フィリピン共和国

地方都市上水道整備計画調査

最終報告書

（付属資料）

昭和62年 3 月

国 際 協 力 事 業 団

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(付属資料)

昭和62年3月

国際協力事業団

Angeles City, Pampanga

本報告書の構成について

本件フィリピン国地方都市上水道整備計画調査に係る最終報告書については和文、英文の双方が作成されるものである。英文報告書は地方水道公社(Local Water Utilities Administration, 以後LWUAと略す）の要望により、各地域について本編と附属資料を一体としてそれぞれ各1冊に編集したが、和文報告書については、次のような構成とした。

すなわち、本調査の対象地域は、4地域に分かれているが、調査としては一つの調査であることを考え4地域を併せて一つの報告書として取扱うこととするとともに、利用の便宜に配意し、要約編、本編及び付属資料の3分冊構成とした。

(1) 要約編については、英文報告書の第1章「要約」と第2章「一般的背景」をまとめて編集としたもので、その構成は下記のとおりである。

Ⅰ	はじめに	－報告書の構成、調査の背景、調査の範囲・内容、等
Ⅱ	施設計画	－現況、将来予測、水源、代替案検討、最適施設計画
Ⅲ	財務・経済分析	－市場調査、財務分析、経済分析
Ⅳ	組織及び経営	－現況組織、水道区の組織及び経営
Ⅴ	まとめ	－結論と提言

(2) 本編については、4地区をA．アンヘレス市、B．ダグパン市、C．カブヤオ－サンタ・ロサービニャン、D．バヨンボンーソラノの順序に編集した。各地区の章の構成は下記のとおりである。なお、本編のみに着目すれば、第3章から始まることはいささか体載上の問題はあろうが、英文版各章との対比の便宜を考えて、あえて章番号の変更をせぬこととした。

第3章	調査地域の概要
第4章	水道施設及び環境衛生施設の現況
第5章	人口及び水需要予測
第6章	水資源
第7章	代替案の比較検討
第8章	最適施設計画
第9章	財務分析
第10章	経済分析
第11章	組織及び経営

(3) 附属資料

附属資料として採録した主なるものは、下記のようなものである。

- 計画給水区域に係る行政区域細分別（Subdivision 等）現在人口
- 私営水道、レベルⅠ水道、レベルⅡ水道関係資料
- 既存さく井水源に設置されているポンプに関する調査関係資料
- 現行水道施設における給水水圧調査関係資料
- 無効水量調査関係資料
- 給水栓数関係資料
- 既存井戸地質（岩質）柱状図
- 揚水可能量試算関係資料
- Ｃ値調査関係資料
- 湧泉取水可能量調査関係資料
- 水質調査資料
- 建設単価関係資料
- 建設費試算関連資料
- 管網計算資料
- 市場調査調査票

4 地区に係る上記資料を本編と同じ編集順序により一冊にまとめた。

付属資料

アンヘレス市，パンパンガ県

APPENDIX 3.2.1 LIST OF SUBDIVISIONS (March 1983)

NAME OF SUBDIVISION	OWNER/OPERATOR	L O C A T I O N	AREA (In Sq. M.)
1. Abacan Subdivision	Nicolas Tinio	Balibago	51,180.00
2. Abad Santos Subdivision			
3. Angelina Subdivision	Rafael Lazatin	San Jose	55,553.00
4. Bagong Bayan Subdivision	Don Pepe Henson	Cutcut	460,017.00
5. Bagong Silang Subdivision	Don Pepe Henson	Cutcut	19,882.00
6. Balibago Subdivision	Isabelo Concepcion	Balibago	190,960.00
7. Beatriz Pangilinan	Beatriz Pangilinan	Balibago	7,433.00
8. Belen Homesite Subdivision	Atty. R. Morales	Sto. Cristo	237,609.00
9. Carmenville Subdivision	Renato Tayag	Cutcut	126,605.00
10. Checkpoint Subdivision	Anacleto Muñoz	Balibago	138,444.00
11. Clarkview Subdivision	Felipe Juico	Balibago	572,300.00
12. Clemente Dayrit	Clemente Dayrit, Jr.	Lourdes Sur East	473,905.70
13. Don Pepe Subdivision	Don Pepe Henson	Balibago	50,000.00
14. Don Bonifacio Subdivision	Timoteo Cruz	Pulung Maragul	720,000.00
15. Doña Agripina Subdivision	Ernesto Lopez, Jr.	Pandan	154,320.00
16. El Cano Subdivision	Dante Timbol	Pulung Bulu	193,800.00
17. El Cano Subdivision	Dante Timbol	Pulung Bulu	227,000.00
18. Essel Park	Jesus Lazatin	Sto. Domingo	49,840.00
19. Felisa Subdivision	Jose Galura	Balibago	94,448.00
20. Fenifel Subdivision	Enrique Baluyut	Balibago	27,177.00
21. Henson Low Cost Housing	Don Pepe Henson	Balibago	76,815.00
22. Hensonville Subdivision	Don Pepe Henson	Malabañas	529,689.00
23. Holy Cross Subdivision	Carmela Narciso	Sapangbato	184,758.00

(List of Subdivisions cont'd.)

NAME OF SUBDIVISION	OWNER/OPERATOR	L O C A T I O N	AREA (In Sq. M.)
24. Josefa Subdivision	Jose Narciso	Balibago	118,351.00
25. Josefaville - 1	Jose Narciso	Malabañas-Amsik	50,144.00
26. Josefaville - II	Jose Narciso	Malabañas	65,267.00
27. Kalayaan Subdivision	Don Pepe Henson	Lourdes Northwest	14,321.00
28. Mountain View Subdivision	Oscar Santos	Balibago	195,462.00
29. Leoncia Subdivision	Rafael Lazatin	Sto. Domingo	231,053.00
30. L & S Subdivision		Sto. Domingo	
31. Marisol Subdivision	Eusebio Lopez, Jr.	Pandan	634,206.00
32. Nepomuceno I	Francisco G. Nepomuceno	Cutcut	116,142.50
33. Nepomuceno II	Francisco G. Nepomuceno	Cutcut	323,462.00
34. Neponuceno III	Francisco G. Npeomuceno	Cutcut	870,480.00
35. Nepomuceno IV	Francisco G. Nepomuceno	Cutcut	365,436.00
36. New Valley	Bonifacio Eusebio	Balibago	88,836.00
37. Ophebia	Abelardo Tinio	Balibago	17.520.00
38. Plaridel I	Anacleto Muñoz	Malabañas	479,929.00
39. Plaridel II	Anacleto Muñoz	Anunas-Amsik	352,444.00
40. Priscilla Subdivision	Priscilla Santos	Balibago	5,529.00
41. Raymond Subdivision	Angel Reyes	Balibago	22,480.00
42. Roque Henson	Roque Henson	Balibago	27,177.00
43. Rovimar Subdivision	Vicente Henson	Balibago	27,185.00
44. Riverside Subdivision	Trinidad Lazatin	Anunas	337,871.00
45. Sor Maria Luisa	Renato Tayag	Balibago	27,177.00
46. Sta. Maria I	Priscilla J. Tinio	Balibago	36,612.00

(List of Subdivision cont'd.)

NAME OF SUBDIVISION	OWNER/OPERATOR	L O C A T O R	AREA (In Sq. M)
47. Sta. Maria II	Priscilla J. Tinio	Balibago	187,360.00
48. San Angelo Subdivision	Anacleto Muñoz	Sto. Domingo	494,300.00
49. Springside Subdivision	Carlos Sandico	Pandan	34,772.00
50. Sabina Tablante	Sabina Gomez	Balibago	37,493.00
51. San Antonio	Renato Tayag	Pulung Maragul	201,658.00
52. Sandico I	Carlos Sandico	Pulung Maragul	119,259.00
53. Sandico II	Carlos Sandico	Pandan	88,614.00
54. San Ignacio	Jose P. Dizon	Pandan	146,570.00
55. San Jose I	Jose Reynoso	Pulung Bulu	62,327.00
56. San Jose II	Jose Reynoso	Pulung Bulu	50,000.00
57. San Jose III	Jose Reynoso	Pulung Bulu	108,546.00
58. Severina Diamond	Severina Lim	Balibago	578,853.00
59. Timog-Silangan Park	Abelardo Tinio	Cutcut	1,090,830.00
60. T. Silangan (Resettlement)	Abelardo Tinio	Cutcut	625,572.00
61. La Buena-Tanhueco	Ben Tanhueco	Balibago	9,920.00
62. Vicente Henson	Vicente Henson	Balibago	27,177.00
63. Villa Amanda	Amanda Henson	Balibago	27,176.00
64. Villa Angela	Jesus Lazatin	Sto. Domingo	447,357.00
65. Villa Dolores	Pablo Panlilio	Sto. Domingo	220,382.00
66. Villa Esperanza	Purification Flores	Malabañas	31,881.00
67. Villa Gloria	Abelardo Tinio	San Jose	153,025.00
68. Villa Henson	Don Pepe Henson	Lourdes Northwest	11,859.00
69. Villa Sol	Sabiano Sagulo	Malabañas	528,000.00

(List of Subdivision cont'd.)

NAME OF SUBDIVISION	OWNER/OPERATOR	L O C A T I O N	AREA (In Sq. M)
70. Villa Teresa	Peter Nepomuceno	Cutcut	650,000.00
71. Abad Santos Compound		Pulung Maragul	
72. Embassy Court		Balibago	
73. Clarkville		Balibago	
74. East West Subdivision		Lourdes Sur East	
75. Villa Angelina	Rafael Lazatin	San Jose	
76. Pacimar Estate	Vladimir Panlilio	Pulung Bulu	26,673.00
77. Pineda Compound			
78. Essel Subdivision			

APPENDIX 3.4.1 Power Rate of Angeles Electric Corporation

Residential

First	15 kwh	₱ 0.40 per kwh
Next	35 kwh	0.38 per kwh
Next	51 kwh	0.35 per kwh
Next	100 kwh	0.33 per kwh
Excess	kwh	0.32 per kwh

Minimum Charge : ₱4.80 for the first 12 kwh

Small General Service

Classification	Conn. Load in Watts	₱0.50/kwh	₱0.40/kwh	₱0.35/kwh
GS-1	2,500 or less	First 50 kwh	Next 150 kwh	Next 300 kwh
GS-2	2,501 to 5,000	90	260	550
GS-3	5,001 to 10,000	160	440	1,200
GS-4	10,001 up	350	900	3,250

Monthly Excess : ₱0.33 per kwh

Minimum Charge : ₱7.20 for the first 12 kwh

Large General Service (GS-5)

Demand Charge		₱10.00 per kw
Plus Energy Charge	First 100 hrs.	₱ 0.35 per kwh
	Next 100 hrs.	0.32 per kwh
	Next 100 hrs.	0.30 per kwh
	Over 300 hrs.	0.28 per kwh

Minimum Charge : ₱300.00

APPENDIX 4.1.1.A Water Supply of the Subdivisions Visited by JICA Study Team

ITEM		Name of Subdivision					
		Carmen-ville	Essel	Sunset	Timog Park	Villa Angela	Villa Teresa
Background Information	Year Established	1968	1969	1985	1981	-	1969
	Number of Households	550	222	70	281	300	500
	Land area (ha.)	47	-	-	32	-	63
Water Supply Status	Ownership of the system	Ass'n.	Ass'n	Ass'n	Ass'n	Ass'n	Ass'n
	Commencement of Op'n	1968	1976	1965	1982	-	1968
	Water source	10 well	1 well	2 well	6 well	4 well	2 well
	Dist. Tank capacity (GAL)	50,000	11,000	100,000	100,000	-	100,000
	Number of Connections	550	222	70	174	300	350
	Served percentage	100	100	100	62	100	70

Note: - No data provided

APPENDIX 4.1.1.B Water Charges for the Subdivisions Visited by JICA Study Team

Villa Teresa WW:

Water Consumption	Residential	Commercial
0 - 10 cu.m	₱14.50 cu.m/minimum	₱17.00 cu.m/minimum
11 - 20	1.50	1.80
21 - 30	1.55	1.90
31 - 40	1.60	2.00
41 - 50	1.65	2.10
51 - 60	1.70	2.20
61 - 70	1.75	2.30
71 - 100	1.90	2.50
over 100	2.00	2.70

Villa Teresa WW:

Water Consumption	Residential
0 - 10 cu.m	₱22.00 cu.m/minimum
11 - 20	2.25
21 - 30	2.30
31 - 40	2.35
41 - 50	2.40
51 - 60	2.45
61 - 70	2.50
71 - 100	2.60
over 100	2.75

Essel WW:

First 10 cu.m (min) is ₱28.00 plus ₱2.00 per cu.m in excess of 10 m^3 Carmenville, Sunset and Timog Park WW - charge is flat rate at ₱160.00 per month.

APPENDIX 4.1.2 POPULATION AND NUMBER OF HOUSEHOLDS SERVED BY TYPE OF WATER SOURCE (1980)

Area		Barangay	No. of HH Population	Waterworks			Private and point source		
				City	Others	Total	Private pipes with pump	Point source with pitcherpump	Total
Urban	1	A. del Rosario	4,508	182	616	798	1,254	2,456	3,740
			791	32	108	140	220	431	651
	2	Amsik	1,111					1,111	1,111
			195					195	195
	3	Anunas	9,477		3,328	3,328	2,308	3,841	6,149
			1,663		584	584	405	674	1,079
	4	Balibago	31,606		21,449	21,449	4,115	6,042	10,157
			5,545		3,763	3,763	722	1,060	1,782
	5	Capaya	2,536					2,536	2,536
			445					445	445
	6	Claro M. Recto	7,695	1,533	519	2,052	1,254	4,389	5,643
			1,350	269	91	360	220	770	990
	7	Cutcut	14,004	194	1,704	1,898	1,601	10,505	12,106
			2,457	34	299	333	281	1,843	2,124
	8	Lourdes North-west	9,501	2,929		2,929		6,772	6,772
			1,667	479		479		1,188	1,188
	9	Lourdes Sur	3,760	2,012		2,012	461	1,287	1,748
			660	353		353	81	226	307
	10	Lourdes Sur East	4,940	1,043		1,043	1,151	2,746	3,897
			867	183		183	202	482	704
	11	Malabañas	13,690	382	6,657	7,039	1,835	4,816	6,651
			2,402	67	1,168	1,235	322	845	1,167
	12	Margot	1,368					1,368	1,368
			240					240	240
	13	Pampang	2,879	450		450	513	1,916	2,429
			505	79		79	90	336	426
	14	Pandan	12,517	3,939		3,939	4,229	4,349	8,578
			2,196	691		691	742	763	1,505

APPENDIX 4.1.2 (cont'd)

Area	Barangay	No. of HH Population	Waterworks			Private and point source		
			City	Others	Total	Private pipes with pump	Point source with pitcherpump	Total
Rural	29 Cuayan	433 76					433 76	433 76
	30 Cutud	672 118					672 118	672 118
	31 Mining	570 100					570 100	570 100
	32 Tabun	684 120					684 120	684 120
	Sub-Total	2,359 414					2,359 414	2,359 414
TOTAL		188,912 33,148	23,681 4,120	42,178 7,400	65,859 11,520	27,872 4,891	95,181 16,737	123,053 21,628

Note: Above: Population
Below: No. of HH

Source: Planning and Development Sec. of Angeles City
City Engineer's Office

APPENDIX 4.1.3 LEVEL I WATER SUPPLY SYSTEMS
(AS OF DEC. 1984)

Barangay	No. of Wells	Number of HH	Estimated Pop. Served	Population (1986)	Served Percentage	Remarks
1. A. del Rosario	3	31	186	5,069	3.7	
2. Anunas	1	12	72	575	12.5	
3. Capaya	3	32	192	3,763	5.1	
4. Cutcut	11	110	660	16,227	4.1	
5. Cutud	1	10	60	943	6.4	
6. Lourdes N.W.	9	90	540	11,201	4.8	
7. Lourdes S.E.	4	40	240	7,504	3.2	
8. Pampang	1	10	60	2,347	2.6	
9. Pulungbulu	7	63	378	7,837	4.8	
10. Pulung Cacutud	3	30	180	1,151	15.6	
11. Pulung Maragul	2	20	120	4,760	2.5	
12. Salapungan	2	22	132	7,615	1.7	
13. San Jose	7	64	384	7,394	5.2	
14. San Nicolas	1	10	60	4,184	1.4	
15. Sapalibutad	2	18	108	2,214	4.9	
16. Sta. Teresita	3	30	180	11,866	1.5	
17. Sto. Cristo	2	20	120	2,811	4.3	
18. Sto. Domingo	1	9	54	14,566	0.4	
19. Tabun	3	30	180	747	24.1	
20. Virgen delos Remedios	1	10	60	1,940	3.1	
Total	67	661	3,966	114,714	3.5%	

Note: Estimated population: 6 persons/HH

APPENDIX 4.1.4 LEVEL II WATER SUPPLY SYSTEMS
(AS OF 1985)

Barangay	No. of HH Served	Estimated Population Served	Population (1986)	Served Percentage	Remarks
1. Anunas	60	360	575	62.6	Ave. persons per HH is 6
2. Cuayan	60	360	342	100	
3. Cutud	40	240	943	25.5	
4. Capaya	120	720	3,763	19.1	
5. Pulung Cacutud	125	750	1,151	65.2	
6. Pandan	198	1,188	15,075	7.9	
Total	603	3,618	21,849	16.6%	

APPENDIX 4.2.1 LEVEL I WATER SUPPLY SYSTEM

As of Dec. 31, 1985

Location	Well No.	No. of Household Per System	Well Casing		Constructed By	Date Constructed	Condition of System	Remarks
			Dia. (inch)	Depth (feet)				
Bgy. Cutud	1	10	2"	140'	MPW	1982	Satisfactory	
Bgy. Pampang	2	10	1-1/2"	80'	MPW	1982	Satisfactory	
Bgy. Lourdes North West	3	10	1-1/2"	100'	MPW	1982	Satisfactory	
Bgy. San Jose	4	10	1-1/2"	140'	MPW	1982	Satisfactory	
Bgy. San Nicolas	5	10	1-1/2"	100'	MPW	1982	Satisfactory	
Bgy. Cutcut	6	10	1-1/2"	120'	MPW	1982	Satisfactory	
Bgy. Tabun	7	10	1-1/2"	120'	MPW	1982	Satisfactory	
Bgy. San Jose	8	10	1-1/2"	120'	MPW	1982	Satisfactory	
Bgy. Pulung Maragal	9	10	1-1/2"	120'	MPW	1982	Satisfactory	
Bgy. Pulung Cacutud	10	10	2"	140'	MPW	1982	Satisfactory	
Bgy. Pulung Cacutud	11	10	1-1/2"	120'	MPW	1982	Satisfactory	
Bgy. Cutcut	12	10	1-1/2"	120'	MPW	1982	Satisfactory	
Bgy. Tabun	13	10	1-1/2"	120'	MPW	1982	Satisfactory	
Bgy. Sapalibutad	14	10	1-1/2"	120;	MPW	1982	Satisfactory	
Bgy. Pulung Maragul	15	10	1-1/2"	120'	MPW	1982	Satisfactory	
Bgy. Tabun	16	10	5"	110'	MPW	1982	Satisfactory	
Bgy. Pulung Cacutud	17	10	5"	140'	MPW	1982	Unsatisfactory	Musky taste
Bgy. Capaya I	18	10	5"	120'	MPW	1982	Unsatisfactory	High iron concentration
Bgy. Cutcut	19	10	5"	130'	MPW	1982	Unsatisfactory	High iron concentration

APPENDIX 4.2.1 (Cont'd) As of Dec. 31, 1985

Location	Well No.	No. of Household Per System	Well Casing		Constructed By	Date Constructed	Condition of System	Remarks
			Dia. (inch)	Depth (feet)				
Sitio Maligaya	44	10	1-1/2"	100'	RWDC	1982	Satisfactory	
Sitio Maligaya	45	10	1-1/2"	100'	RWDC	1982	Satisfactory	
Bgy. Lourdes North West	46	10	1-1/2"	60'	RWDC	1982	Satisfactory	
Bgy. Cutcut	47	10	1-1/2"	100'	RWDC	1982	Satisfactory	
Sitio Maligaya	48	10	1-1/2"	100'	RWDC	1982	Satisfactory	
Sitio Maligaya	49	10	1-1/2"	100'	RWDC	1982	Satisfactory	
Bgy. Lourdes North West	50	10	1-1/2"	100'	RWDC	1982	Satisfactory	
Bgy. Lourdes North West	51	10	1-1/2"	80'	RWDC	1982	Satisfactory	
Bgy. Lourdes Sur East	52	10	1-1/2"	60'	RWDC	1983	Satisfactory	
Bgy. Lourdes Sur East	53	10	1-1/2"	60'	RWDC	1983	Satisfactory	
Bgy. Lourdes Sur East	54	10	1-1/2"	60'	RWDC	1983	Satisfactory	
Bgy. Agapito del Rosario	55	10	1-1/2"	60'	RWDC	1983	Satisfactory	
Bgy. Pulungbulu	56	10	1-1/2"	60'	RWDC	1983	Satisfactory	
Bgy. Cutcut	57	10	1-1/2"	60'	RWDC	1983	Satisfactory	
Bgy. Virgen de los Remedios	59	10	1-1/2"	60'	RWDC	1983	Satisfactory	
Bgy. Lourdes North West	60	10	1-1/2"	80'	RWDC	1983	Satisfactory	
Bgy. Sto. Cristo	61	10	1-1/2"	40'	RWDC	1983	Satisfactory	
Bgy. Cutcut	62	10	1-1/2"	80'	RWDC	1983	Satisfactory	
Bgy. Sto. Cristo	63	10	1-1/2"	40'	RWDC	1983	Satisfactory	
Bgy. Lourdes Sur East	64	10	1-1/2"	60'	RWDC	1983	Satisfactory	

APPENDIX 4.2.2 LEVEL II WATER SUPPLY SYSTEM

As of Dec. 31, 1985

Location	No. of Household Served	No. of Connection	Source	System	Pump	Tank	Pipe			Conducted by	Date Constructed	Remarks
							Size (mm)	Length (m)	Type			
Bgy. Anuas	60	7	Deepwell	Pumped	Centrifugal	Steel	50	541	PE	MPWH	1981	
Bgy. Cauayan	60	5	Deepwell	Pumped	Centrifugal	Steel	50	498	PE	MPWH	1981	
Bgy. Cutud	40	3	Deepwell	Pumped	Centrifugal	Steel	63-75	207	PE	MPWH	1981	
Bgy. Capaya	120	11	Deepwell	Pumped	Centrifugal	Steel $V=6.4m^3$	25-63	872	PVC	MPWH	1984	
Bgy. Pulung Cacutud	125	-	Deepwell	Pumped	Centrifugal	Steel	-	-	PVC	MPWH	1984	
Bgy. Pandan (land tenure)	198	21	Deepwell	Pumped	Centrifugal	Steel $V=6.4m^3$	38-100	1,440	PVC	BWP/MLG	1985	

Source: City Engineer's Office

APPENDIX 4.2.3 Pump Efficiency Test at No. 1 Pumping Station

The pump discharge rate, water pressure, and voltage and electric current were measured using different opening ratios of the gate valve. The following is a rough percentage of the opening ratio of the gate valve for the four examination steps. Approximately 50 to 60% of the ratio seemed to be allowable during the examination as a response of the pump and motor to the valve operation.

