit organizations envisioned to operate and manage water supply facilities constructed by DPWH, LWUA, DILG, DOH and LGUs.

(4) Local Government Units (LGUs)

As for the provincial government, the Office of Provincial Planning and Development Coordinator (PPDC) is responsible for coordination of the water supply development programs in cooperation of the above mentioned agencies. In municipal or city level, the Office of Municipal/City Planning and Development Coordinator (MPDC/CPDC) is responsible for coordination on water supply development.

Since national government functions and responsibilities for basic services including water supply are to be devolved to LGUs according to the Local Government Code of 1991, a more responsive and accountable structure shall be required in LGUs.

7.3 WATER QUALITY STANDARDS

7.3.1 Drinking Water

National Standards for Drinking Water (NSDW) of the Philippines, shown in **Table 7.3–1**, were established in 1976 and revised in 1994. The establishment and the revision are based on World Health Organization (WHO) Standards. The NSDW involves standards on physical, chemical, toxic and other deleterious substance like persistent pesticides. Most of these are for the protection of human health and others have been set out to provide acceptable aesthetic and taste characteristics.

In general, the revised NSDW gives more stringent standards especially in the section of health significance. Compared with the former one, items included in the new NSDW are increased from 45 to 51. New items are concentrated in sections concerning biological organisms and disinfectants such as chlorine and chlorite. Ironic with this increase, section on radioactive substance and some items like calcium and magnesium are erased.

Table 7.3-1 WATER QUALITY STANDARD FOR DRINKING WATER

BIOLOGICAL ORGANISMS

Constituent	Permissible limit
Total count/mL	10

HEALTH SIGNIFICANCE

A. Inorganic Constituents

Constituent	Maximum Level (mg/L)
Antimony	0.005
Arsenic	0.01
Barium	0.7
Boron	0.3
Cadmium	0.003
Chromium	0.05
Cyanide	0.07
Fluoride	1.0
Lead	0.01
Mercury (total)	0.001
Nitrate as NO3	50
Nitrite as NO2	3
Selenium	0.01

B. Organic Constituents (Pesticides)

Constituent	Maximum Level (μg/L)
Aldrin & Dieldrin	0.03
Chlordane	0.2
DDT	2
Endrin	0.2
Heptachlor and Heptachlor expoxide	0.03
Lidane	2
Methoxychlor	20
Petroleum oils & grease	nil
Toxyphane	5
2,4-D	30
2,4,5-T	9

AESTHETIC QUALITY

Constituent or Characteristic	Maximum Level (mg/L)
Taste	Unobjectionable
Odor	Unobjectionable
Color	5 TCU
Turbidity	5 NTU
Aluminum	0.2
Chloride	250
Copper	1
Hardness	300(as $CaCO_3$)°
Hydrogen Sulfide	0.05
Iron	1
Manganese	0.5
pH	6.5-8.5
Sodium	200*
Sulfate	250
Total Dissolved Solids	500
Zinc	5*

DISINFECTANTS AND DISINFECTANT BY-PRODUCTS

Constituent	Maximum Level (mg/L)
a. Disinfectant	
Chlorine(residual)	0.2-0.5
b. Disinfectant By-products	
Bromate	0.025
Chlorite	0.2
2,4,6 trichlorophenol	0.2
Formaldehyde	0.9
Phenolic substances	0.001
Bromoform	0.1
Dibromochloromethane	0.1
Bromodichloromethane	0.06
Chloroform	0.2

* Secondary standards; compliance with the standard and analysis are not obligatory.

Reference: WHO guidelines for DWQ, 1984; Revision of WHO guidelines for DWQ, 1993.

Initial examinations of water from newly constructed sources are required before they are opened and operated for public use.

It is also stipulated that periodic examinations of water supplies be performed, at a minimum, annually for surface and groundwater supplies.

7.3.2 Environment of Water Area

The first water usage classification or water quality criteria was performed by the National Pollution Control Commission (NPCC) in Rules and Regulations of NPCC, 1978. In this work, public waters were classified into 6 grades of surface water, 2 of ground water, and 4 of marines and estuarine water.