Valve Operation:

Case	Handle Ope.	Estimated Opening ratio
1	17.5	50 - 60%
2	11.5	40 - 50
3	6.5	30
4	4.5	20

Note: Number of turning for opening the valve completely; 23.5

The following Table shows the results of measurement.

TABLE 4.2.3.1 DATA ON PUMP TEST

Case	Discharge Rate (1/s)	TDH (m)	Ia (Amp)	Va (Volts)	Op (KW)	IPM (KW)	λo (%)	OPM (KW)	p (%)
1	43.3	27.9	93.3	240.0	11.8	33.0	35.8	28.1	42.0
2	43.2	29.9	92.3	246.6	12.7	33.5	37.9	28.5	44.6
3	43.1	32.9	93.0	250.0	13.9	34.2	40.6	29.1	47.8
4	42.2	34.9	94.7	250.0	14.4	34.9	41.3	29.7	48.4

Note: TDH = (measured water pressure) + (distance between pump operation water level and level of pressure gauge: 18.3)

Abbreviations and adopted formulas in the Table are given below.

Q : Pump Discharge Rate (1/s)

TDH : Total Dinamic Head (m)

I_a : Current (Amp)

V_a : Voltage (Volt)

O_p : Pump Output (kw)

$$O_p = \frac{Q \times TDH}{102}$$

IPM : Input Power to Motor (Kw)

$$IPM = \frac{Ia \times Va \times PF \times 3}{1000}$$

PF : Power Factor (0.85)

λo : Overall Efficiency of Pump and Motor (%)

$$\lambda o = \frac{OP}{IPM} \times 100$$

OPM : Motor Output (Kw)

$$OPM = IPM \times m$$

λm : Motor Efficiency (0.85)

λp : Pump Efficiency (%)

$$\lambda p = \frac{OP}{OPM} \times 100$$

FIGURE 4.2.3.1 shows the pump performance curb.

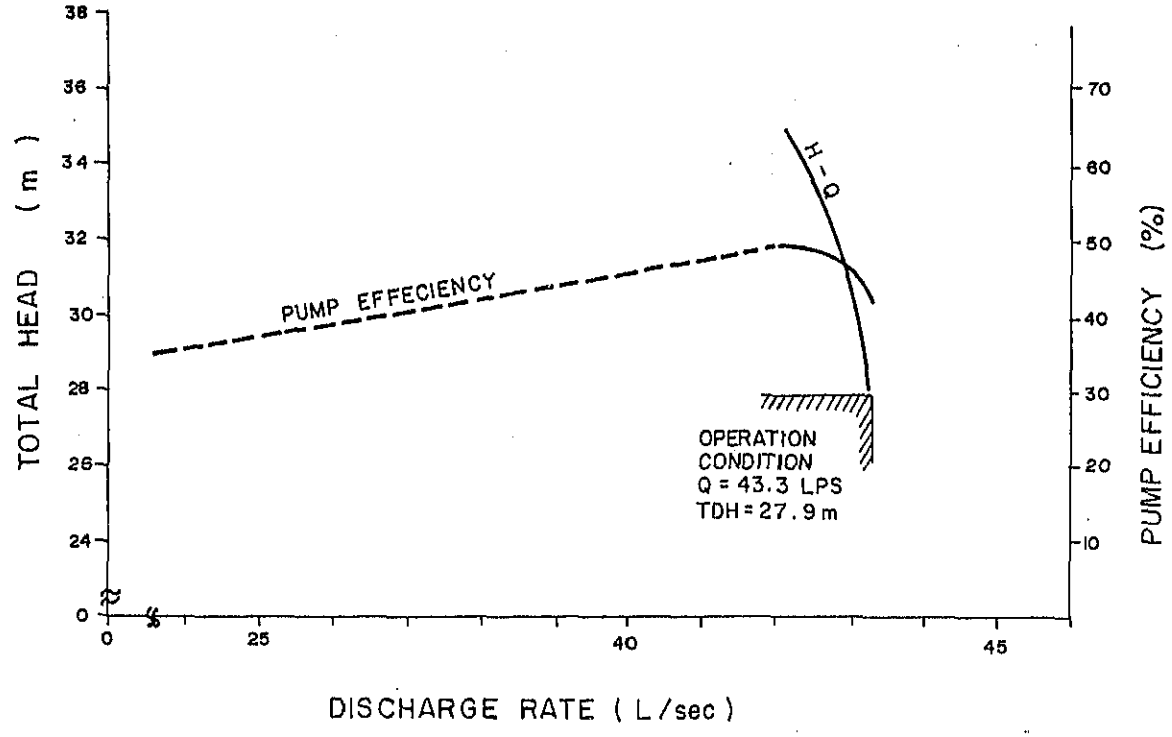
There is no data available on the conditions in selecting an appropriate pump and pump performance curb for the test pumping station. As such, a comparative study of the pump efficiency between those initially planned and operated at present cannot be made except from a general view point.

The coefficient assumed in estimating the efficiency of the pump, the pump and motor, are general figures based on field experience as follows:

PF = 0.85

λm = 0.85 - 0.90 under the conditions of 60 Hz, 2-6p and 30-37 Kw

The distance between water level during pump operation and the elevation of the water pressure gauge in order to estimate dynamic head is also assumed to be 18.3 m using the data on the pumping test conducted about 16 years ago. There is a possibility that the water level during pump operation at present might be about three meters below the assumed water level. This calculation is based on the information on the declining of water level at No. 9 pumping station (0.2m/year).



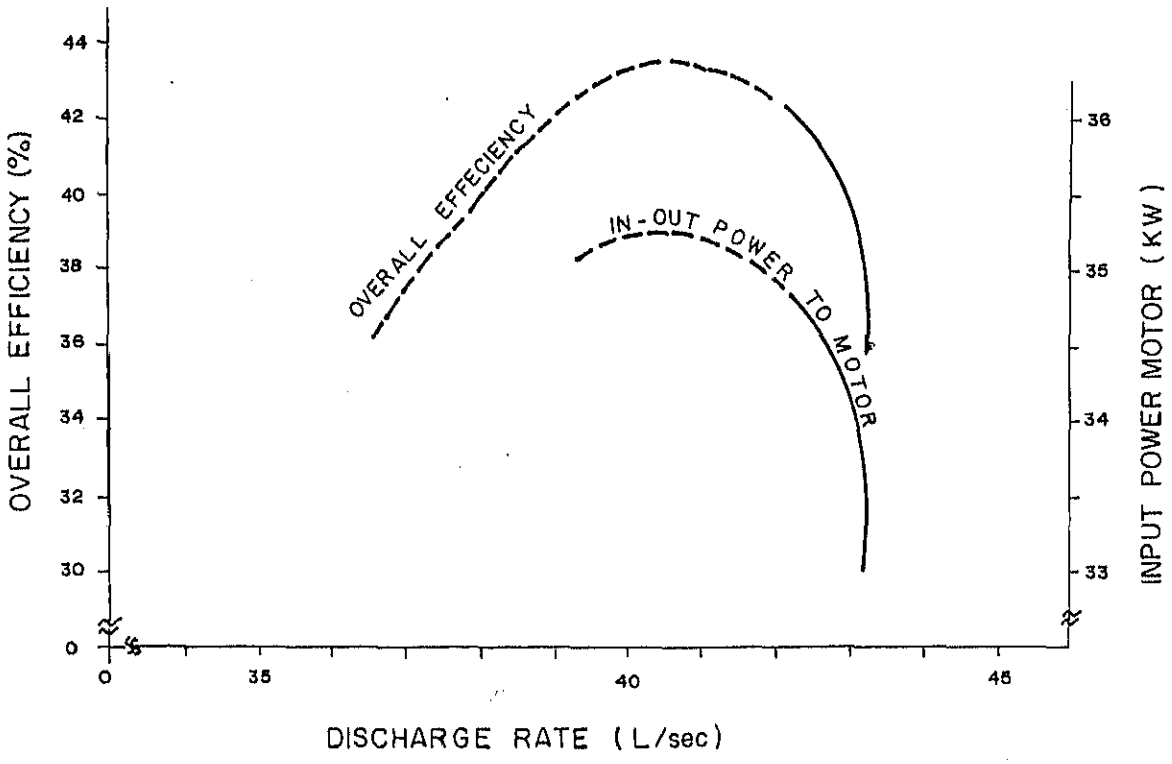


FIGURE 4.2.3.1

PUMP PERFORMANCE CURVE
(NUMBER I PUMPING STATION)

The result of measurements revealed that the pump discharge rate is around 42 to 43 l/s with a dynamic water head between 28 to 35 m. The input Power to motor and motor output, gradually increased in accordance with reduction of valve open ratio. The figures of OPM varied from 28 to 30 KW.

The motor output (60 Hz) for the vertical type multi-stage turbine pump is as follows:

OPM = 30 KW
Pump discharge rate : 42 l/s
Dynamic water head : 35 m

The above figures are almost the same as those measured at the pumping station. Because of the lowering of the water table, the present pump operation conditions may be concluded as:

a) Pump discharge rate : 42 - 43 l/s
b) Total dinamic water head : 31 - 38 M
c) Input power to motor : 33 - 35 KW
d) Motor output : 28 - 30 KW

APPENDIX 4.2.4 Water pressure in the Service Area

Twenty-five points were pinpointed to measure water pressure as shown in TABLE 4.2.4.1 and FIGURE 4.2.4.1. Sixteen points were service connections, while nine were pumping stations. A topographic survey was likewise conducted at 60 points.

TABLE 4.2.4.1 MEASURING POINTS

ITEM	No.	Location/address of the Points	Consumer type	Dia. of Connect.
Pump Station	1	A. Mabini St.	Domestic	1/2"
	2	San Nicolas St.	"	"
	3	Rizal Extension	"	"
	4	Kuliat St	"	"
	5	Sta. Teresita	"	"
	6	Bo. Pandan Marison	"	"
	7	San Angelo	"	"
	8	Pampang Rd	"	"
	9	Division Rd. Mc Arthur Highway	"	"
Service Area	1	224, Astoria cor. Vgutls	Domestic	1/2"
	2	308, 8th St. Marison	"	"
	3	San Jose St.	"	"
	4	1524, Jeus St.	"	"
	5	427, Aran Malavak	"	"
	6	23, Magkalinis St.	"	"
	7	628, M.L. Quezon St.	"	"
	8	593, Rizal St.	Commercial	"
	9	819, Henson St.	Domestic	"
	10	3 Ar 17 Rizal St.	"	"
	11	235, Harvard cor. Astoria	"	"
	12	1042, Henson St.	Commercial	"
	13	J. Surla St.	Domestic	"
	14	1948, Jesus Ext.	"	"
	15	319, St. Rosario St.	"	"
	16	San Joaquin St.	"	"

The results of the measurements are given in TABLE 4.2.4.3. The contour line of the total water head and water pressure at 12:00 and 24:00 are depicted in FIGURE 4.2.4.2 A & B and 4.2.4.3 A & B. These may represent distribution of water pressure for day time and night time, respectively. The ground elevation at each point is given in TABLE 4.2.4.2, which is used in estimating the total water head.

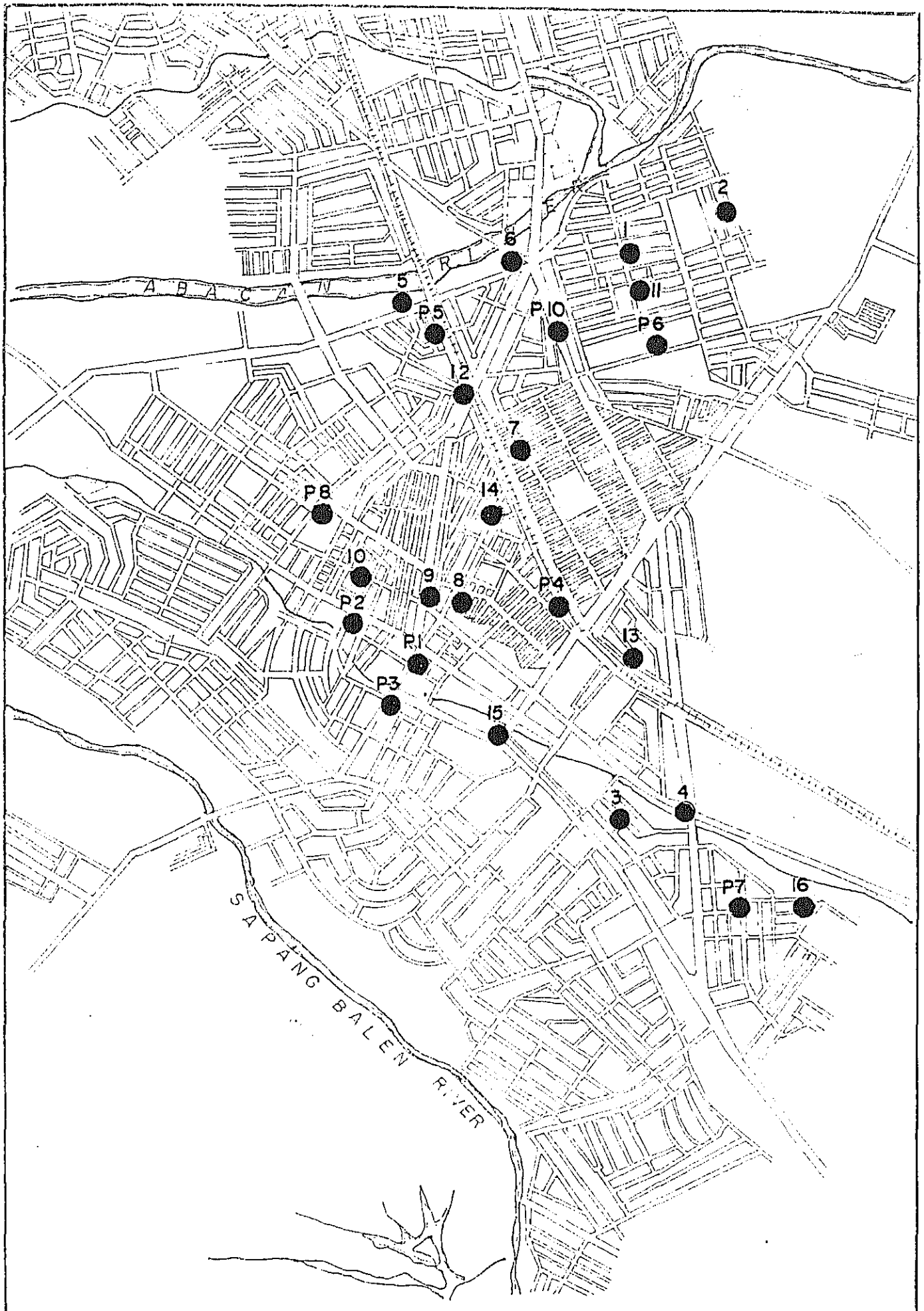


FIGURE 4.2.4.1

LOCATION OF MEASURING POINTS

TABLE 4.2.4.3 RESULT OF WATER PRESSURE TEST

Unit : kg/cm^2

	No. \ hour	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Service Area	1	0.3	0.3	0.3	0.3	0.2	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.1	0.1	0.2	0.1	0.1	0.2	0.3	0.3	0.3
	2	1.1	1.2	1.1	1.0	0.9	0.9	<0.1	<0.1	<0.1	<0.1	<0.1	0.2	0.2	0.5	0.5	0.5	0.5	0.4	0.5	0.5	0.8	0.9	1.1	1.1
	3	<0.1	<0.1	<0.1	0.25	0.25	<0.1	<0.1	<0.1	<0.1	<0.1	0	0	0	0	0	0	0	0	0	0	0	0	0.1	0.1
	4	0.5	0.5	0.5	0.5	0.5	0.25	<0.1	<0.1	<0.1	<0.1	0.1	0.1	0.2	0.2	0.25	0.25	0.25	0.5	0.5	0.1	0.25	0.5	0.5	0.5
	5	0.2	0.5	0.5	0.5	0.5	0.2	0.2	0.2	0.1	0.1	0.2	0.1	0.1	0.2	0.1	0	0	0.1	0.1	0.1	0.1	0.1	0.3	0.3
	6	0.4	0.5	0.5	0.6	0.4	0.1	<0.1	<0.1	<0.1	<0.1	0.1	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.2	0.3	0.2	0.3	0.25	0.4
	7	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
	8	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0	0	0	0	0	0	0	0	0	0	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
	9	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	<0.1	<0.1
	10	0.35	0.35	0.25	0.1	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.1	0.1	0.1	0.1	0.15	0.2	0.25	0.3
	11	0.6	0.6	0.5	0.3	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.1	0.1	0.1	0.1	0.1	0.3	0.4	0.5	0.5	0.5	0.6
	12	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0	0	0	0	0	0	0	0	0	0	0	0.1	0.1	0.1
	13	0.5	0.6	0.6	0.6	0.6	0.5	0.3	<0.1	<0.1	<0.1	<0.1	0.1	0.25	0.3	0.5	0.7	0.25	0.15	0.3	0.3	0.5	0.5	0.5	0.5
	14	<0.1	0.1	0.25	0.25	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	<0.1
	15	<0.1	0.1	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.1
	16	0.5	0.5	0.4	0.2	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.2	0.2	0.2	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.2	0.4
P.S	1	0.8	0.8	0.8	0.8	0.8	0.7	0.7	0.7	0.6	0.6	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.8	0.8	0.8
	2	0	0	0	0	0	0	0.1	0.1	0.6	0.6	0.6	0.7	0.7	0.7	0.8	0.8	0.7	0.7	0.7	0.8	0.9	0.9	0	0
	3	0.4	0.4	0.4	0.4	0.3	0.2	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.25	0.25	0.25	0.25	0.2	0.4
	4	0.2	1.3	1.1	0.3	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.2	0.2
	5	0.4	0.4	0.4	0.4	0.4	0.3	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.3	0.3	0.2	0.3	0.4	0.4
	6	0.6	0.75	1.0	1.0	1.0	1.0	1.0	1.0	1.1	1.1	1.2	1.3	1.4	1.4	1.4	1.2	1.1	1.0	1.0	1.0	0.75	0.75	0.75	0.6
	7	1.25	1.25	1.25	1.25	1.0	1.0	0.75	0.5	0.5	0.5	0.5	0.5	0.5	0.75	0.75	0.75	0.75	0.75	0.75	1.0	1.0	1.0	1.25	1.25
	8	1.0	1.0	0.8	0.8	0.8	1.0	0.8	0.7	0.7	0.7	0.6	0.6	0.7	0.8	0.7	0.7	0.7	0.7	0.7	0.8	0.8	1.0	1.0	1.0
	10	1.7	1.7	1.7	1.7	1.5	1.4	1.3	1.2	1.2	1.2	1.3	1.3	1.4	1.4	1.4	1.4	1.3	1.4	1.4	1.5	1.6	1.7	1.7	1.7

Note: <0.1 ; less than 0.1 kg/cm^2

Operation of No. 2 P.S; 6:00 AM - 10: PM

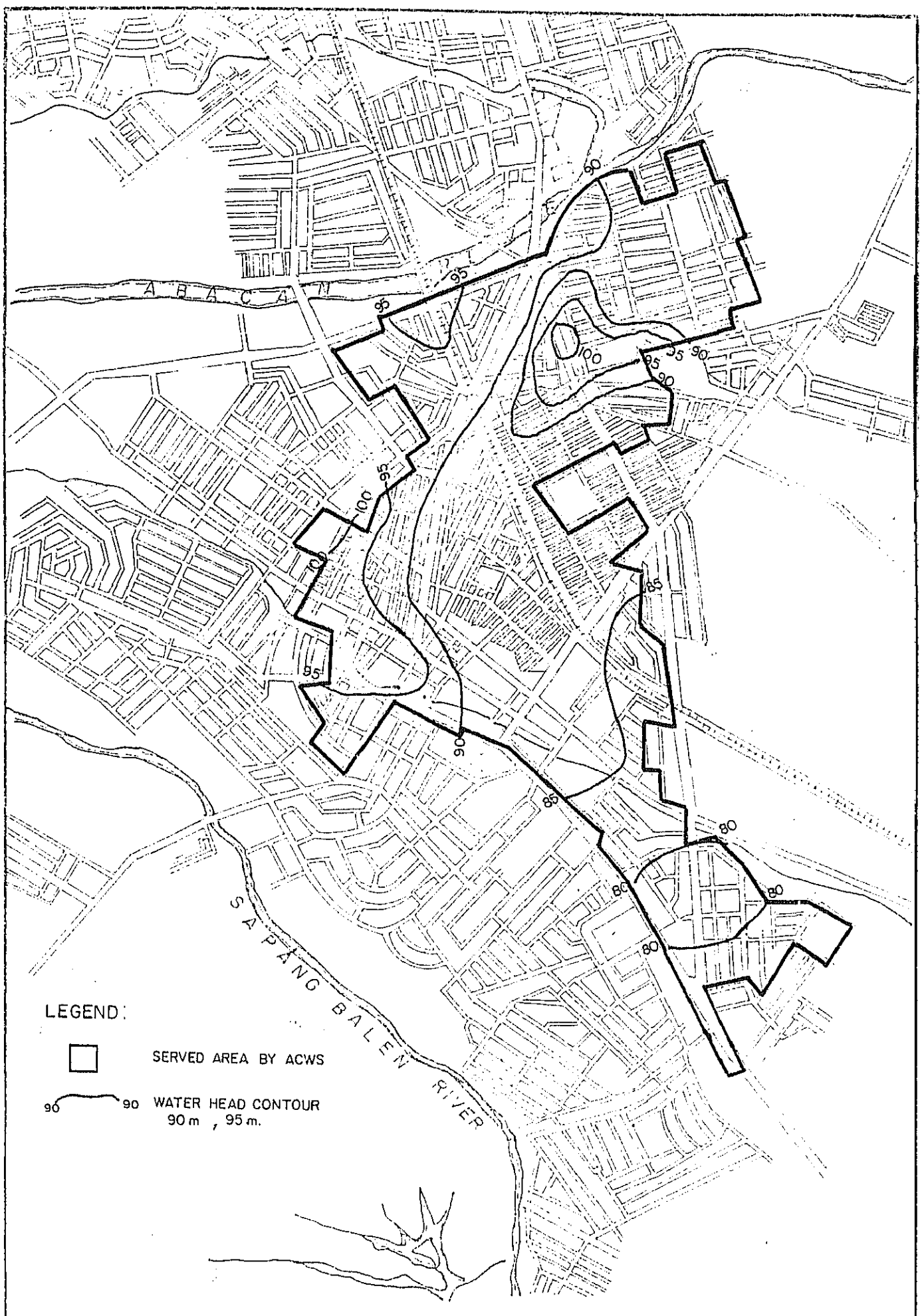


FIGURE 4.2.4.2.A

CONTOUR LINE OF TOTAL WATER HEAD AT 12:00

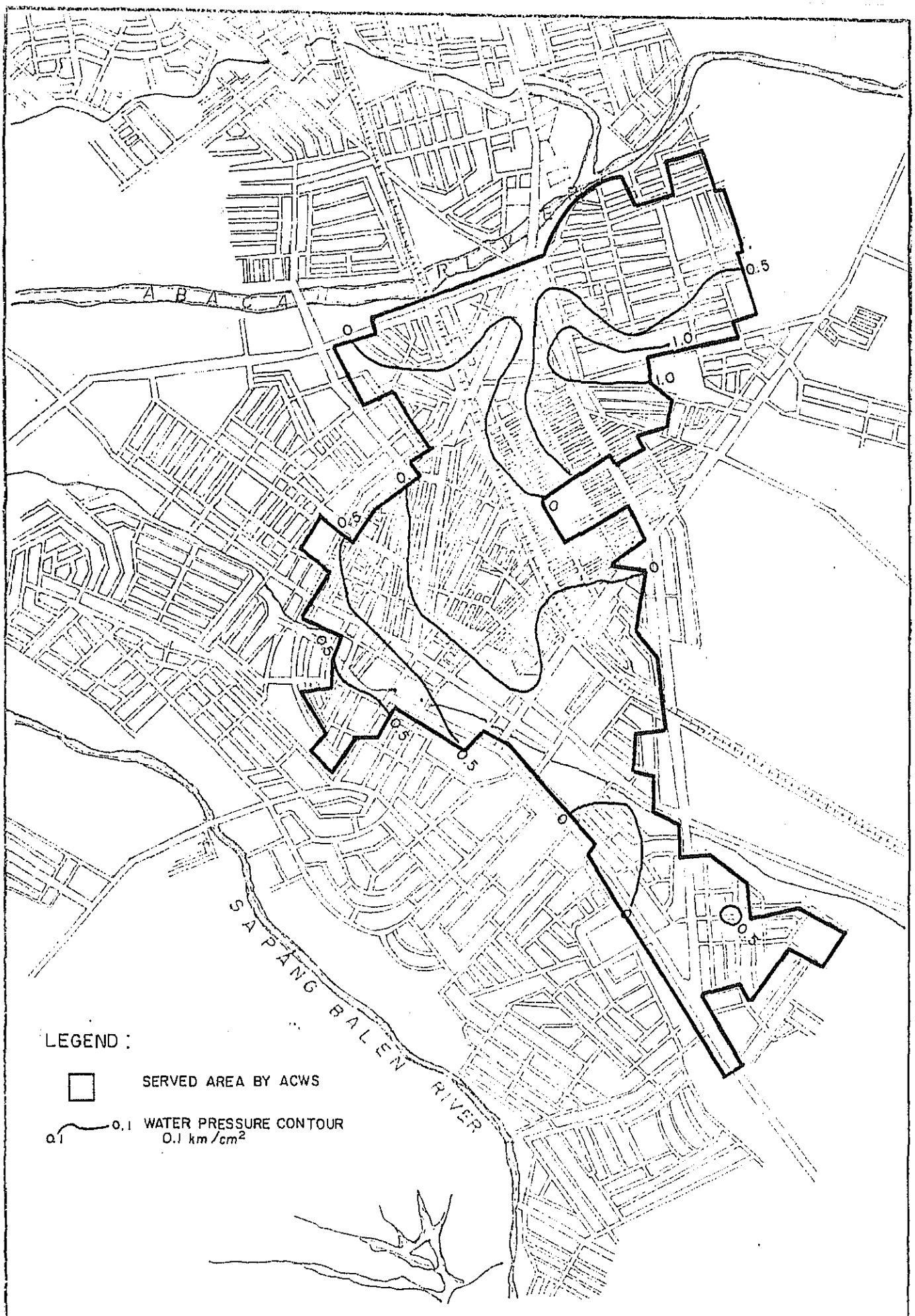


FIGURE 4.2.4.2.B

CONTOUR LINE OF WATER PRESSURE AT 12:00

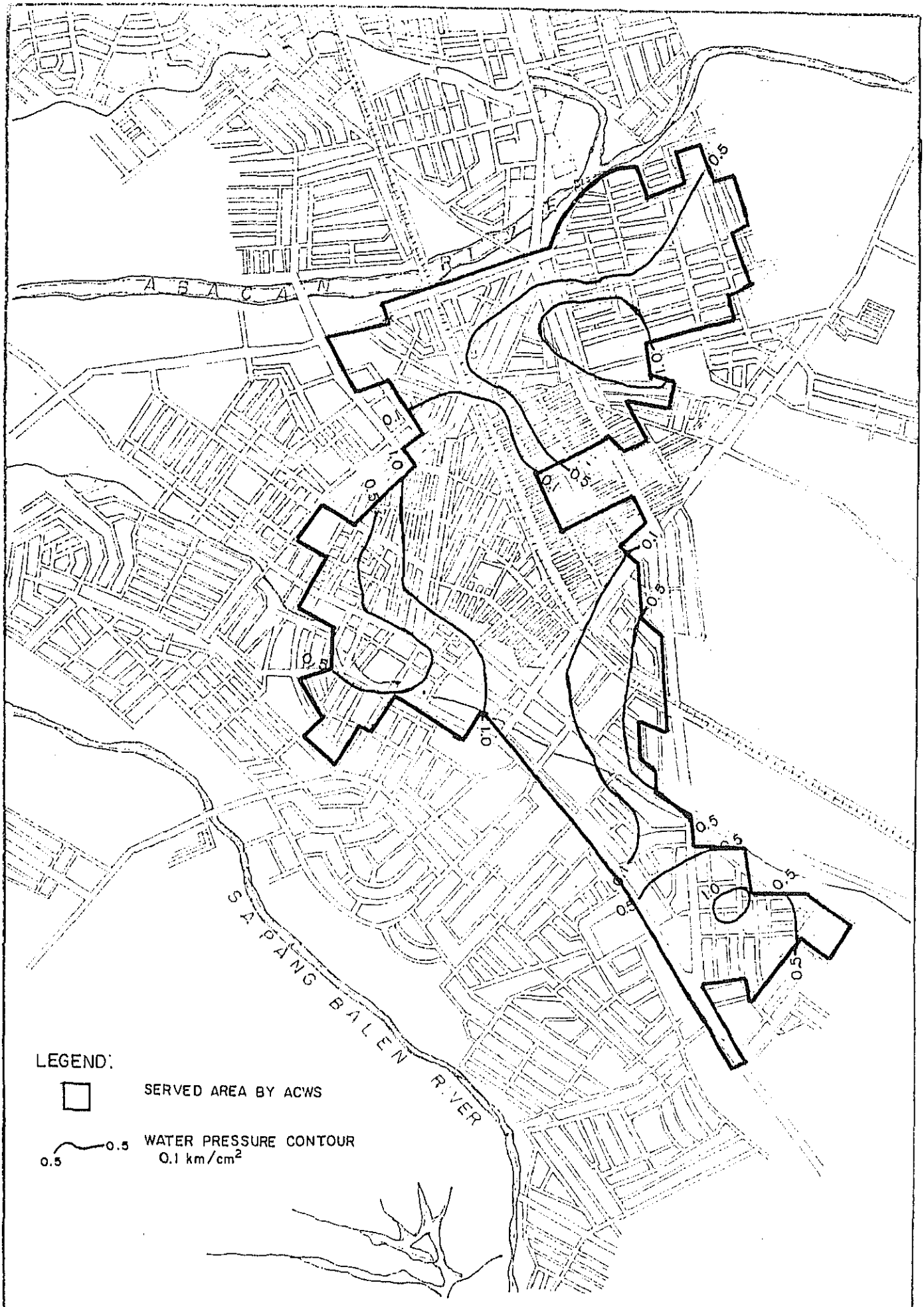


FIGURE 4.2.4.3.A

CONTOUR LINE OF WATER PRESSURE AT 24:00

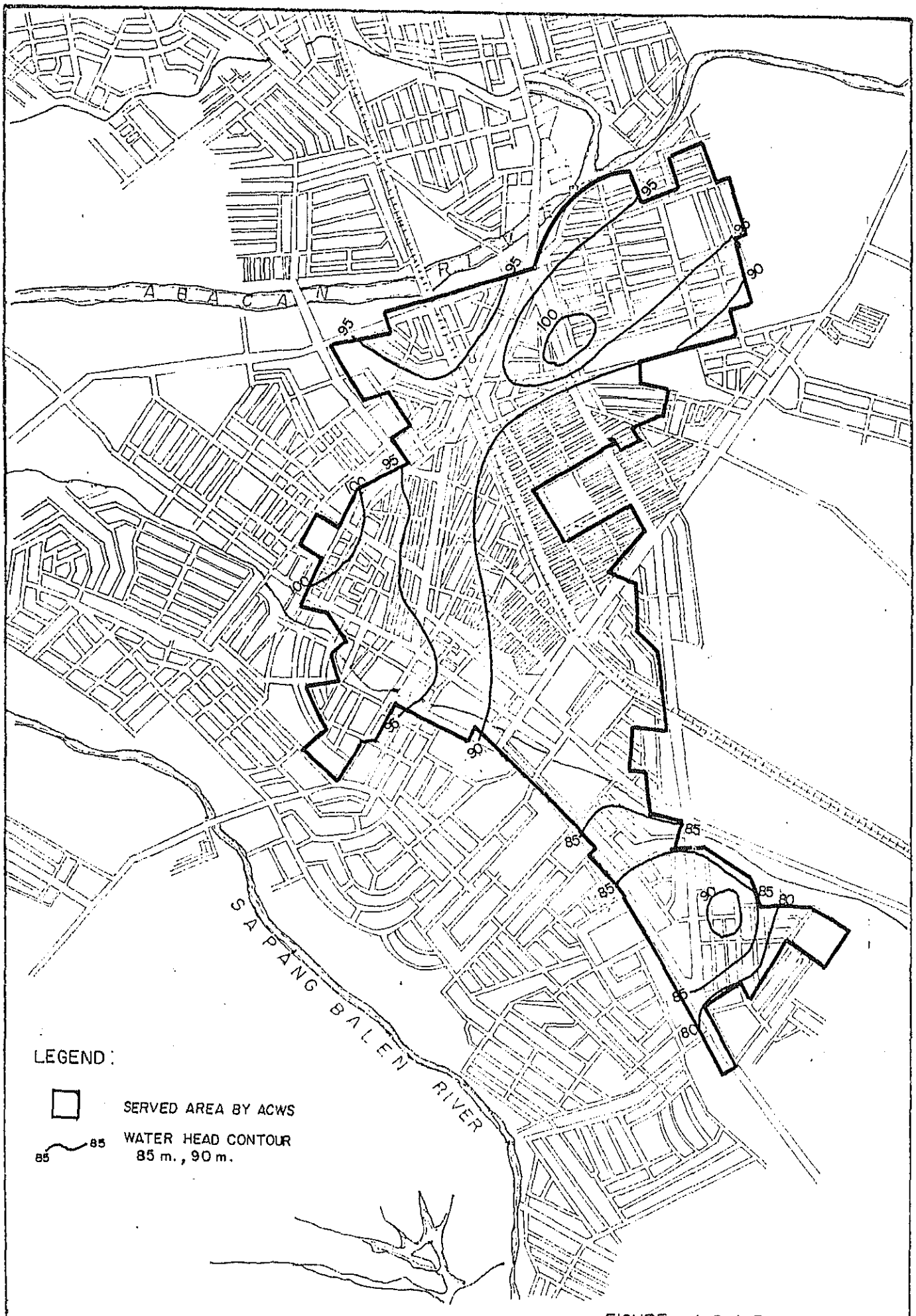


FIGURE 4.2.4.3.B

CONTOUR LINE OF TOTAL WATER HEAD AT 24:00

TABLE 4.2.4.2

GROUND ELEVATION AT SELECTED MEASURING POINTS

Point	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Service Area G.L. (m)	86	84	82	81	95	91	89	90	90	95	86	92	83	90	89	72

Point	1	2	3	4	5	6	7	8	9	10
Pumping Station G.L. (m)	91	93	91	86	94	84	79	97	-	88

Source: Topographic survey (JICA) and data from City Engineers Office

The service area has a gentle slope of one to two percent form northeast to southeast. The maximum difference of ground level in the area is approximately 20 meters.

The location of the existing 11 pumping stations in ground level terms is delineated below.

a) Northern portion of the area with a higher elevation; 8 P.S.
b) Western portion of the area with a higher elevation ; 2 P.S.
c) Southern portion of the area with a lower elevation : 1 P.S.

The ground level of the pumping stations affects the distribution status of total water head and the area covered by each pumping station, as shown in FIGURE 4.2.4.2.A and 4.2.4.3.A. In addition to the influence made by topographic conditions, water pressure in the area is directly affected by the pumping stations. The figures at the pumping stations vary from 0.2 - 0.4 kg/cm^2 at No. 5 P.S. to 1.2 - 1.7 kg/cm^2 at No. 10 P.S. The results of measurements made at the pumping stations revealed a dominant tendency in the daytime and nighttime; the highest water pressure during the hours from 8:00 A.M. to 5:00 P.M.; and the lowest from 6;00 A.M. to 7:00 P.M. This corresponds to general water use patterns during the day.

With regard to the distribution of water pressure in the area and the hourly variation, Figures 4.2.4.2.B and 4.2.4.3.B show the following:

a) The water pressure changes through the day

b) The figure during daytime (6:00 A.M. to 7:00 P.M.) is quite low (less than 0.1 kg/cm^2) in most of the area except for the limited area in the vicinity of the pumping stations. Furthermore, there is no water supply to the central portion of the service are in the daytime (about 1/3 of service area).

c) Water pressure throughout the service are in the nighttime (8:00 P.M. to 5:00 A.M.)shows a little better figure than that in daytime. However the pressure in the central portion (1/3 of service area) is still quite low with a figure of less than 0.1 kg/cm^2.

APPENDIX 4.2.5 NUMBER OF CONNECTION BY METERED AND UNMETERED

Consumer Type			Zone No. / Hills	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	Total
				351	670	241	270	442	212	349	413	574	696	194	751	342	630	527	581	715	475	442	158	172	276	9471
Metered	Domestic	1/2	No. of Connect.	89	173	12	90	105	20	57	12	12	23	-	15	-	33	27	19	27	64	165	16	9	2	970
			m^3/month	2754	5687	276	2516	4519	478	395	877	332	799	-	251	-	1386	1011	433	792	1900	7072	552	195	65	33690
		3/4	No. of Connect.	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
			m^3/month	-	-	10	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	10
		1	No. of Connect.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
			m^3/month	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Commercial	1/2	No. of Connect.	1	3	-	-	1	22	2	134	17	11	1	2	-	1	-	-	1	-	7	-	5	55	263
			m^3/month	20	350	-	-	30	582	64	3395	430	513	68	13	-	50	-	-	15	-	275	-	107	1114	7026
		3/4	No. of Connect.	1	-	-	-	2	1	-	7	1	3	-	-	-	-	-	-	-	-	-	-	-	-	15
			m^3/month	14	-	-	-	29	15	-	553	294	152	-	-	-	-	-	-	-	-	-	-	-	-	1057
		1	No. of Connect.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
			m^3/month	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Institutional		No. of Connect.	-	-	-	-	1	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	1
			m^3/day	-	-	-	-	414	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	414
Unmetered	Domestic	1/2	No. of Connect.	92	136	44	72	73	24	147	21	155	186	6	342	23	113	134	210	148	218	227	45	63	74	2553
		3/4	No. of Connect.	-	-	1	1	1	2	1	5	-	1	-	-	-	-	-	2	-	-	-	-	1	-	15
		1	No. of Connect.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Commercial	1/2	No. of Connect.	5	6	3	2	2	37	10	63	11	32	8	-	1	5	10	5	-	-	3	3	5	87	298
		3/4	No. of Connect.	-	-	1	-	-	-	-	3	-	1	-	-	-	-	-	-	-	-	-	-	-	-	5
		1	No. of Connect.	-	1	-	-	-	-	-	2	-	1	-	-	-	-	-	-	-	-	-	1	-	-	5
	Institutional	1/2	No. of Connect.	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2

Note: Data in May 1986

APPENDIX 4.4.1 NUMBER OF CONNECTIONS, CONSUMPTION AND WATER CHARGES

DOMESTIC:

Zone Number	Metered			Unmetered		Total	
	Number of Connections	Consumption (m^3/month)	Charges (₱)	Number of Connections	Charges (₱)	Number of Connections	Charges (₱)
1	89	2,754	3,016.18	92	1,681.66	181	4,697.84
2	173	5,687	5,863.40	136	2,858.25	309	8,721.65
3	13	286	292.00	45	1,017.75	58	1,309.75
4	90	2,516	2,624.00	73	1,813.40	163	4,437.40
5	105	4,419	4,270.00	74	1,772.95	179	6,042.95
6	20	878	846.40	26	530.00	46	1,376.40
7	57	1,395	1,583.80	148	3,232.60	205	4,816.40
8	12	877	854.00	26	833.00	38	1,687.00
9	12	332	394.00	155	3,404.00	167	3,798.00
10	23	799	887.80	187	4,139.13	210	5,026.93
11	-	-	-	6	122.00	6	122.00
12	15	251	321.20	342	7,523.60	357	7,844.80
13	-	-	-	23	458.00	23	458.00
14	33	1,386	1,430.40	113	2,497.20	146	3,927.60
15	27	1,011	1,019.20	134	2,878.00	161	3,897.20
16	19	433	490.00	212	4,592.60	231	5,082.60
17	27	792	816.00	148	3,277.40	175	4,093.40
18	64	1,900	2,140.40	218	5,012.21	282	7,152.61
19	165	7,092	6,659.00	227	5,453.95	392	12,112.95
20	16	552	550.80	45	1,030.00	61	1,580.80
21	9	195	168.40	64	1,374.00	73	1,542.40
22	2	65	64.00	74	1,611.20	76	1,675.20
Sub-Total	971	33,700	34,290.98	2,568	57,112.90	3,539	91,403.88

APPENDIX 4.4.1 (cont'd)

COMMERCIAL & INSTITUTIONAL

Zone Number	Metered			Unmetered		Total	
	Number of Connections	Consumption (m^3/month)	Charges (₱)	Number of Connections	Charges (₱)	Number of Connections	Charges (₱)
1	2	34	126.40	5	409.00	7	535.40
2	3	350	641.60	7	795.00	10	1,436.60
3	-	-	-	4	475.00	4	475.00
4	-	-	-	2	120.00	2	120.00
5	3	59	219.60	2	134.80	5	354.40
6	23	597	1,563.20	37	3,230.00	60	4,793.20
7	2	64	152.80	10	900.00	12	1,052.80
8	141	3,948	10,078.00	68	6,471.35	209	16,549.35
9	18	724	1,636.80	11	978.90	29	2,615.70
10	14	665	1,502.70	34	3,348.00	48	4,850.70
11	1	68	132.80	8	999.60	9	1,132.40
12	2	13	81.60	-	-	2	81.60
13	-	-	-	1	64.00	1	64.00
14	1	50	104.00	5	450.00	6	554.00
15	-	-	-	10	886.00	10	886.00
16	-	-	-	5	350.00	5	350.00
17	1	15	48.00	-	-	1	48.00
18	-	-	-	-	-	-	-
19	7	275	608.00	3	270.00	10	878.00
20	-	-	-	4	525.00	4	525.00
21	5	107	291.20	5	450.00	10	741.20
22	55	1,114	3,494.60	87	7,277.35	142	10,771.95
Sub-Total	278	8,083	20,681.30	308	28,134.00	586	48,815.30

APPENDIX 4.4.1 (cont'd)

INSTITUTIONAL:

Zone Number	Metered			Unmetered		Total	
	Number of Connections	Consumption (m^3/month)	Charges (₱)	Number of Connections	Charges (₱)	Number of Connections	Charges (₱)
1	-	-	-	2	181.20	2	181.20
5	1	414	710.00	-	-	1	710.00
Sub-Total	1	414	710.00	2	181.20	3	891.20
TOTAL	1,250	42,197	55,682.28	2,878	85,428.10	4,128	141,110.38

APPENDIX 4.4.2 COMPOSITION OF EACH BARANGAY IN TERMS OF WATER ZONE

Barangay	Composition (Zone Number)	Percentage of the Zone	Remarks
A. del Rosario	11	75	
	13	100	
Claro M. Recto	15	20	
	16	90	
Cutcut	21	50	
Lourdes Northwest	12	100	
	22	50	
Lourdes Sur	7	75	
	9	100	
Lourdes Sur East	16	10	
	17	90	
Malabanas	15	50	
	18	5	
Pampang	22	45	
Pandan	18	95	
	19	100	
Pulung Bulu	3	25	
	4	100	
	5	60	
Salapungan	20	100	
San Jose	1	5	
	2	50	
	3	30	
San Nicolas	8	70	
	10	60	
	11	25	
Sta. Teresita	14	100	
	22	5	
Sta. Trinidad	10	40	
Sto. Cristo	3	15	
	5	40	
	6	50	
	7	25	
	17	10	
Sto. Domingo	1	95	
	2	50	
Sta. Rosario	3	30	
	6	50	
	8	30	
	21	50	
Virgen de los Remedios	15	30	

Note: The percentage is calculated using household number distributed in related barangays.