This classification was revised by DENR in DENR Administrative Order No. 34, in 1990. Compared with the former, the new classification repealed groundwater category and reduced the grades to 5 grades of fresh water and 4 of coastal and marine waters. Parameters in the new classification were also reduced from 50 to 34 and instead of several heavy metal parameters, pesticides were adopted.

The usage classification of public waters and the water quality criteria are shown in **Table 7.3–2** and **7.3–3**.

7.3.3 Wastewater

Similar to the water usage classification, the effluent water quality standards were established in 1982 and revised by DENR in DENR Administration Order No.35, 1990.

At present effluent standards shown in **Table 7.3–4**, toxic and other deleterious substances and conventional and other pollutants are regulated in accordance with the water quality criteria stated above.

In this AO No.35, it is also prescribed that "No industrial or domestic sewage effluent shall be discharged into class AA and SA waters", and that "no industrial or manufacturing plant shall be operated without the control facilities or wastewater treatment system in good order or in proper operation".

For strong industrial wastewater with high BOD and where the receiving body of water is class C, D, SC, and AO No.35 established interim effluent standards to achieve the increase of removal rate of BOD from 90–95 percent in 1990 to 97–99 percent in 1995.

Table 7.3-2 WATER AREA CLASSIFICATION AND BENEFICIAL USE

Classification		Beneficial Use
Fresh Surface Waters (Rivers, Lakes, Reservoirs, etc.)	AA	Public water supply class I
	A	Public water supply Class II
	B	Recreation water class I (Bath, Swimming, etc.)
	C	Fishery water (Preparation and growth of fish)
		Recreational water Class II (Boating, etc.)
		Industrial Water supply class I
	D	Agriculture irrigation, Livestock watering, etc.
		Industrial water supply Class II
		Other land waters
Costal and Marine Waters	SA	For propagation survival and harvesting of shellfish
		Tourist zones and national marine parks,etc.
		Coral reef parks, etc.
	SB	Recreational water Class I
		Fishery water Class I
	SC	Recreational water Class II
		Fishery water Class II
		Marshy and/or mangrove areas
	SD	Industrial water supply Class II
		Other coastal and marine waters

Source: DENR Administrative Order No.34, 1990

Table 7.3-3 WATER QUALITY STANDARD FOR PUBLIC WATER AREA

PARAMETER	UNIT	Fresh Surface Waters					Coastal and Marine Waters			
		AA	A	B	C	D	SA	SB	SC	SD
Color	PCU	15	50	(a)	(a)	(a)	(a)	(a)	(a)	(a)
Temperature	> deg. C	-	3	3	3	3	3	3	3	3
pH	-	6.5-8.5	6.5-8.5	6.5-8.5	6.5-8.5	6.0-9.0	6.5-8.5	6.0-8.5	6.0-8.5	6.0-9.0
DO	%	70	70	70	60	40	70	70	70	50
DO	mg/l	5.0	5.0	5.0	5.0	3.0	5.0	5.0	5.0	2.0
BOD	mg/l	1	5	5	7(10)	10(15)	3	5	7(10)	-
TSS	mg/l	25	50	(b)	(c)	(d)	(b)	(c)	(c)	(d)
TDS	mg/l	500	1000	-	-	1000	-	-	-	-
Surfactants (MBAS)	mg/l	nil	0.2(0.5)	0.3(0.5)	0.5	-	0.2	0.3	0.5	-
Oil/Grease	mg/l	nil	1	1	2	5	1	2	3	5
Nitrate as N	mg/l	1.0	10	nr	10	-	-	-	-	-
Phosphate as P	mg/l	nil	0.1	0.2	0.4	-	-	-	-	-
Phenolic Substance	mg/l	nil	0.002	0.005	0.02	-	nil	0.01	(e)	-
Total Coliforms	MPN/100ml	50	1000	1000	5000	-	70	1000	5000	-
Fecal Coliforms	MPN/100ml	20	100	200	-	-	nil	200	-	-
Chloride as Cl	mg/l	250	250	-	350	-	-	-	-	-
Copper	mg/l	1.0	1.0	-	0.05	-	-	0.02	0.05	-
Arsenic	mg/l	0.05	0.05	0.05	0.05	0.1	0.05	0.05	0.05	-
Cadmium	mg/l	0.01	0.01	0.01	0.01	0.05	0.01	0.01	0.01	-
Chromium	mg/l	0.05	0.05	0.05	0.05	0.1	0.05	0.1	0.1	-
Cyanide	mg/l	0.05	0.05	0.05	0.05	-	0.05	0.05	0.05	-
Lead	mg/l	0.05	0.05	0.05	0.05	0.5	0.05	0.05	0.05	-
Total Mercury	mg/l	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	-
Organophosphate	mg/l	nil	nil	nil	nil	nil	nil	nil	nil	-
Aldrin	mg/l	0.001	0.001	-	-	-	0.001	-	-	-
DDT	mg/l	0.05	0.05	-	-	-	0.05	-	-	-
Dieldrin	mg/l	0.001	0.001	-	-	-	0.001	-	-	-
Heptachlor	mg/l	nil	nil	-	-	-	nil	-	-	-
Lindane	mg/l	0.004	0.004	-	-	-	0.004	-	-	-
Texaphane	mg/l	0.005	0.005	-	-	-	0.005	-	-	-
Methoxychlor	mg/l	0.10	0.10	-	-	-	0.10	-	-	-
Chlordane	mg/l	0.003	0.003	-	-	-	0.003	-	-	-
Erdrin	mg/l	nil	nil	-	-	-	nil	-	-	-
PCB	mg/l	0.001	0.001	-	-	-	0.001	-	-	-