APPENDIX 4.4.3 WATER CONSUMPTION

4.4.3.A UNIT COMMERCIAL WATER CONSUMPTION (METERED)

Zone	Water Consumption(m3) Monthly	Daily	No. of Connection	Per Connection Per Day(m3)	Remarks
6	630	21	63	0.333	
8	4173	139	159	0.874	
9	1228	41	35	1.171	
10	1113	37	39	0.949	
11	82	3	1	3.000	
12	1297	43	18	2.389	
13	0	0	0	-	
21	432	14	14	1.000	
22	570	19	57	0.333	
Total	9525	317	386	0.821	

4.4.3.B ESTIMATION OF TOTAL WATER CONSUMPTION

No. of Connections			Unit Consumption	Daily Consumption	Remarks
Domestic	Sub-Total	3,567	1.567 m^3/d	5,589 m^3/d	
Commer-cial	Metered	298	0.821	245	
	Unmetered	255	2.18*	556	
	Sub-Total	553		801	
	Total	4,120		6,390	

Note: * Average Consumption in Balibago Waterworks System

APPENDIX 4.5.1 Unaccounted-for Water/Not Utilized Water

The Zone No. 1, southern tip of the existing service area was selected as a model area in accordance with the following criteria.

a) Easy measurements of flow rate into or out of the area ensuring served population of about 10% of the city total population served.
b) The total maximum number of flow meter required should be less than three.
c) The area should be predominantly residential.
d) Easy data collection

FIGURE 4.5.1.1 shows the flow chart to analyze unaccounted for water/not utilized water.

(1) Background information and existing water supply in Zone No. 1

1) Description of the model study area

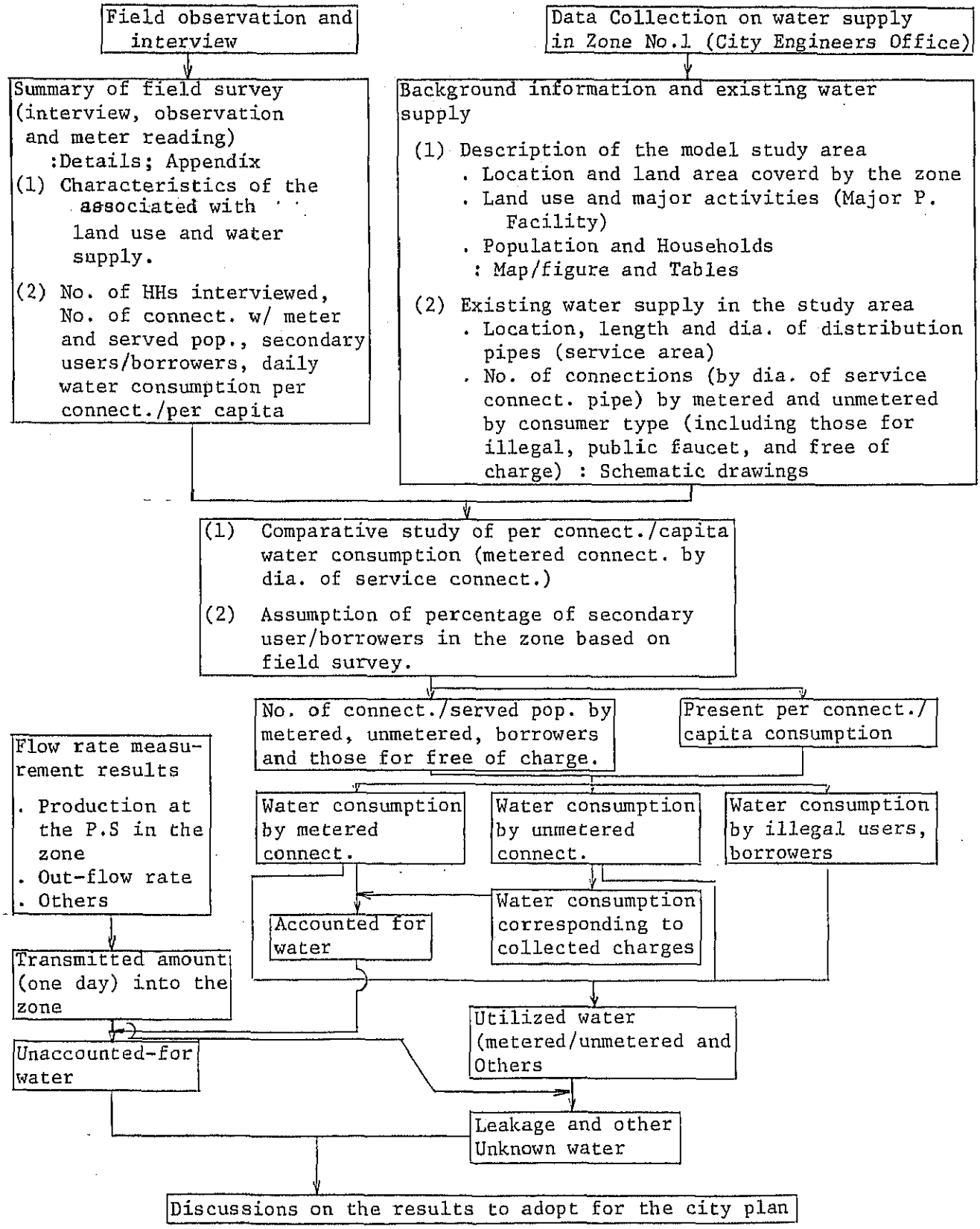
The model study area, Zone No. 1 (see FIGURE 4.5.1.2) is located in the southern tip of the existing service area with an approximate area of 60 ha and population of 2,112 (352 households).

The area is predominantly residential with small commercial establishments along the Mc Arthur Highway. The major public facilities within the zone are St. Domingo Elementary School and Camp Tomas Pepito. The following is information obtained through the field survey.

- o St. Domingo Elementary School : 1,300 pupils and 33 teaching staff members
- o Camp Tomas Pepito : 155 personnel and 150 detainees

The location of households, commercial establishments and public facilities as well as road networks in the zone is given in FIGURE 4.5.1.3.

FIGURE 4.5.1.1 FLOW CHART FOR ESTIMATION OF UNACCOUNTED-FOR-WATER/ AND SOME FUNDAMENTALS



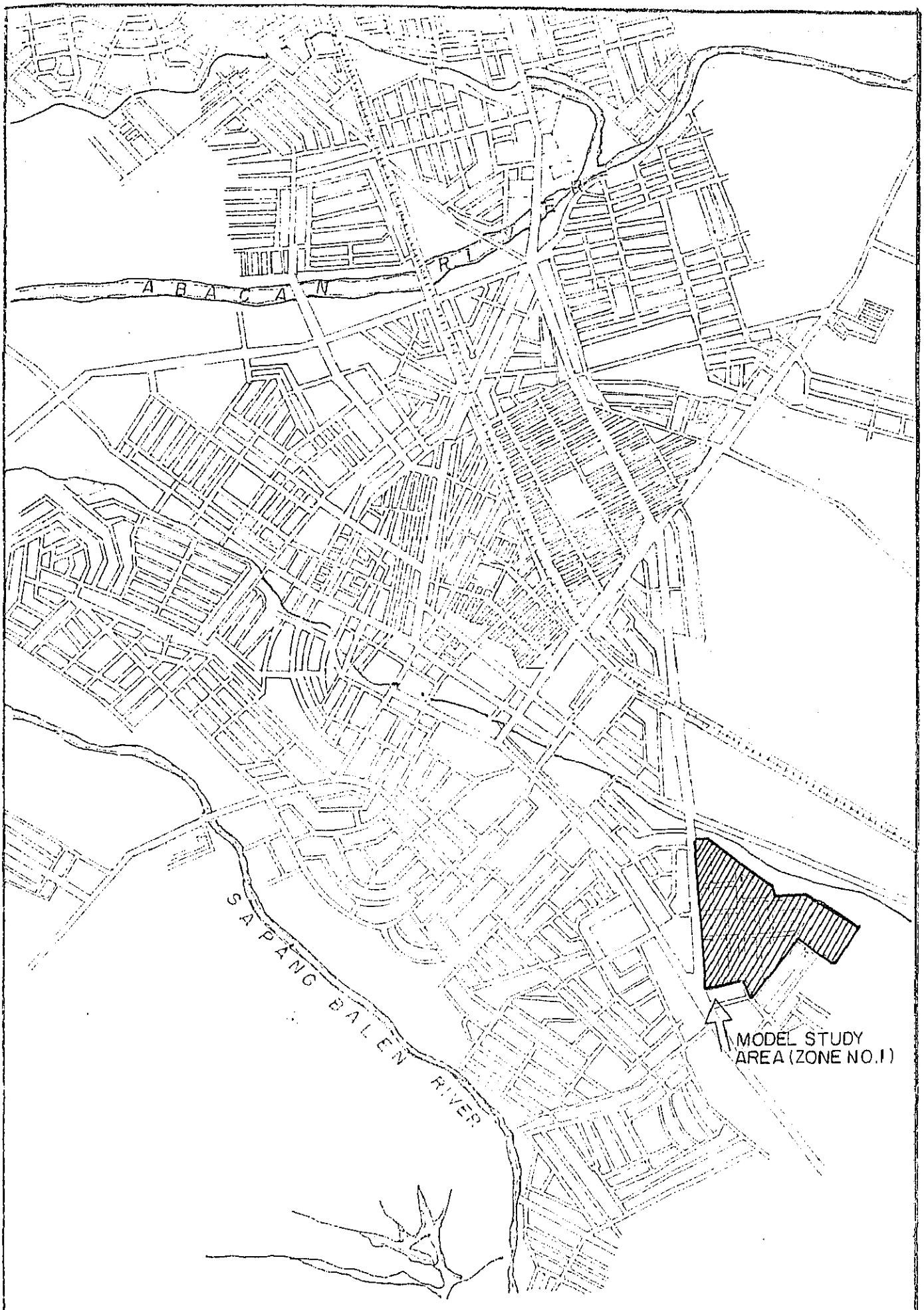


FIGURE 4.5.1.2

LOCATION MAP
OF STUDY AREA

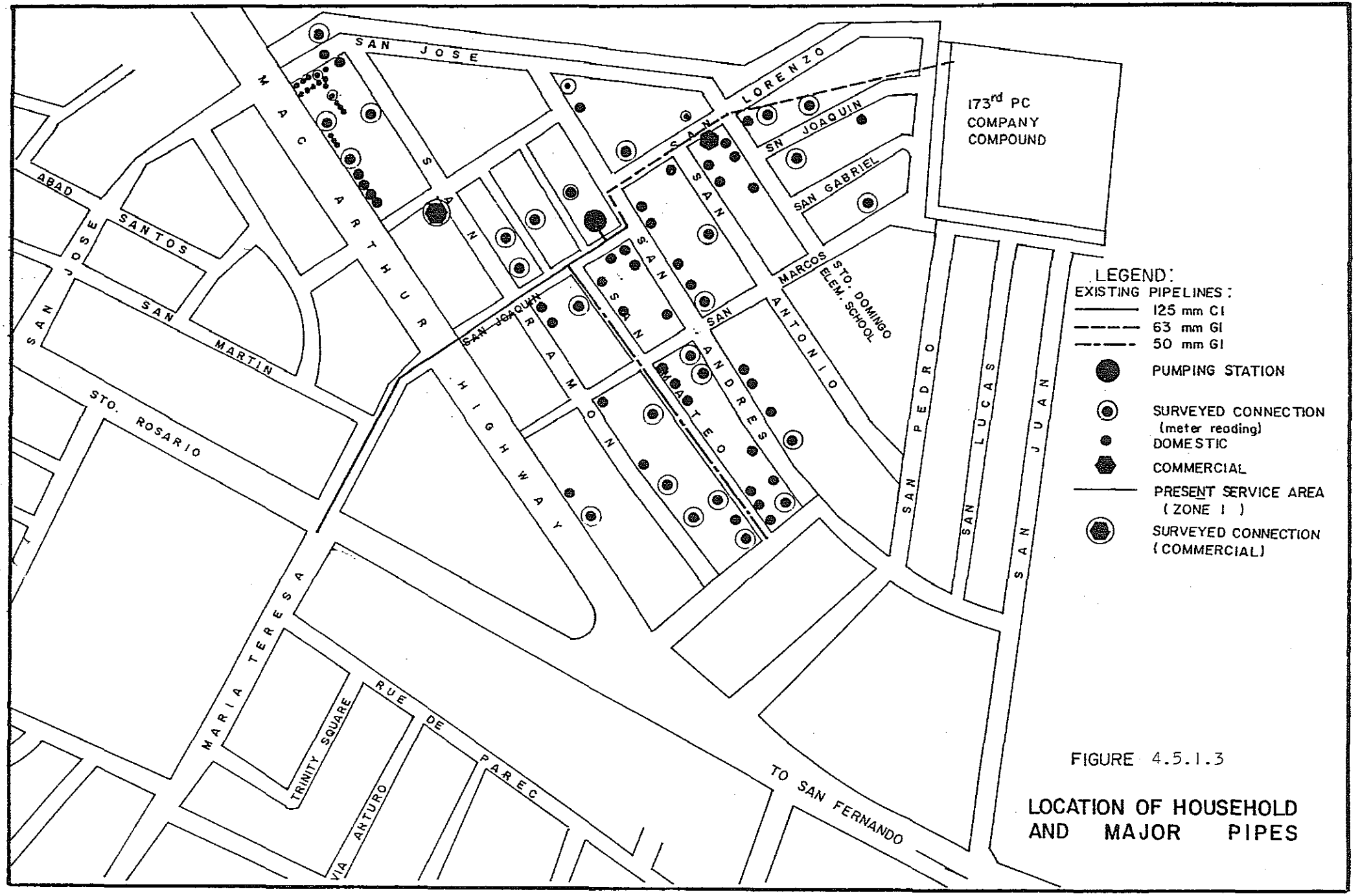


FIGURE 4.5.1.3

LOCATION OF HOUSEHOLD AND MAJOR PIPES

2) Existing water supply in the zone

The water sources for the zone is a deep well with a pumping station (No. 7). The water produced at the pumping station is used not only for the zone including the Camp area but also for Zone No. 2. However the water pressure during daytime in the area far from the pump station in Zone No. 1 is quite low. There is no water supply to the elementary school during daytime. The diameter of distribution pipes ranges from 50 to 125 mm with a total length of 620 m. (Refer to FIGURE 4.5.1.3 on the location of distribution pipes).

a) Served population in the Zone

The served population comprises primary users and secondary users/borrowers, which were identified through the field interview. The following is the outline of the findings.

Field interview results

Investigations on the 36 domestic connections, which account for 40% of total metered connections, revealed the following composition of users.

Type	No. of HHs	Served Pop.
Primary users	36	228
Secondary users/ borrowers	21	85
T o t a l	57	313

The percentage of secondary users/borrowers to the primary users is calculated at 37%. The figure seems to reflect the fact that the zone is predominantly composed of apartment houses.

Estimating the population in the zone and the number of concessionaires

The study zone consists of 15 sub-areas. Population by sub-area was estimated knowing the number of households and

using six persons as the average number of persons per HH. Number of primary users was also estimated in the same manner.

The population served is the total of primary users and secondary users/borrowers. The percentage of secondary users/borrowers to the primary users was assumed to be 35, based on the field investigation, although this figure should be further studied before an average figure for the city is made (See TABLE 4.5.1.1).

TABLE 4.5.1.1 POPULATION IN THE ZONE AND CONCESSIONAIRES

Sub-Area	Zone Population	Served Population				
		Primary	Secondary/ borrowers	Total	Served Percent	R. M.
1	180	24	8	32	17.8	
2	54	12	4	16	29.6	
3&4	186	84	29	113	60.8	
5	138	42	15	57	41.3	
6	102	66	23	89	87.3	
7	60	60	-	60	100.0	All primary user
8	114	108	6	114	100.0	Most of population is primary user
9	312	210	74	284	91.0	
10	-	-	-	-	-	No connection
11	108	78	27	105	97.2	
12	96	66	23	89	92.7	
14	300	84	29	113	37.7	
15	378	222	78	300	79.4	
Total	2,112	1,098	331	1,429	67.7	

Note : a) Secondary users/borrowers is 35% of primary users; average number of HH : 6 persons
b) Population/pupils at the camp and elementary school is not included in the Table.

The estimated total population served is 1,098 out of the Zone population of 2,112. The percentage of primary users to the zone population is approximately 52%, while total population served is 68%.

b) Water supply status in the Zone.

Number of connections by type of consumer as of May 1986 is summarized in TABLE 4.5.1.2. Public faucets installed in the premise of elementary school and those for the Camp were excluded. The total number of connections is 190 of which 91 (48%) is metered.

TABLE 4.5.1.2 NUMBER OF CONNECTIONS BY CONSUMER TYPE

Sub-Area	Domestic				Commercial			Institutional			Total		
	No. of HHs	Metered	Unmetered	Total	Metered	Unmetered	Total	Metered	Unmetered	Total	Metered	Unmetered	Total
1	30	2	2	4	-	1	1	-	-	-	2	3	5
2	9	-	1	1	-	-	-	-	1	1	-	2	2
3&4	31	11	3	14	1	-	1	-	-	-	12	3	15
5	23	1	6	7	1	3	4	-	-	-	2	9	11
6	17	8	3	11	-	-	-	-	-	-	8	3	11
7	10	4	6	10	-	-	-	-	-	-	4	6	10
8	19	15	3	18	-	-	-	-	-	-	15	3	18
9	52	4	31	35	-	-	-	-	-	-	4	31	35
10	-	-	-	-	-	-	-	-	-	-	-	-	-
11	18	10	3	13	-	-	-	-	-	-	10	3	13
12	16	7	4	11	-	-	-	-	-	-	7	4	11
13	14	4	3	7	-	-	-	-	-	-	4	3	7
14	50	9	5	14	-	-	-	-	-	-	9	5	14
15	63	14	22	36	-	1	1	-	1	1	14	24	38
Total	352	89	92	181	2	5	7	-	2	2	91	99	190

Note: Diameter of service connections by consumer type
Domestic: metered and unmetered; 1/2 inches
Commercial: metered, one 1/2 inch and another 3/4 inch;
unmetered, 1/2 inch
institutional: unmetered, 1/2 inch

TABLE 4.5.1.3 SUMMARY OF WATER CONSUMPTION AND CHARGES

Consumer Type	Metered			Unmetered		Total	
	No. of Connect.	m^3/month	Charge (₱)	No. of Connect.	Charge (₱)	No. of Connect.	Charge (₱)
Domestic	89	2,754	2,802	92	2,077.04	181	4,879.04
Commercial	2	34	126.4	5	409	7	535.40
Institutional	-	-	-	2	181	2	181
Total	91	2,788	2,928.4	99	2,618.04	190	5,546.44

Data Source : City Engineers Office

The following is a summary of connections.

Type of Consumer	Metered	Unmetered	Total	Unmetered Additional Faucet
Domestic	89 (1/2")	92 (1/2")	181	182
Commercial	2 (1/2" & 3/4")	5 (1/2")	7	
Institutional	-	2 (1/2")	2	
Total	91	99	190	182

Water consumption and collected charges by consumer type

Water consumption and collected charges from metered/unmetered connections by consumer type for the month of May, 1986 are summarized in TABLE 4.5.1.3. (Details are given in TABLE 4.5.1.4.A to 4.5.1.4.C)

c) Per capita water consumption and domestic daily water consumption.

Per capita water consumption was studied by metered and unmetered connection due to the following:

i) Insufficiency of water supply because of limited water sources and pump capacity, especially in the remote areas where water pressure is less than 0.1 kg/cm^2 through the day.

ii) Some areas are provided with water supply only during daytime or nighttime by means of valve operation of the distribution pipes.

iii) Most of the metered connections are installed along the main distribution pipeline, where comparatively good service is provided. On the other

TABLE 4.5.1.4.A WATER CONSUMPTION AND CHARGES (DOMESTIC CONNECTION)

Sub-area	Metered			Unmetered		Total		R.M.
	No. of Connect.	m^3/month	Charge (₱)	No. of Connect	Charge (₱)	No. of Connect	Charge(₱)	
1	2	28	35.20	2	42	4	77.2	
2	-	-	-	1	20	1	20.	
3 & 4	11	318	337.20	3	68	14	405.2	
5	1	35	34.	6	120	7	154	
6	8	266	260.80	3	74	11	334.8	
7	4	99	103.20	6	156	10	259.2	
8	15	328	370.	3	69.45	18	439.45	
9	4	111	114.4	31	668.06	35	782.46	
11	10	269	276.8	3	62.	13	338.80	
12	7	232	251.6	4	90	11	341.60	
13	4	162	153.6	3	66.	7	219.60	
14	9	405	378.	5	114	14	492.	
15	14	501	487.2	22	527.53	37	1,014.73	
Total	89	2,754	2,802.	92	2,077.04	182	4,879.24	

TABLE 4.5.1.4.B WATER CONSUMPTION AND CHARGES (COMMERCIAL CONNECTION)

Sub-area	Metered			Unmetered		Total		R.M.
	No. of Connect.	m^3/month	Charge(₱)	No. of Connect.	Charge(₱)	No. of Connect.	Charge(₱)	
1	-	-	-	1	90.	1	90.0	
3 & 4	1	14	70.40	-	-	1	70.40	
5	1	20	56.	3	270	4	326.	
15				1	49	1	49	w/meter but not working
Total	2	34	126.40	5	409	7	535.40	

TABLE 4.5.1.4.C WATER CONSUMPTION AND CHARGES (INSTITUTIONAL CONNECTION)

Sub-area	Metered			Unmetered		Total		R.M.
	No. of Connect.	m^3/month	Charge(₱)	No. of Connect.	Charge(₱)	No. of Connect.	Charge(₱)	
2	-	-	-	1	125.	1	125.	
15	-	-	-	1	56.	1	56.	
Total	-	-	-	2	181.	2	181.	

hand, the remaining areas experience shortage of water.

Water consumption and per capita daily consumption (metered)

Daily water consumption (metered)was reported for the month of May at 91.8 cu.m/day for the 89 connections. Total population served for the metered connections is about 700 calculated by estimating the zone total population served (1,429 persons) in Table 2.3.1 and the percentage of metered connections to the total number of connections(89/181 = 49%).

Daily per capita water consumption was calculated to be 131 l/cap.day.

The calculated figure using the meter reading results from concessionaires selected at random during field survey is 183 l/cap.day.

The summary of findings is shown in TABLE 4.5.1.5 in addition to the water consumption for the month of May. The average per capita consumption for the month of May for the 36 concessionaires is calculated at 157 l/cap.day. The figures calculated using data collected through field survey are 20 to 40% bigger than the estimated zone average for the month of May. This result may be attributed to the difference of service level in the zone due to insufficiency in water supply and the daily fluctuation in consumption. The average figure of 131 l/cap.day, can be the daily zone average considering the constraints of the present water supply.

Water consumption and per capita daily consumption for unmetered connections

Collections from unmetered connections for May was ₱2,077.04. These come from the flat rate connections as well as metered connections whose meters are under repair. For the latter, water charge is an average of previous month's consumption. It is difficult to assess the number of faucets per household using collection as a basis. Estimates were made, therefore, using the following:

Water consumption per connection for the flat rate (₱18/month, 1/2" service connection) is 15 cu.m/month ((₱18-₱14) ÷ ₱0.8/cu.m + 10 cu.m = 15 cu.m). On the other hand, the consumption range for the metered connection (See TABLE 4.5.1.6) gives an idea of the average figure for majority of the concessionaires.

The Table reveals that approximately 90% of metered connections belongs to the consumption range of 0-60 cu.m/month. The average consumption within the range was calculated at 24.2 cu.m/month.

TABLE 4.5.1.5

No.	Address	Field Survey				Data	R. M.
		Daily Consump.	Primary User	Secondary User	Pop. Served		
1	1-1-8	0.7	5	12	17	0.6	
2	1-3-13A	0.8	3		3	0.8	
3	1-3-13E	0.7	7		7	0.7	
4	1-8-12M	0.5	4		4	0.8	
5	1-8-12G	1.6	5		5	2.7	
6	1-5-5	2.1	5		5	1.1	
7	1-3-2	1.7	12		12	1.8	
	1-3-19A	0.5	3		3	0.5	Commercial connection (excluded from the Total)
8	1-9-17A	1.0	6		6	1.4	
9	1-9-25	1.0	5		5	0.8	
10	1-14-8	2.3	10		10	2.1	
11	1-15-50B	2.2	15		15	0.7	
12	1-14-20A	6.6	5	26	31	4.3	
13	1-15-51	1.0	10		10	1.1	
14	1-14-29	1.0	8		8	(1.0)	
15	1-15-50E	1.8	4	2	6	1.5	
16	1-15-50F	2.3	8	5	13	1.3	
17	1-15-61	1.0	3		3	0.5	
18	1-15-17	0.9	5		5	0.2	
19	1-15-30	2.0	5	10	15	1.7	
20	1-15-37	2.2	6	4	10	2.5	
21	1-11-23	0.8	7		7	0.3	
22	1-13-9	1.7	6		6	(1.7)	
23	1-12-8A	1.4	5		5	0.9	
24	1-11-12	2.0	5	2	7	1.9	
25	1-14-28	1.9	8		8	1.3	
26	1-12-2	0.6	3		3	0.4	
27	1-9-46	0.3	3		3	1.1	

TABLE 4.5.1.5(cont'd)

No.	Address	Field Survey				Data	R. M.
		Daily Consump.	Primary User	Secondary User	Pop. Served		
28	1-7-2	1.4	5		5	(1.4)	
29	1-12-3A	1.9	4	10	14	2.1	
30	1-11-7A	2.4	5		5	2.3	
31	1-6-8	0.6	3		3	0.7	
32	1-6-4	1.4	6		6	0.5	
33	1-6-1A	3.0	10	8	18	2.1	
34	1-6-19	0.9	6	5	11	1.5	
35	1-6-17	1.4	10		10	1.3	
36	1-6-14B	2.5	11	3	14	(2.5)	
Total (Domestic)		57.6	228	87	315	49.6	

Note : Daily consumption obtained by meter reading (Field survey)

( ) : used same figures of measured

TABLE 4.5.1.6

RANGE OF WATER CONSUMPTION (METERED) AND MAJORITY AVERAGE CONSUMPTION

Consumption. Range (cu.m/mon.)	No. of Connect.	Percen-tage	Summation of percent.	Calculation of majority average				
				Ave. cu.m	cu.m/ mon.	Total	Ave. cu.m /mon.	l/cap. day
0 - 10	15	16.9	16.9	5	84.5			
11 - 20	22	24.7	41.6	15	370.5			
21 - 30	16	18.0	59.6	25	450			
31 - 40	13	14.6	74.2	35	511			
41 - 50	6	6.7	80.9	45	301.5			
51 - 60	7	7.9	88.8	55	434.5	2,152	24.2	102
61 - 70	4	4.5	93.3	65	292.5			
71 - 80	3	3.4	96.7	75	255			
81 - 90	1	1/1	97.8	85	93.5			
91 - 100	0	0.0	97.8	95				
101 - 110	1	1.1	98.9	105	115.5			
111 -	1	1.1	100.0	120	132	3,040.5	30.4	128
Total	89	100.0						

Note : Overall average; 128 which corresponds to that estimated using data of May (131)

Per capita daily consumption for the unmetered connections was estimated using estimated served population and number of connections as follows:

i) Figure corresponding to the flat charge:

15 cu.m/month x 92 connect ÷ 30 day÷(1429 - 700)

= 0.063 cu.m/cap.day

ii) The average consumption of majority of metered connections 24.2 cu.m/month x 92 connect.÷ 30 ÷ 729

= 0.102 cu.m/cap.day

Per average per capita consumption for the unmetered connections seems to be between 63 to 131 l/cap.day. Being within the consumption range, 102 l/cap.day may be used for the purpose of this study.

Daily water consumption for the unmetered concessionaires is accordingly estimated at 74.2 cu.m/day (24.2 cu.m/month ÷ 30 days x 92 connection).

The water consumption of the domestic origin is, therefore, 166 cu.m/day as a total of metered (91.8 cu.m/day) and unmetered (74.2 cu.m/d).

d) Unit water consumption and total consumption for commercial use: Water consumption by the existing metered connections for the month of May was recorded at 34 cu.m/month. Daily per connection consumption is calculated at 0.57 cu.m/day. A figure of 0.5 cu.m/day was meter-read in one of the two connections during the field survey. Inferred consumption for the unaccounted connections was estimated using charge composition as follows:

(₱90 - ₱40) ÷ ₱1.6/cu.m + 10 cu.m = 41.25 cu.m/month
41.25 ÷ 30 = 1.375 cu.m/day

The figure of 1.375 cu.m/day may be used for the unmetered connections since it corresponds to the charges paid by them on a same basis of the metered connection.

Water consumption for commercial use is 8.01 cu.m/day as shown below.

metered	:	1.13 cu.m/day (2 connections)
unmetered	:	1.375 cu.m/day x 5 = 6.88 cu.m/day (5 connections)
Total	:	8.01 cu.m/day

e) Unit water consumption and total consumption for the institutional use: The existing two connections; the camp and

elementary school are unmetered. Unit water consumption based on the charges is same as that for the commercial unmetered connections. However, it was confirmed in the field that there is no water supply to the elementary school during daytime. Therefore water consumption for the institutional use in the zone may be accounted to be 1.38 cu.m/day (one governmental office).

(4) Water consumption in the zone (Utilized water in Zone No. 1)

The total water consumption including domestic/commercial and institutional uses is estimated at 175.39 cu.m/day.

Estimate of the water transmitted/distributed to Zone No. 1 from No. 7 pumping station

Preliminary survey revealed that part of water produced at no. 7 pumping station is distributed to the Zone No. 2 and is also provided to the Camp without charge (unmetered).

Under these conditions, flow rate measurement was conducted through the day at the two points as shown in FIGURE 4.5.1.4 (the point connected to the Zone No. 2 and that before the Camp compound.) The measurement records are given in TABLE 4.5.1.7.

The water balance between production and distribution/consumption is given below.

$$Q = (q_1 + q_2) = q_3 + q_4$$

where, Q : production (cu.m/day)
q_1 : supply to the Camp (cu.m/day)
q_2 : supply to the No. 2 zone
q_3 : Consumption in the No. 1 zone
q_4 : water not utilized in zone No. 1 (leakage and unknown water)

The results of flow rate measurement are summarized as follows:

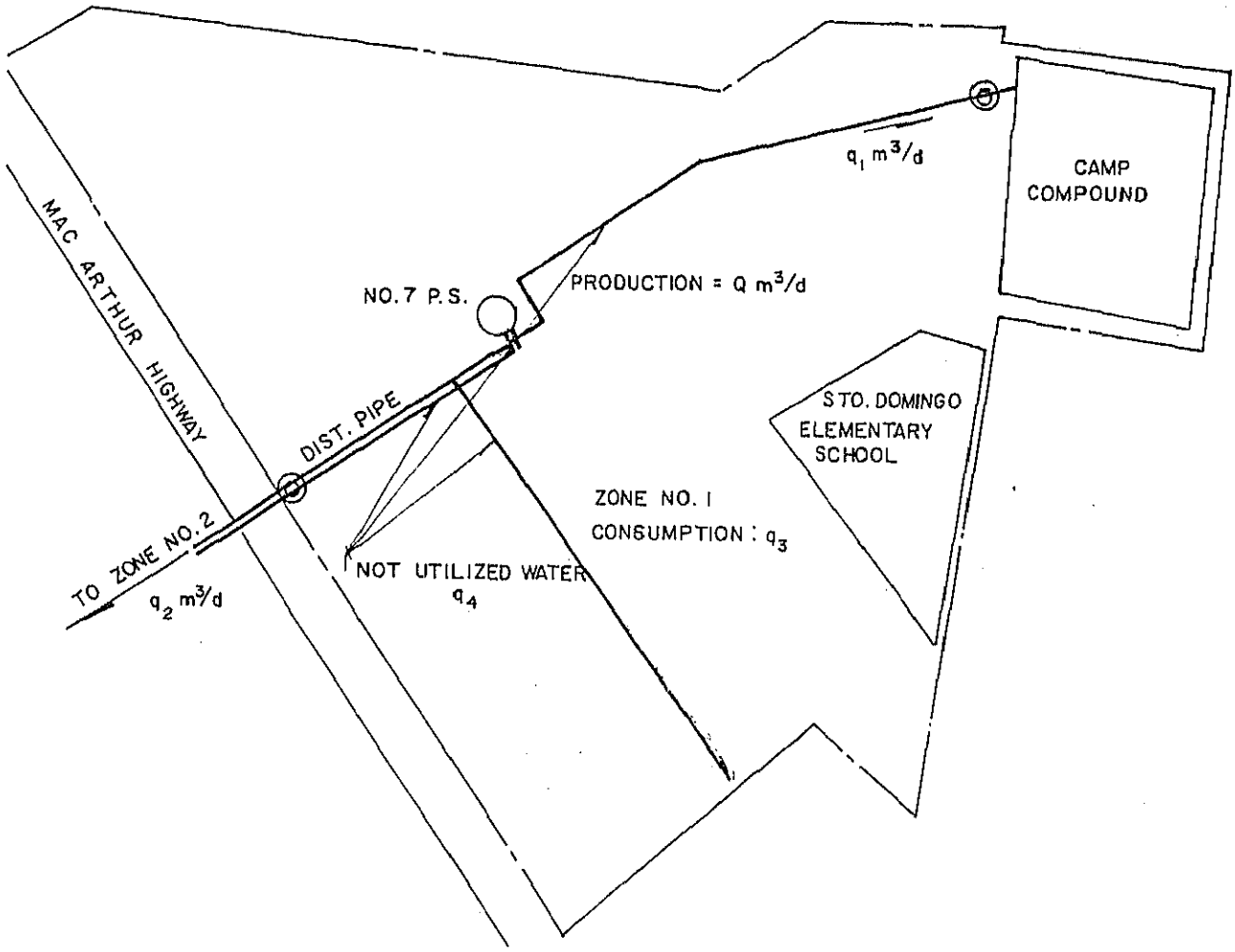
Q = 812,8 cu.m/day

$q_1 = 114.5$

$q_2 = 495.0$

$q_3 + q_4 = Q - (q_1 + q_2)$:water distributed to Zone No. 1

$= 203.3$ cu.m/day



BALANCE BETWEEN PRODUCTION AND DISTRIBUTION

$Q = (q_1 + q_2) + q_3 + q_4$

LEGEND :

◎ FLOW RATE MEASURING POINT

FIGURE 4.5.1.4

FLOW RATE MEASURING POINTS

TABLE 4.5.1.7 FLOW RATE MEASUREMENT RESULTS

Unit: cu.m/hour

Time	Production (No. 7 P.S.)	Flow rate		Distributed into Zone No. 1	R. M.
		Connection (Zone 1 & 2)	Near Capamp		
0 - 1	32.9	26.5	6.4	0.0	
1 - 2	32.9	26.6	6.3	0.0	
2 - 3	32.9	26.9	6.0	0.0	
3 - 4	32.9	26.8	6.1	0.0	
4 - 5	33.0	26.4	6.4	0.2	
5 - 6	33.9	22.1	4.9	6.9	
6 - 17	34.7	17.1	3.4	14.2	
7 - 8	34.6	15.6	3.6	15.4	
8 - 9	34.5	16.0	3.5	15.0	
9 - 10	33.9	16.1	3.5	14.3	
10 - 11	34.0	16.8	3.6	13.6	
11 - 12	34.3	17.6	3.8	12.9	
12 - 13	34.4	17.1	3.8	13.5	
13 - 14	34.2	19.0	4.2	11.0	
14 - 15	34.2	20.3	4.8	9.1	
15 - 16	34.2	19.6	4.5	10.1	
16 - 17	34.4	17.2	3.6	13.6	
17 - 18	34.5	18.3	3.6	12.6	
18 - 19	34.2	18.8	4.1	11.3	
19 - 20	34.1	17.9	4.2	12.0	
20 - 21	33.9	19.8	4.7	9.4	
21 - 22	33.8	21.9	5.7	6.2	
22 - 23	33.4	24.6	6.8	2.0	
23 - 0	33.0	26.0	7.0	0.0	
Hourly Ave.	33.9	20.6	4.8	8.5	
Daily Total	812.8	495.0	114.5	203.3	

Utilized water in the zone and unaccounted-for water

Based on the above water consumption and production/distribution from the water source, water utilized in Zone No. 1 is calculated at approximately 85% of distributed amount from No. 7 pumping station (See FIGURE 4.5.1.5).

This FIGURE is comparatively high attributed seemingly to the low water pressure and water use through the day.

Utilized water (percentage)

a) Distributed: 203.3, 100%

b) Consumption: 175.39, 85%

c) Leakage & Unknown:
27.9, 15%

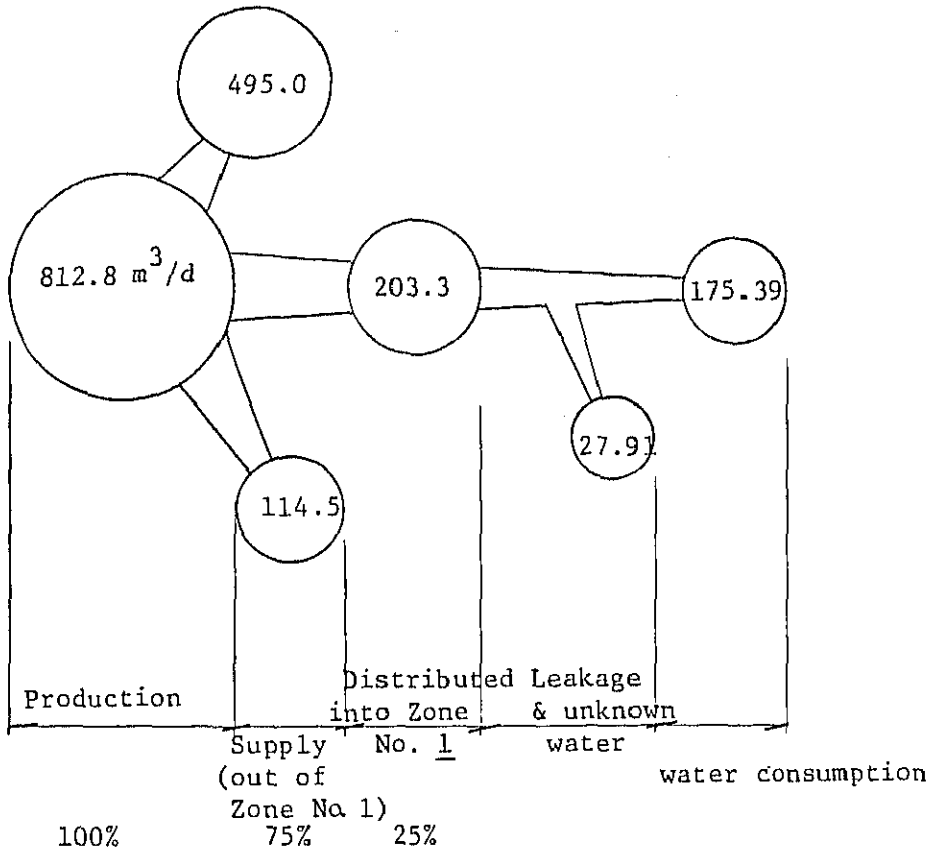


FIGURE 4.5.1.5 RELATIONSHIP AMONG PRODUCTION, DISTRIBUTION, LEAKAGE & UNKNOWN WATER AND CONSUMPTION

Of the water distributed into the Zone (203.3 cu.m/day), approximately 15% (27.9/cu.m/day) is lost to leakage and other reasons. Accounted-for water was estimated according to the following procedure.

Domestic consumption

a) metered = 91.8 cu.m/day (89 connections)

b) unmetered :

87 connections (₱18 - ₱14) ÷ 0.8 + 10 cu.m
= 15 cu.m/connect.month(0.5 cu.m/connect.day)
0.5 x 87 = 43.5 cu.m/day

182 additional faucet ₱2 ÷ 0.8
= 2.5 cu.m/faucet.month (0.083 cu.m/faucet.day)
0.083 x 182 = 151 cu.m/day

5 metered (but not functioning)
1.03 cu.m/connect.day (metered average) x 5
= 5.2 cu.m/day

Sub-total 63.8 cu.m/day
(92 connections & 182 additional faucets)

Total 155.6 cu.m/day
(181 connections & 182 additional faucets)

Commercial consumption

a) metered : 1.1 cu.m/day (2 connections)

b) unmetered : (₱90 - ₱40) ÷ ₱1.6 cu.m + 10 cu.m
= 41.3 cu.m/connect.month (1.375 cu.m/-conn.day) 1.375 x 5 = 6.9 cu.m/day

Total : 8 cu.m/day (7 connections)

Institutional consumption

a) unmetered: 1.4 cu.m/day (1 connection)

Total accounted-for water is accordingly 165 cu.m/day. The percentage of accounted-for water distributed form the source is approximately 80, which seems to be above the city's average.