Source: DENR Administrative Order No. 34 (1990)

(a) - No abnormal discoloration from unnatural causes
(b) - Not more than 30% increase
(c) - Not more than 30mg/l increase
(d) - Not more than 60 mg/l increase
(e) - Not present in concentrations to affect fish flavor/taste

TABLE 7. 3-4 EFFLUENT STANDARDS

PARAMETER	UNIT	(A.B. SB)		C		D		SC		SD	
		OEI	NPI	OEI	NPI	OEI	NPI	OEI	NPI	OEI	NPI
Color	PCU	150	100	200	150	-	-	(a)	(a)	(a)	(a)
Temperature	>deg. C	3	3	3	3	3	3	3	3	3	3
pH	-	6.0 - 9.0		6.0-9.0	6.5-9.0	5.0-9.0	6.0-9.0	6.0 - 9.0		5.0 - 9.0	
COD	mg/l	100	60	150	100	250	200	250	200	300	200
Settleable Solids	mg/l	0.3	0.3	0.5	0.5	-	-	-	-	-	-
BOD	mg/l	50	30	80	50	150	120	120	100	150	120
TSS	mg/l	70	50	90	70	200	150	200	150	(b)	(c)
TDS	mg/l	1200	1000	-	-	2000	1500	-	-	-	-
Surfactants	mg/l	5.0	2.0	7.0	5.0	-	-	15	10	-	-
Oil/Grease	mg/l	5.0	5.0	10.0	5.0	-	-	15	10	15	15
Phenolic Sub.	mg/l	0.1	0.05	0.5	0.1	-	-	1.0	0.5	5.0	1.0
Total Coliforms	MPN/100ml	5000	3000	15000	10000	(500)	(500)	-	-	-	-
Arsenic	mg/l	0.2	0.1	0.5	0.2	-	-	1.0	0.5	1.0	0.5
Cadmium	mg/l	0.05	0.02	0.1	0.05	-	-	0.2	0.1	0.5	0.2
Chromium	mg/l	0.1	0.05	0.2	0.1	-	-	0.5	0.2	1.0	0.5
Cyanide	mg/l	0.2	0.1	0.3	0.2	-	-	0.5	0.2	-	-
Lead	mg/l	0.2	0.1	0.5	0.3	-	-	1.0	0.5	-	-
Total Mercury	mg/l	0.005	0.005	0.005	0.05	-	-	0.005	0.005	0.05	0.01
PCB	mg/l	0.003	0.003	0.003	0.003	-	-	0.003	0.003	-	-
Formaldehyde	mg/l	2.0	1.0	2.0	1.0	-	-	2.0	1.0	-	-

Source: DENR Administrative Order No. 35 (1990)