APPENDIX 6.6.1 EXISTING WELL INVENTORY IN PAMPANGA PROVINCE

Well No JICA	Original	Depth Well (m)	Tested Yield (l/min)	Drawdown (m)	Specific Capacity (l/min/m)	Trans-missivity (m^2/day)	Location Barangay /	Municipality
	CL-34	244	3,705	19.5	190	400		Magalang
	CL-35	237	2,543	25.4	100	180		Porac
	CL-38	240	4,201	13.5	311	610		Sta.Ana
	CL-41	256	6,052	14.7	412	900		Bacalor
	Ex-20	204	1,694	29.5	57	110	St Rosario	Magalang
1	PS- 1	153	1,892	18.3	90	-	Mabini st	Angeles
2	PS- 2	243	821	19.8	42	-	Mabini st	Angeles
3	PS- 3	126	394	18.3	22	-	Mabini st	Angeles
4	PS- 4	80	394	15.0	17.5	-	Kulliat st	Angeles
5	PS- 5	110	985	14.6	67	-	Balagtas	Angeles
6	PS- 6	120	985	6.4	154	-	Pandan	Angeles
7	PS- 7	214	821	13.7	60	-	San Joaquin	Angeles
8	PS- 8	104	755	13.7	55	-	Pampang	Angeles
9	PS- 9	110	181	15.3	12	-	St Cristo	Angeles
10	PS-10	92	657	18.3	36	-	McArther	Angeles
11	PS-11	98	493	15.3	32	-	Mirasol	Angeles
14	PS-14	148	602	3.7	163	370	Ele school	Angeles
16	17991	27	64	1.3	49	-	Mining	Angeles
19	17992	34	76	0.6	127	-	Pandan	Angeles
20	17996	49	26	1.5	17	-	Sapalibutad	Angeles
22	426025	14	22	1.2	18	-	Pulun Cacutud	Ageles
24	BWS- 6	183	1,970	14.6	141	-	Lakandula	Ageles
27	43673	57	227	3.1	73	-	Balibago	Ageles
29	BWS- 4	183	1,325	25.6	52	-	Balibago	Ageles
30	BWS- 2	85	1,473	20.4	72	-	Josefa Subd	Ageles
31	17994	25	23	2.7	8	-	Pamcang	Ageles
32	17993	25	133	0.9	144	-	Pampang	Ageles
34	TW	152	385	80.3	4.8	-	Cutcut	Ageles
39	13159	16	57	1.6	35	-	Calzadang	Porac
40	43672	32	33	1.1	35	-	Senora	Porac
41	13156	19	30	1.6	19	-	Macantian	Porac
42	13155	15	140	0.6	229	-	Macantian	Porac
43	13155	13	30	0.9	34	-	Macantian	Porac
44	13158	12	49	0.3	164	-	Mnlbaug	Porac
46	19352	48	76	0.9	84	-	St Cruz	Angeles
46	19353	44	33	2.7	14	-	St Cruz	Angeles
46	22091	20	33	1.5	25	-	Pulung Maraba	Porac
52	426253	49	33	1.2	32	-	Pasbulbulu	Porac
53	426622	49	26	3.1	8.4	-	Margot	Angeles
54	426039	40	30	2.1	14	-	Margot	Angeles
55	426032	62	19	8.0	2.4	-	Margot	Angeles
57	3234	64	38	1.5	25	-	Saparbato	Angeles
59	6653	60	23	5.4	4.2	-	Saparbato	Angeles
61	20241	106	530	4.6	116	-	Clark A.B.	Angeles
62	20771	26	33	0.3	126	-	Baluga VIII	Angeles
63	17989	25	66	0.6	105	-	Malabanas	Angeles
65	C- 5	208	-	-	-	160	Calzadang	Porac
66	BWS- 7	92	1,806	8.5	212	-	Dau	Angeles
67	BWS- 8	92	2,496	15.9	157	-	Henson VIII	Angeles
68	EPZA	92	869	8.3	104	150	Export Proc	Angeles
70	426111	68	56	1.8	31	-	Balibago	Angeles
71	13162	21	38	0.3	126	-	Sepungbulaon	Porac
72	17040	24	56	1.5	37	-	Sepungbulaon	Porac
73	14784	21	26	4.9	5.4	-	Pulong Santol	Porac
74	18059	37	45	1.5	30	-	Planas	Porac
75	5957	32	26	1.5	17	-	Planas	Porac
76	17183	28	26	3.7	7	-	Palat	Porac
77	13161	22	38	0.6	63	-	Mitla	Porac
78	42601	40	26	0.6	43	-	Mitla	Porac
79	13159	12	56	1.5	37	-	Calzadang	Porac
80	43671	24	33	0.9	41	-	Balubad	Porac
81	426017	20	38	2.5	15	-	Cangatba	Porac

APPENDIX 6.6.2 WELL LITHOLOGIC LOGS (ANGELES CITY, PAMPANGA)

LWUA / JICA WELL NO. CL-36
OWNER'S NO.
LOCATION : CALZADANG BAYO, PORAC
GROUND ELEVATION :
WELL DEPTH : 237 m
CASING DEPTH :
CASING DIAMETER :
STATIC WATER LEVEL : 4.65 mbgs
DISCHARGE :
SPECIFIC CAPACITY :
TRANSMISSIVITY :

DEPTH (m)	WELL DESIGN	STRATA DESCRIPTION
96	340mmØ BLANK	SAND WITH SOME SILT
105		SILTY SAND
137	200mmØ SLOTTED	SAND W/ SILT
143		SAND
181		SAND W/ SILT
204		SAND
211		SAND W/ SILT
226		SILT & SAND
237		SAND

LWUA / JICA WELL NO. CL-34
OWNER'S NO.
LOCATION : SAN JOSE, MAGALANG
GROUND ELEVATION :
WELL DEPTH : 256.5 m
CASING DEPTH :
CASING DIAMETER :
STATIC WATER LEVEL : 2.97
DISCHARGE :
SPECIFIC CAPACITY :
TRANSMISSIVITY :

DEPTH (m)	WELL DESIGN	STRATA DESCRIPTION
3	340mmØ BLANK	SILT, SAND & GRAVEL
10		MED. COARSE SAND
16		COARSE - V. COARSE SAND
27		V. COARSE SAND & GRAVEL SILTY, CLAYEY
40		SAND & GRANULES W/ PUMICE
42		SAND & PEBBLES
45		ANDESITE, PUMICE SILT & S
48		PEBBLE, SAND & CLAY
106	ALTERNATE 200mmØ BLANK & SLOTTED	SILT & CLAY SOME PEBBLES & SAND
110		SAND, GRAVEL, SILT, CLAY
113		SILT & CLAY
116		SAND, GRAVEL, SILT, CLAY
121		SANDY SILT, CLAY, GRAVEL
132		SAND & GRAVEL W/ SILT, CLAY
144		SAND & GRAVEL W/ SILT
236		SAND & GRAVEL
240		SAND, GRAVEL & SILT
250		SILT & SAND
256.5		SANDY SILT, GRANULE GRAVEL

NO 34

WELL NO 34 TW
LOCATION : CUT CUT, ANGELES
DEPTH : 152 m
CASING DEPTH :
CASING DIAMETER : 150mm
STATIC WATER LEVEL : 3.66m
PUMP TEST
DISCHARGE : 6.42 lps
DRAWDOWN : 80.25 m

DEPTH (m)	LOG
	SANDY SOIL
	SILT
	SAND, F~m
	SAND, TUFFACEOUS
	TUFF
	SAND, F~C
	SAND, TUFFACEOUS
	TUFF
50	SAND, TUFFACEOUS SILTY
	SAND, F~m
	SAND, m WELL SORTED, LOOSE
	SANDY TUFF, SILTY
100	SAND, TUFFACEOUS SILTY, POORLY SORTED
	SANDY TUFF, SILTY
	SAND, TUFFACEOUS COMPACT
	SILTY SAND, m CLAYEY, TUFF.
150	SAND, m~c
	W/ RESISTIVITY LOG

NO 58

WELL NO 58 TW
LOCATION : SAPANG BATO, ANGELES
DEPTH : 152m
CASING DEPTH :
CASING DIAMETER :
STATIC WATER LEVEL :
DISCHARGE :
DRAWDOWN :

DEPTH (m)	LOG
	SANDSTONE, F~m
	SANDSTONE F~m PEBBLY SILTY, TUFFACEOUS
50	SANDSTONE, m~f TUFFACEOUS
	CLAY, STICKY
	SANDSTONE, f~m SILTY
	CLAY, STICKY
100	SANDSTONE, f~m
	CLAY
	SANDSTONE, f~m
	SANDSTONE, f
	CLAY, STICKY
150	SANDSTONE, PEBBLY
	W/ RESISTIVITY LOG

NO 22

WELL NO BPW 426025
LOCATION : PULONG CACUTAD, ANGELES
DEPTH : 13.7
CASING DEPTH :
CASING DIAMETER :
STATIC WATER LEVEL : 3.66 m
DISCHARGE : 0.38 lps
DRAWDOWN : 1.23m

DEPTH (m)	LOG
	WHITE SAND
	ADOBE
	SAND, WHITE
20	SAND, COARSE

NO. 40

LWUA well no. 43672 (BPW)

LOCATION : BO. SEÑORA
PORAC, PAMPANGA

DEPTH : 30.0 M

CASING DEPTH :

CASING DIAMETER :

STATIC WATER LEVEL :

PUMP TEST DATA

DISCHARGE : 0.631 LPS

DRAWDOWN :

DEPTH LOG

30

- SAND
- BLUE CLAY
- SAND & GRAVEL
- ADOBE
- SANDSTONE

NO. 44

LWUA well no. 22091 (BPW)

LOCATION : BO. PULUNGMABA
PORAC, PAMPANGA

DEPTH : 20.1 M

CASING DEPTH :

CASING DIAMETER :

STATIC WATER LEVEL : 14.63 M

PUMP TEST DATA

DISCHARGE : 0.63 LPS

DRAWDOWN :

DEPTH LOG

50

- SAND ROCK
- SAND W/ STONE
- SAND
- COARSE SAND W/ GRAVEL

LWUA well no. 13158 (BPW)

LOCATION : BO. MANIBAOG
PORAC, PAMPANGA

DEPTH : 11.9 M

CASING DEPTH :

CASING DIAMETER :

STATIC WATER LEVEL : 5.18 M

PUMP TEST DATA

DISCHARGE : 0.82

DRAWDOWN :

DEPTH LOG

50

- SANDY CLAY W/ BOULDER
- SAND & GRAVEL

NO 56

WELL NO BPW 531715

LOCATION : MARGOT, ANGELES

DEPTH : 161.6 m

CASING DEPTH :

CASING DIAMETER :

STATIC WATER LEVEL : 24.39m

PUMP TEST

DISCHARGE : 9.46 Lps

DRAWDOWN :

DEPTH (m) LOG

50

100

150

161.6

- SAND
- ADOBE
- BOULDER
- SANDSTONE
- ADOBE
- SANDY CLAY
- SAND & GRAVEL
- SANDY CLAY W/GRAVEL
- LOOSE ROCK
- ADOBE (TUFF)
- SAND & GRAVEL
- SANDY CLAY
- LOOSE ROCK
- SANDY CLAY

NO 52

WELL NO BPW 426253

LOCATION : PASBUL, PORAC

DEPTH : 48.8 m

CASING DEPTH : 48.8m

CASING DIAMETER : 100

STATIC WATER LEVEL : 26.2m

DISCHARGE : 0.63 Lps

DRAWDOWN :

DEPTH (m) LOG

48.7

50

100

- SAND, F
- SAND, C
- ADOBE, SOFT
- SAND & GRAVEL, COMPACT
- SAND, C
- SANDY CLAY
- ADOBE
- SAND, F
- SAND, F~C

WELL NO

LOCATION :

DEPTH :

CASING DEPTH :

CASING DIAMETER :

STATIC WATER LEVEL :

DISCHARGE :

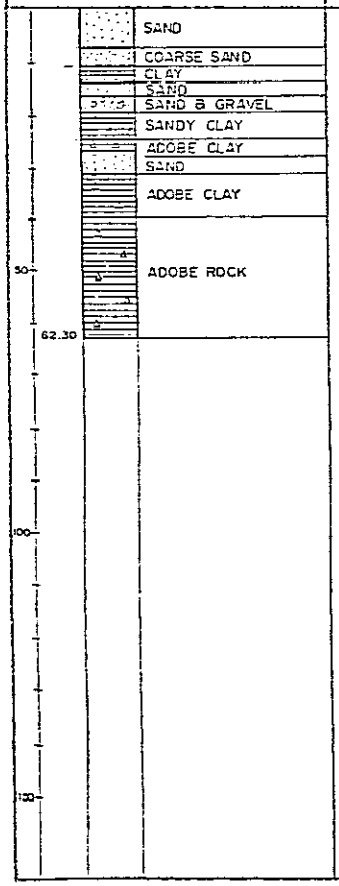
DRAWNDOWN :

DEPTH (m) LOG

NO. 55

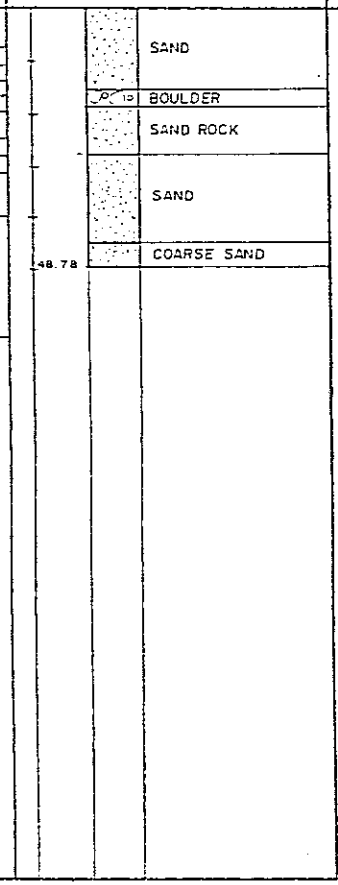
LWUA well no. BPW-426032

LOCATION : BO. MARGOT, ANGELES CITY, PAMP.
DEPTH : 62.30 M
CASING DEPTH :
CASING DIAMETER
STATIC WATER LEVEL 27.44
PUMP TEST DATA
DISCHARGE : 032 LPS
DRAWDOWN :



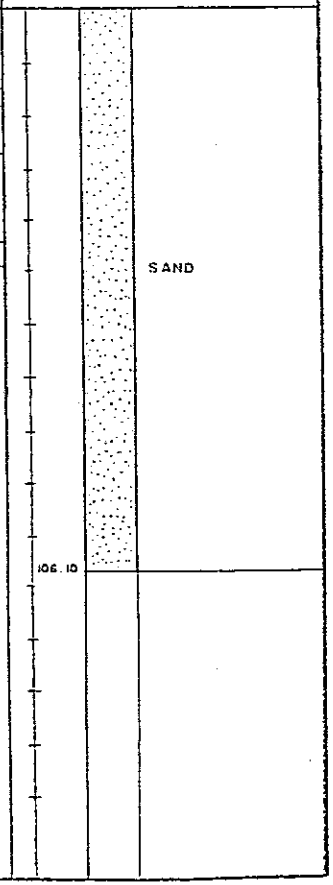
LWUA well no. BPW-436622

LOCATION : MARGOT, ANGELES CITY, PAMPANGA
DEPTH : 48.78 M
CASING DEPTH :
CASING DIAMETER .
STATIC WATER LEVEL : 27.44
PUMP TEST DATA
DISCHARGE : 0.44 LPS
DRAWDOWN :



LWUA well no. BPW-10857

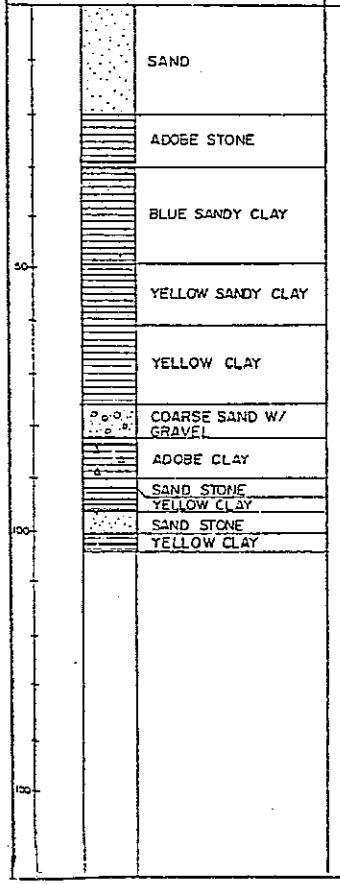
LOCATION . BO. LOURDES, ANGELES CITY, PAMP.
DEPTH : 106.10 M
CASING DEPTH :
CASING DIAMETER :
STATIC WATER LEVEL : 4.26
PUMP TEST DATA
DISCHARGE : 18.93 LPS
DRAWDOWN :



NO. 61

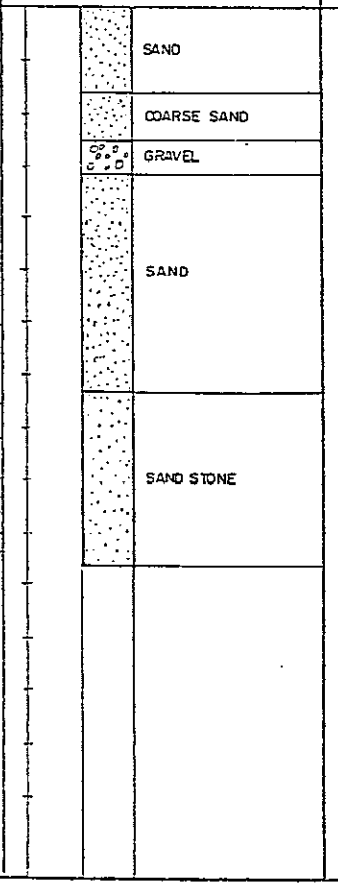
LWUA well no. BPW 6286

LOCATION : KULIAT, BO. LOURDES ANGELES CITY, PAMP.
DEPTH : 103.65 M
CASING DEPTH :
CASING DIAMETER
STATIC WATER LEVEL 2.44
PUMP TEST DATA
DISCHARGE : 7.57 LPS
DRAWDOWN :



LWUA well no. BPW 20241

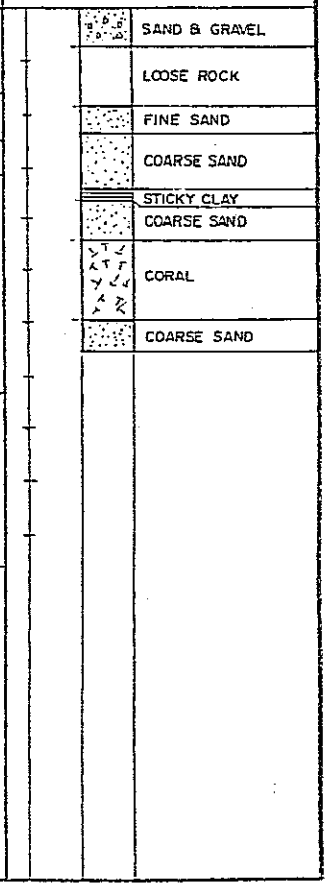
LOCATION : CLARK FIELD ANGELES CITY, PAMP.
DEPTH : 106.10 M
CASING DEPTH :
CASING DIAMETER
STATIC WATER LEVEL : 25.91
PUMP TEST DATA
DISCHARGE : 8.83 LPS
DRAWDOWN :



NO. 62

LWUA well no. BPW 20771

LOCATION :
DEPTH :
CASING DEPTH :
CASING DIAMETER :
STATIC WATER LEVEL :
PUMP TEST DATA
DISCHARGE :
DRAWDOWN :



NO 69

WELL NO C-4

LOCATION : STA. MARIA, MABALACAT

DEPTH : 143.3m

CASING DEPTH : 135.6 m

CASING DIAMETER : 400/300mm

STATIC WATER LEVEL : 1.22

PUMP TEST

DISCHARGE :

DRAWDOWN :

DEPTH (m)	LOG
	SANDY LOAM
	SAND W/ GRANULE FINE - VERY COARSE
	CLAY W/ GRANULE
	SAND, COARSE W/ GRANULE
	CLAY, SANDY
50	CLAYEY SAND
	CLAY, SANDY W/ PEBBLES
	SAND, FINE - VERY COARSE W/ GRANULE
	CLAYEY SAND
	SAND, FINE ~ MEDIUM
100	SAND, VERY FINE
	SAND, FINE
	SAND W/ GRAVEL
143.3	SAND, FINE
150	

NO 65

WELL NO C-5

LOCATION : CALSADONG BAYO PORAC

DEPTH : 208.8 m

CASING DEPTH : 208.8 m

CASING DIAMETER : 400/300 mm

STATIC WATER LEVEL : 6.67

DISCHARGE :

DRAWDOWN :

DEPTH (m)	LOG
	SAND W/ CLAY
	SAND, COARSE
	SAND, CLAYEY
50	SAND W/ PEBBLE ~ GRAVEL
	SAND, COARSE, CLAYEY
	SILT
	SILT W/ SAND, FINE
100	CLAY, SILTY ~ SANDY
	SAND & GRAVEL
	SAND, F ~ C
	SAND & GRAVEL W/ CLAY
	CLAY
	SAND & GRAVEL
150	SAND, F ~ C.
	SAND & GRAVEL
170	SAND, F ~ C

NO 65

WELL NO (Cont.')