* Discharge of sewage and/or trade effluent are prohibited or not allowed to Class AA and SA

OEI - Old Existing Industry
NPI - New/Proposed Industry or wastewater treatment plants to be constructed
TSS - Total Dissolved Solids
(a) - Discharge shall not cause abnormal discoloration in the receiving waters outside of the mixing zone
(b) - Not more than 60 mg/l increase (dry season)
(c) - Not more than 30 mg/l increase (dry season)

7.4 WATER RATE AND ITS COLLECTION SYSTEM

7.4.1 Water Rates

According to the LWUA methodology manual, the water rates are decided in consideration of (a) financial self sufficiency, (b) socialized pricing scheme, (c) ability – to– pay by the consumers, (d) discouragement of excessive use and water wastage, and other factors. Also, for calculation of water rates, the revenue derived from water shall cover cash requirements such as (a) operation expenses of the system, (b) debt services, (c) normal day–to–day extensions to the system, and (d) a reasonable portion of expenditures for any major expansion of the system.

Three basic methods of computing water rates are generally applied. They are the revenue unit method, the quantity block method and the optional method, which is a combination of the former two methods. In fact, more simple trial and error calculation in the financial statements program is conducted according to the LWUA financial services. As for the basic conditions of ability–to–pay of the consumers, LWUA recommends that the water rate should be within 5% of the family income in the low income class and should not be increased by more than 60% in a year.

After satisfying the basic conditions and requirements of financial indicators by LWUA, the revised or new water rate is proposed at the public hearing for users. If the agreement is not reached here, the proposed rate shall be adjusted.

Water rates as of March 1994 in the Water Districts, RWSAs in the Study Area are shown in **Table 7.4–1**. The rates vary because of the variation of the cash requirements and other conditions in the Water Districts and RWSAs.

7.4.2 Collection System

Water tariffs are collected in a monthly basis in response to the bill through meter reading. Generally, in small water district, collectors are going around in the barangay to collect the fee from users. In large water district, on the other hand, users pay the fee to the water district office directly or the banks, which are agents of the office.

As common feature of water utilities, the excessive amount of water unaccounted for is recognized. Typically, half of the water loss is due to administrative failures, such as illegal connections, faulty meters, and lack of meter reading and billing, and to the provision of unmetered water to a variety of public or other institutions. The other half is attributable to physical leaks in the distribution system. According to the Water Districts in the Study Area, their targets of the ratio of the unaccounted water in the year 2000 are about 20–25%.

Table 7.4-1 Water Rates in the Study Area (1994)

(1) Water Districts

Unit: Peso

No.	Water Districts	Minimum Charge	Commodity Charge				
		1-10 cum	11-20	21-30	31-40	41-50	51 above
1	Dasmarinas I	35.00	4.00	4.75	5.75	6.90	6.90
1	Dasmarinas II	35.00	4.35	4.60	5.00	5.65	6.70
2	Indang	48.00	5.00	6.00	7.00	7.00	7.00
3	G. M. A.	80.00	8.80	9.20	11.50	11.50	11.50
4	Mendez	95.00	10.00	10.75	11.75	11.75	11.75
5	Silang	50.00	5.30	6.30	7.45	7.45	7.45
6	Tanza	45.00	4.50	4.65	4.75	4.75	4.75
7	Tagaytay City	110.00	5.80	7.05	9.05	11.85	13.55
10	Maragondon	45.00 *	2.00	2.50	3.00	3.00	5.00

Source: Local Water Utility Administration (LWUA)
Note: *Less than 15 cum is 45 peso and 2 peso is charged between 16-20 as commodity charge.

(2) RWSA and LGU

Unit: Peso

No.	Municipality/City	Rates	Remarks
8	Amadeo	50.00	Minimum Charge per month
9	Magallanes	40.00	Flat rate for Level III per month; 30.00 peso for Level II
12	Alfonso	50.00	Flat rate per month
13	Naic	30.00	Flat rate per month
14	Gen. Aguinaldo	2.84	per cubic meter
16	Trece Martirez City	2.40	per cubic meter

Source: JICA Study Team; Based on the Survey of Existing Water Supply Facilities