LOCATION :

DEPTH :

CASING DEPTH :

CASING DIAMETER :

STATIC WATER LEVEL :

DISCHARGE :

DRAWDOWN :

DEPTH (m)	LOG
170	SAND, FINE
	SILT W/ SAND
	SAND, C. GRAVEL
200	SILT W/ SAND
208.8	

NO. 67

LWUA Well No. BWS 8

LOCATION : Henson Village, Balibago

DEPTH : 91.5

CASING DEPTH:

CASING DIAMETER:

STATIC WATER LEVEL: 6.10

PUMP TEST DATA

DISCHARGE: 41.6 LPS

DRAWDOWN: 15.81

DEPTH	LOG
	Sand
	Sandy clay
50	clay w/ gravel
	Sandy Clay
	Gravel
	Sand w/ gravel
	Gravel w/ coarse San.
91.5	Clay w/ sand
100	

NO. 70

LWUA well no. #26/// .

LOCATION : Balibago, Angeles

DEPTH : 69.5m

CASING DEPTH:

CASING DIAMETER:

STATIC WATER LEVEL: 2.74m

PUMP TEST DATA

DISCHARGE: 0.94 LPS

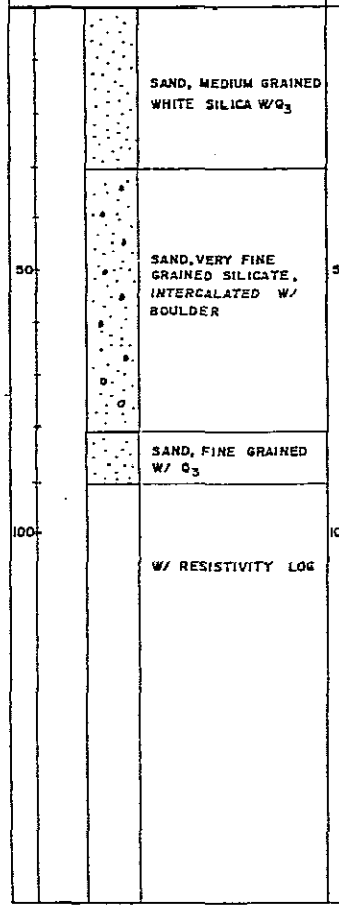
DRAWDOWN :

DEPTH	LOG
	Sand & gravel
	loose boulder
	Sand, F
	Sand, C
	clay, sticky
	Sand, C
50	Coral
	Sand, C

NO. 68

WELL NO EPZA

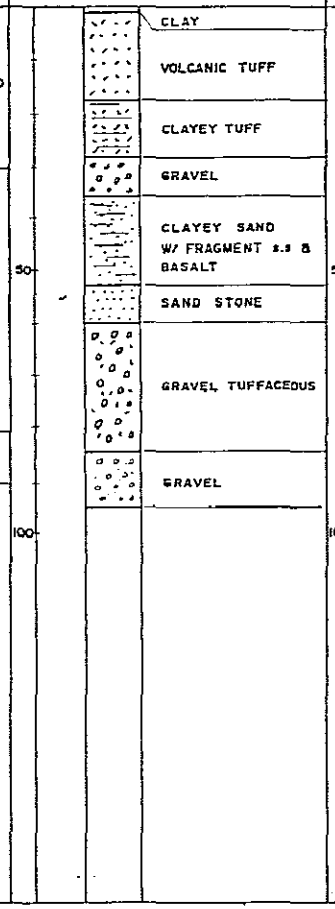
LOCATION : EXPORT PROCESSING ZONE
DEPTH : 91.5 m
CASING DEPTH :
CASING DIAMETER :
STATIC WATER LEVEL :
PUMP TEST
DISCHARGE : 14.49 lps
DRAWDOWN : 8.33 m



NO. 81

WELL NO C-20A

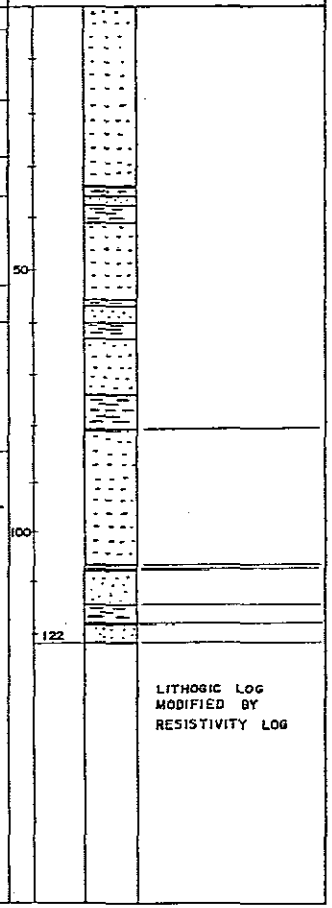
LOCATION : PULONG BOLO, ANGELES
DEPTH :
CASING DEPTH :
CASING DIAMETER :
STATIC WATER LEVEL :
DISCHARGE :
DRAWDOWN :



NO. 17

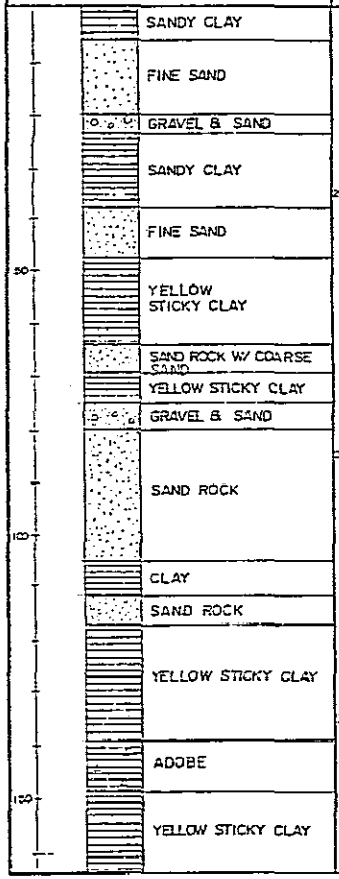
WELL NO CAPAYA II

LOCATION : CAPAYA II
DEPTH : 122 m
CASING DEPTH : 122 m
CASING DIAMETER :
STATIC WATER LEVEL :
DISCHARGE :
DRAWDOWN :



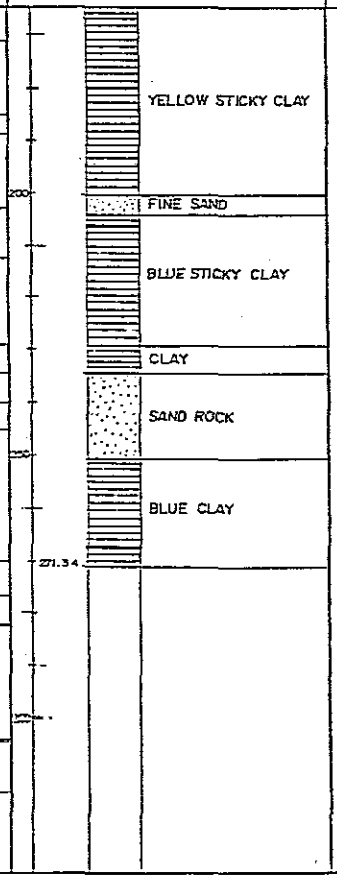
LWUA Well No. BPW-4901

LOCATION: HERANDA ST. ANGELES CITY, PAMPANGA
DEPTH: 271.34 M
CASING DEPTH:
CASING DIAMETER:
STATIC WATER LEVEL: 7.32 M
PUMP TEST DATE:
DISCHARGE: 4.73 LPS
DRAWDOWN:



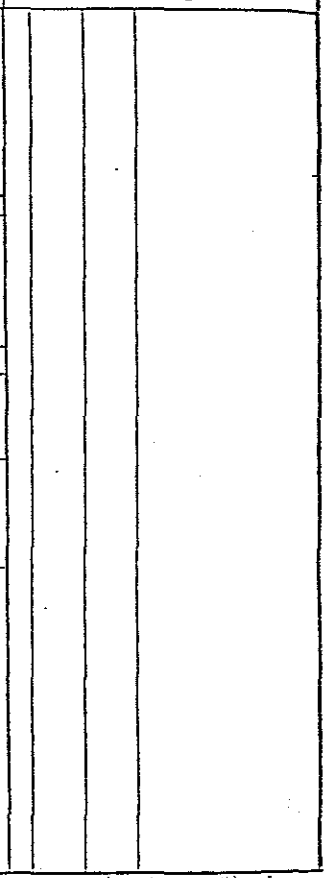
LWUA Well No. BPW-4901 (CONT.)

LOCATION:
DEPTH:
CASING DEPTH:
CASING DIAMETER:
STATIC WATER LEVEL:
PUMP TEST DATA
DISCHARGE:
DRAWDOWN:



LWUA Well No.

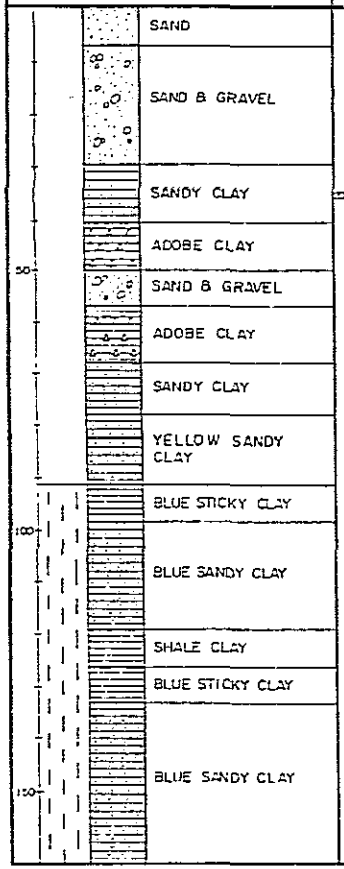
LOCATION:
DEPTH:
CASING DEPTH:
CASING DIAMETER:
STATIC WATER LEVEL:
PUMP TEST DATA
DISCHARGE:
DRAWDOWN:



LWUA Well No. 3

LOCATION: BALIBAGO, ANGELES CITY, PAMPANGA
DEPTH: 183.0 M
CASING DEPTH:
CASING DIAMETER: 300-200 mm
STATIC WATER LEVEL: 4.88 M
PUMP TEST DATE:
DISCHARGE: 28.4 LPS
DRAWDOWN:

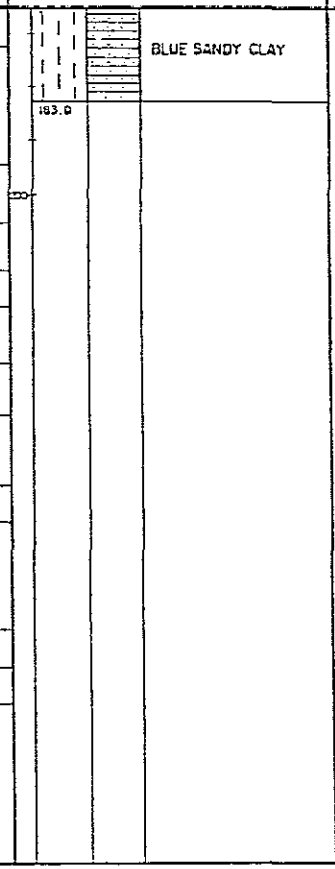
DEPTH LOG



LWUA Well No. 3 (CONT.)

LOCATION:
DEPTH:
CASING DEPTH:
CASING DIAMETER:
STATIC WATER LEVEL:
PUMP TEST DATA
DISCHARGE:
DRAWDOWN:

DEPTH LOG



LWUA Well No.

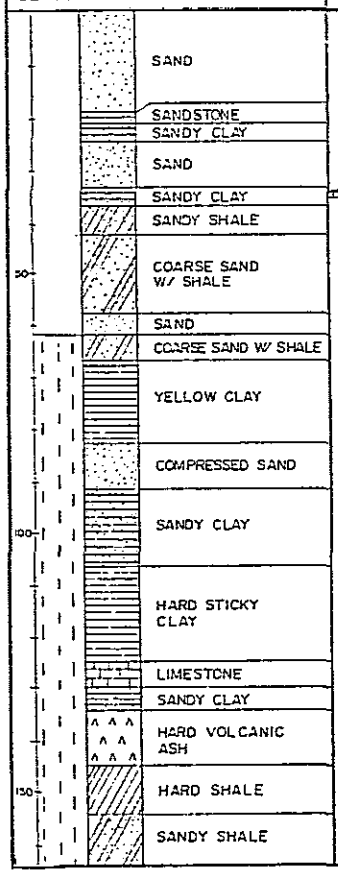
LOCATION:
DEPTH:
CASING DEPTH:
CASING DIAMETER:
STATIC WATER LEVEL:
PUMP TEST DATA
DISCHARGE:
DRAWDOWN:

DEPTH LOG

LWUA Well No. 6 (BWS INC.)

LOCATION: BALIBAGO, ANGELES CITY, PAMPANGA
DEPTH: 183.3 M
CASING DEPTH:
CASING DIAMETER: 300-200 mm
STATIC WATER LEVEL: 1.85 M
PUMP TEST DATE:
DISCHARGE: 37.85 LPS
DRAWDOWN: 14.6 M

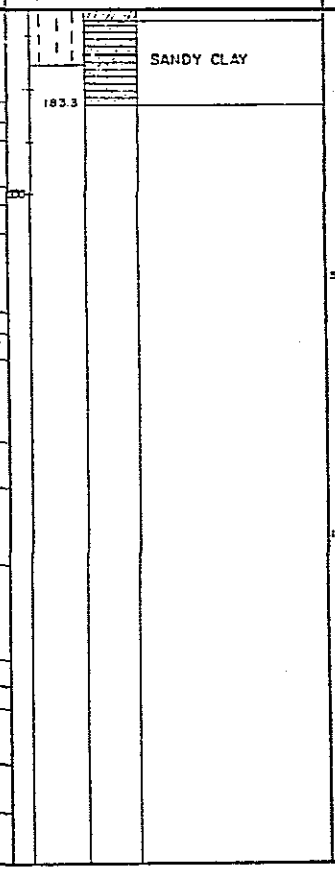
DEPTH LOG



LWUA Well No. 6 CONT.

LOCATION:
DEPTH:
CASING DEPTH:
CASING DIAMETER:
STATIC WATER LEVEL:
PUMP TEST DATA
DISCHARGE:
DRAWDOWN:

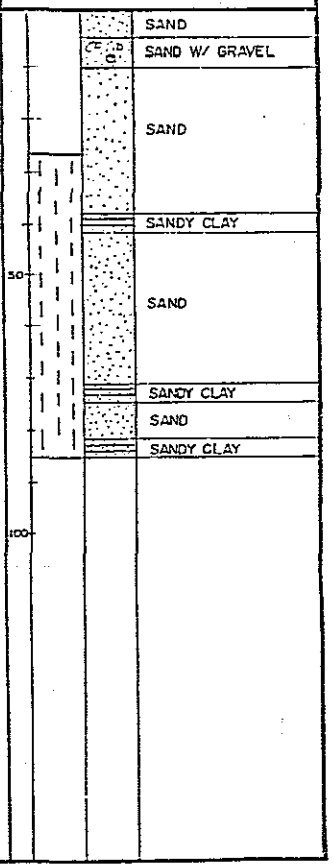
DEPTH LOG

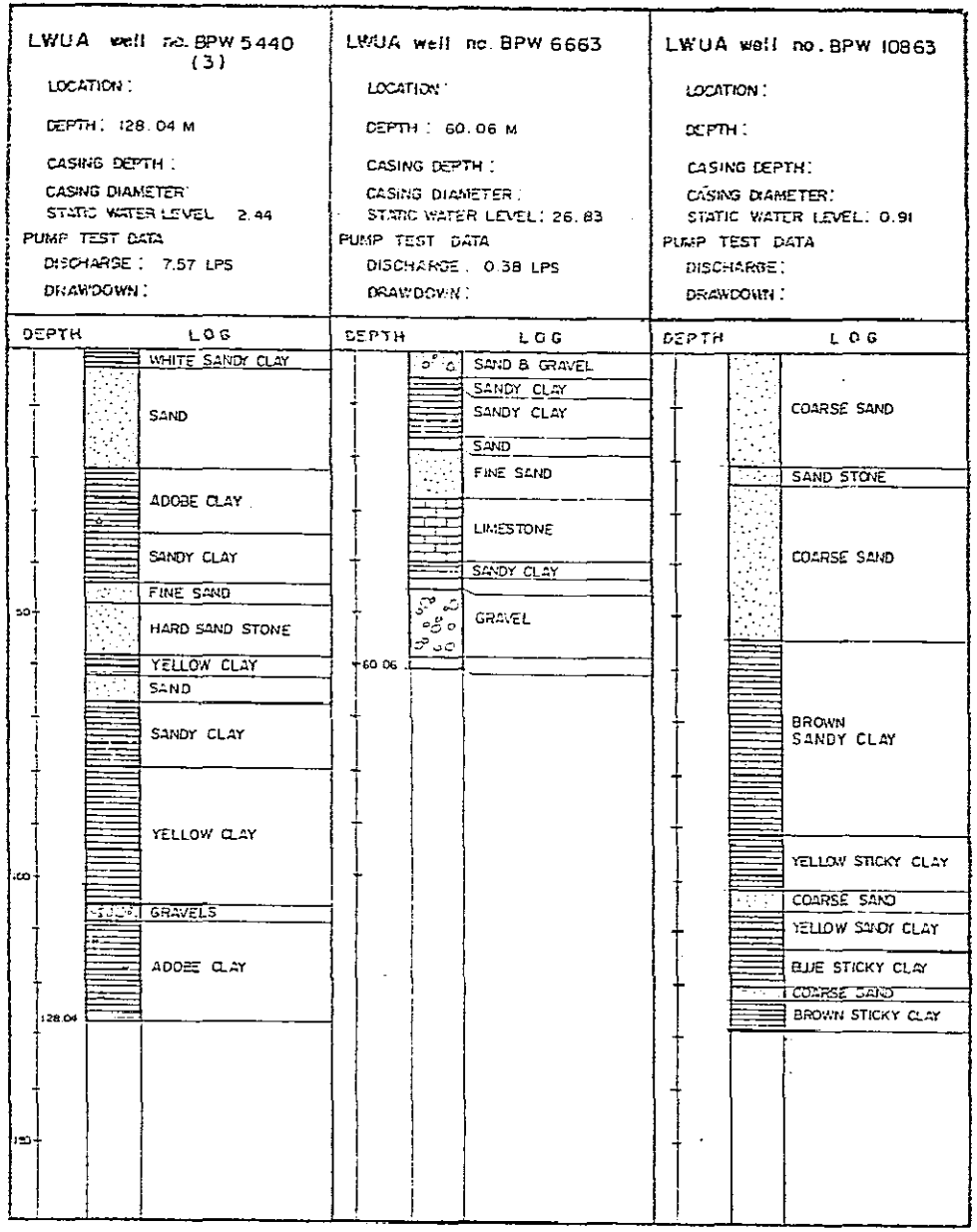


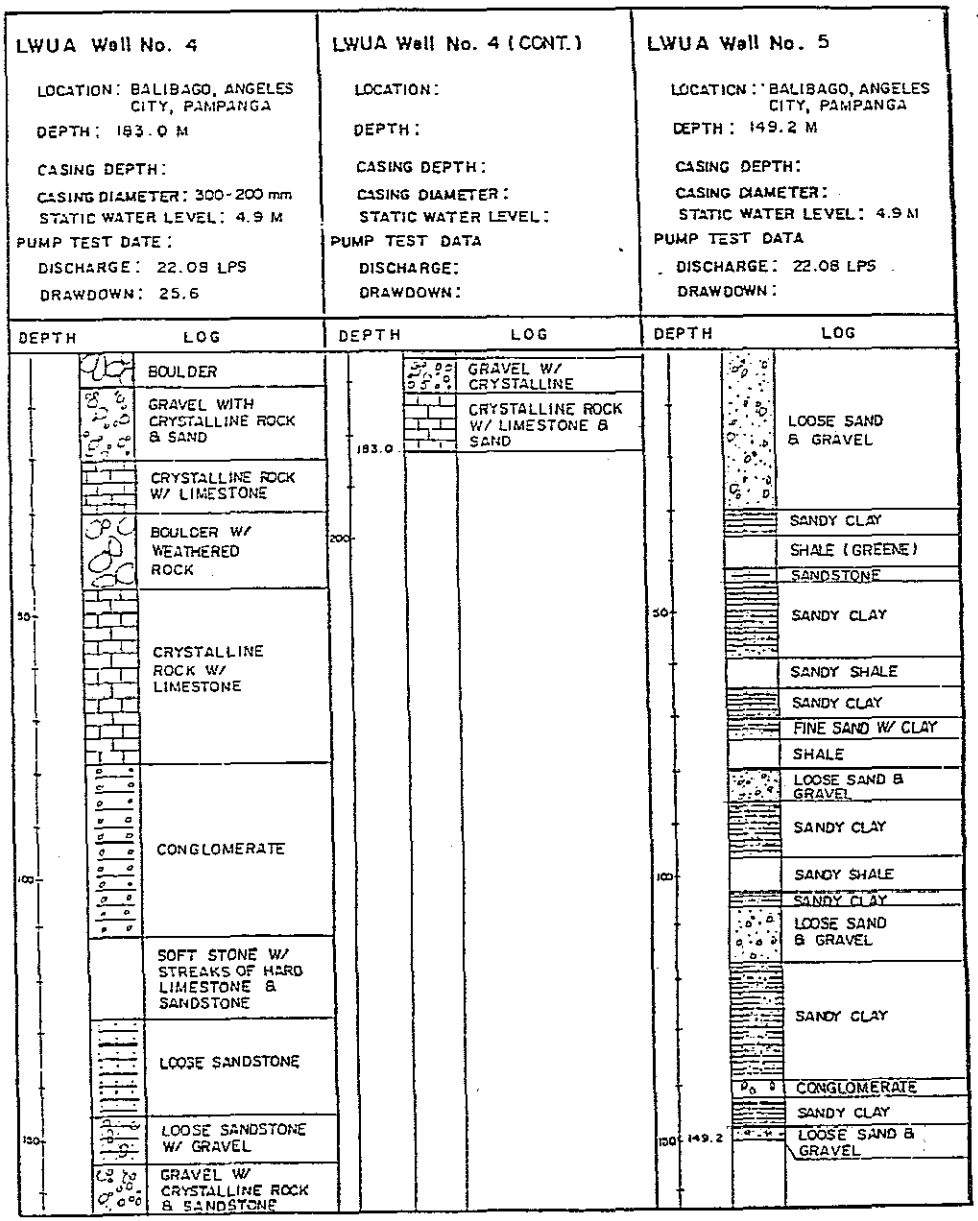
LWUA Well No. 2

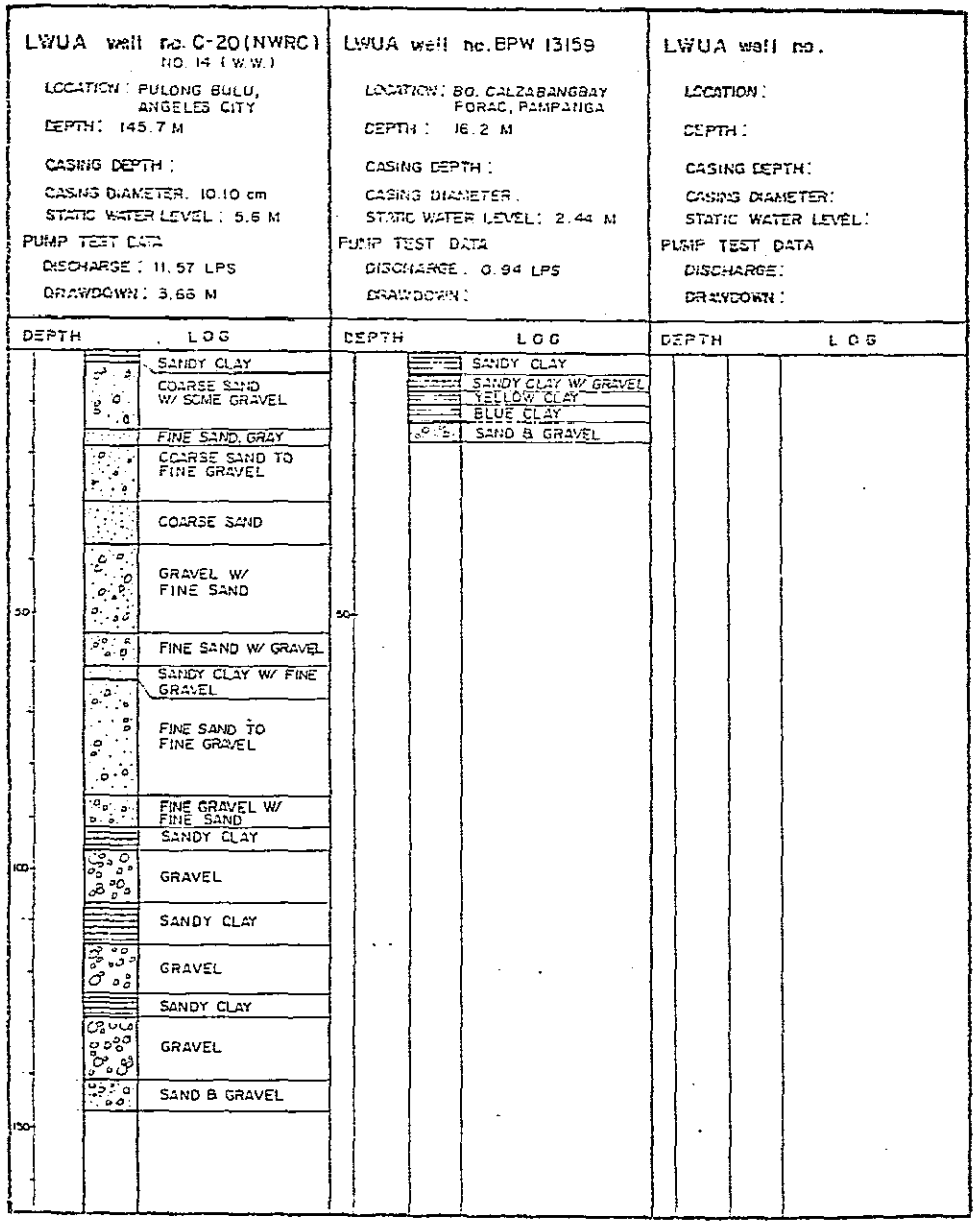
LOCATION: BALIBAGO, ANGELES CITY, PAMPANGA
DEPTH: 85.4 M
CASING DEPTH:
CASING DIAMETER: 300 mm
STATIC WATER LEVEL: 4.9 M
PUMP TEST DATA
DISCHARGE: 28.4 LPS
DRAWDOWN: 20.4 M

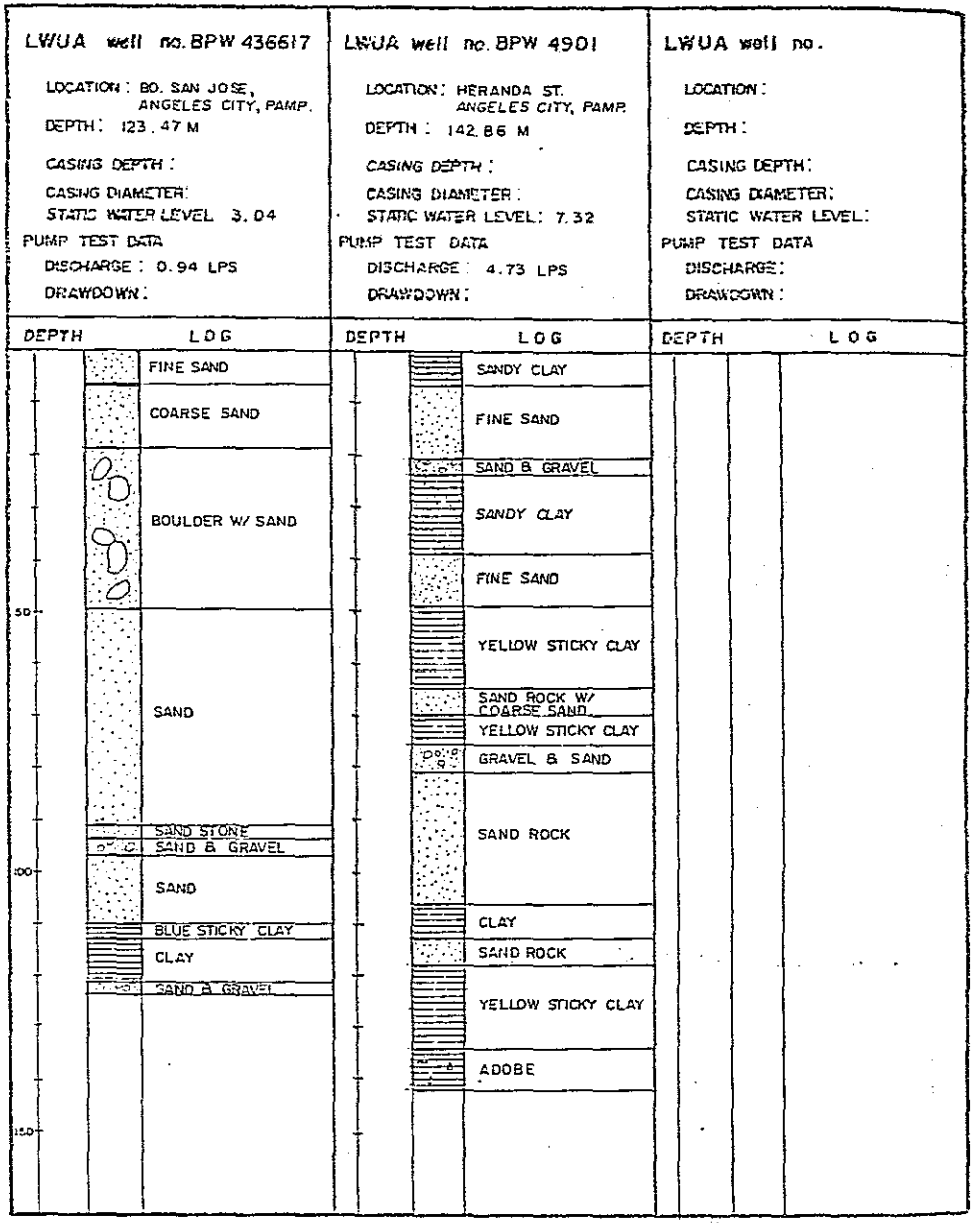
DEPTH LOG

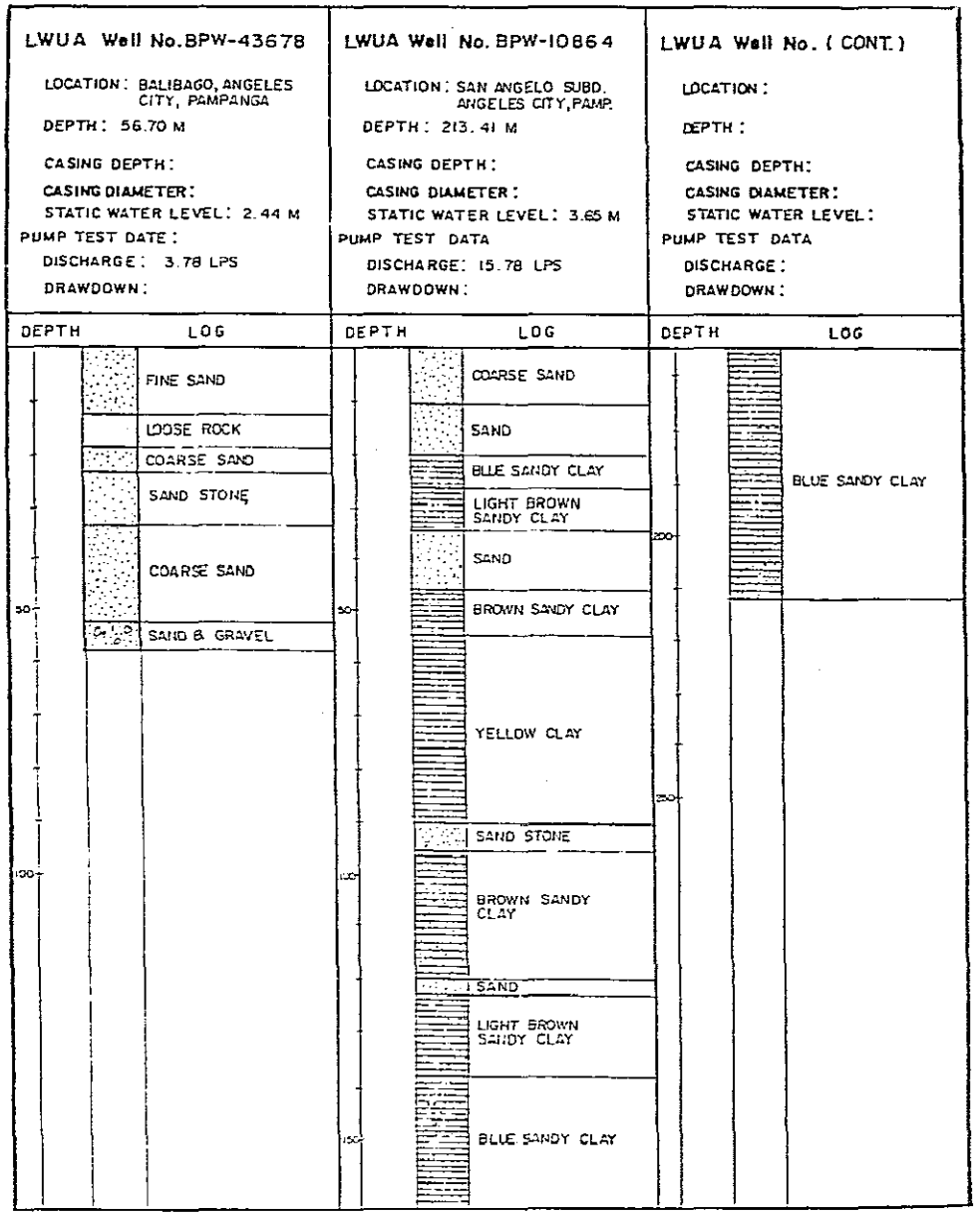



LWUA well no. BPW 5440 (3)
LOCATION :
DEPTH : 128.04 M
CASING DEPTH :
CASING DIAMETER :
STATIC WATER LEVEL 2.44
PUMP TEST DATA
DISCHARGE : 7.57 LPS
DRAWDOWN :
DEPTH
LOG
WHITE SANDY CLAY
SAND
ADOBE CLAY
SANDY CLAY
FINE SAND
HARD SAND STONE
YELLOW CLAY
SAND
SANDY CLAY
YELLOW CLAY
GRAVELS
ADOBE CLAY
128.04
LWUA well no. BPW 6663
LOCATION :
DEPTH : 60.06 M
CASING DEPTH :
CASING DIAMETER :
STATIC WATER LEVEL : 26.83
PUMP TEST DATA
DISCHARGE : 0.38 LPS
DRAWDOWN :
DEPTH
LOG
SAND & GRAVEL
SANDY CLAY
SANDY CLAY
SAND
FINE SAND
LIMESTONE
SANDY CLAY
GRAVEL
60.06
LWUA well no. BPW 10863
LOCATION :
DEPTH :
CASING DEPTH :
CASING DIAMETER :
STATIC WATER LEVEL : 0.91
PUMP TEST DATA
DISCHARGE :
DRAWDOWN :
DEPTH
LOG
COARSE SAND
SAND STONE
COARSE SAND
BROWN SANDY CLAY
YELLOW STICKY CLAY
COARSE SAND
YELLOW SANDY CLAY
BLUE STICKY CLAY
COARSE SAND
BROWN STICKY CLAY


LWUA Well No. 4
LOCATION : BALIBAGO, ANGELES CITY, PAMPANGA
DEPTH : 183.0 M
CASING DEPTH :
CASING DIAMETER : 300-200 mm
STATIC WATER LEVEL : 4.9 M
PUMP TEST DATE :
DISCHARGE : 22.08 LPS
DRAWDOWN : 25.6
DEPTH
LOG
BOULDER
GRAVEL WITH CRYSTALLINE ROCK & SAND
CRYSTALLINE ROCK W/ LIMESTONE
BOULDER W/ WEATHERED ROCK
CRYSTALLINE ROCK W/ LIMESTONE
CONGLOMERATE
SOFT STONE W/ STREAKS OF HARD LIMESTONE & SANDSTONE
LOOSE SANDSTONE
LOOSE SANDSTONE W/ GRAVEL
GRAVEL W/ CRYSTALLINE ROCK & SANDSTONE
LWUA Well No. 4 (CONT.)
LOCATION :
DEPTH :
CASING DEPTH :
CASING DIAMETER :
STATIC WATER LEVEL :
PUMP TEST DATA
DISCHARGE :
DRAWDOWN :
DEPTH
LOG
GRAVEL W/ CRYSTALLINE
CRYSTALLINE ROCK W/ LIMESTONE & SAND
183.0
LWUA Well No. 5
LOCATION : BALIBAGO, ANGELES CITY, PAMPANGA
DEPTH : 149.2 M
CASING DEPTH :
CASING DIAMETER :
STATIC WATER LEVEL : 4.9 M
PUMP TEST DATA
DISCHARGE : 22.08 LPS
DRAWDOWN :
DEPTH
LOG
LOOSE SAND & GRAVEL
SANDY CLAY
SHALE (GREENE)
SANDSTONE
SANDY CLAY
SANDY SHALE
SANDY CLAY
FINE SAND W/ CLAY
SHALE
LOOSE SAND & GRAVEL
SANDY CLAY
SANDY SHALE
SANDY CLAY
LOOSE SAND & GRAVEL
SANDY CLAY
CONGLOMERATE
SANDY CLAY
LOOSE SAND & GRAVEL
149.2


LWUA well no. C-20 (NWRC) NO. 14 (W.W.)
LOCATION : PULONG BULU, ANGELES CITY
DEPTH : 145.7 M
CASING DEPTH :
CASING DIAMETER. 10.10 cm
STATIC WATER LEVEL : 5.6 M
PUMP TEST DATA
DISCHARGE : 11.57 LPS
DRAWDOWN : 3.66 M
DEPTH
LOG
SANDY CLAY
COARSE SAND W/ SOME GRAVEL
FINE SAND, GRAY
COARSE SAND TO FINE GRAVEL
COARSE SAND
GRAVEL W/ FINE SAND
FINE SAND W/ GRAVEL
SANDY CLAY W/ FINE GRAVEL
FINE SAND TO FINE GRAVEL
FINE GRAVEL W/ FINE SAND
SANDY CLAY
GRAVEL
SANDY CLAY
GRAVEL
SANDY CLAY
GRAVEL
SAND & GRAVEL
50
100
150
LWUA well no. BPW 13159
LOCATION : BO. CALZADANGBAY FORAC, PAMPANGA
DEPTH : 16.2 M
CASING DEPTH :
CASING DIAMETER :
STATIC WATER LEVEL : 2.44 M
PUMP TEST DATA
DISCHARGE : 0.94 LPS
DRAWDOWN :
DEPTH
LOG
SANDY CLAY
SANDY CLAY W/ GRAVEL
YELLOW CLAY
BLUE CLAY
SAND & GRAVEL
50
LWUA well no.
LOCATION :
DEPTH :
CASING DEPTH :
CASING DIAMETER :
STATIC WATER LEVEL :
PUMP TEST DATA
DISCHARGE :
DRAWDOWN :
DEPTH
LOG


LWUA well no. BPW 436617
LOCATION : BO. SAN JOSE, ANGELES CITY, PAMP.
DEPTH : 123.47 M
CASING DEPTH :
CASING DIAMETER :
STATIC WATER LEVEL 3.04
PUMP TEST DATA
DISCHARGE : 0.94 LPS
DRAWDOWN :
DEPTH
LOG
FINE SAND
COARSE SAND
BOULDER W/ SAND
SAND
SAND STONE
SAND & GRAVEL
SAND
BLUE STICKY CLAY
CLAY
SAND & GRAVEL
50
100
150
LWUA well no. BPW 4901
LOCATION : HERANDA ST. ANGELES CITY, PAMP.
DEPTH : 142.86 M
CASING DEPTH :
CASING DIAMETER :
STATIC WATER LEVEL : 7.32
PUMP TEST DATA
DISCHARGE : 4.73 LPS
DRAWDOWN :
DEPTH
LOG
SANDY CLAY
FINE SAND
SAND & GRAVEL
SANDY CLAY
FINE SAND
YELLOW STICKY CLAY
SAND ROCK W/ COARSE SAND
YELLOW STICKY CLAY
GRAVEL & SAND
SAND ROCK
CLAY
SAND ROCK
YELLOW STICKY CLAY
ADOBE
LWUA well no.
LOCATION :
DEPTH :
CASING DEPTH :
CASING DIAMETER :
STATIC WATER LEVEL :
PUMP TEST DATA
DISCHARGE :
DRAWDOWN :
DEPTH
LOG


LWUA Well No.BPW-43678
LOCATION: BALIBAGO, ANGELES CITY, PAMPANGA
DEPTH: 56.70 M
CASING DEPTH:
CASING DIAMETER:
STATIC WATER LEVEL: 2.44 M
PUMP TEST DATE:
DISCHARGE: 3.78 LPS
DRAWDOWN:
DEPTH
LOG
FINE SAND
LOOSE ROCK
COARSE SAND
SAND STONE
COARSE SAND
SAND & GRAVEL
50
100
LWUA Well No. BPW-10864
LOCATION: SAN ANGELO SUBD. ANGELES CITY, PAMP.
DEPTH: 213.41 M
CASING DEPTH:
CASING DIAMETER:
STATIC WATER LEVEL: 3.65 M
PUMP TEST DATA
DISCHARGE: 15.78 LPS
DRAWDOWN:
DEPTH
LOG
COARSE SAND
SAND
BLUE SANDY CLAY
LIGHT BROWN SANDY CLAY
SAND
BROWN SANDY CLAY
YELLOW CLAY
SAND STONE
BROWN SANDY CLAY
SAND
LIGHT BROWN SANDY CLAY
BLUE SANDY CLAY
50
100
150
LWUA Well No. (CONT.)
LOCATION:
DEPTH:
CASING DEPTH:
CASING DIAMETER:
STATIC WATER LEVEL:
PUMP TEST DATA
DISCHARGE:
DRAWDOWN:
DEPTH
LOG
BLUE SANDY CLAY
200
250

APPENDIX 6.7.1 Selection of Water Quality Examination Points

Selection of these source were done in consideration of the following favors.

- The points are located strategically i.e. possibly covering the whole municipality whereby the results would be representative of the overall condition in the area.
- Samples were collected from areas where water quality is reported to be undesirable.
- Accessibility and easy facilitation for sampling

Over selection of these points was done comprising of:

- Eleven (11) deep wells int he city water supply system (ACWS)
- Five (5) deep wells in the private/public system
- Five (5) shallow wells
- One (1) river
- Four (4) water taps on the service pipe for bacteriological analysis the location of these points is shown in FIGURE 6.7.1.1.

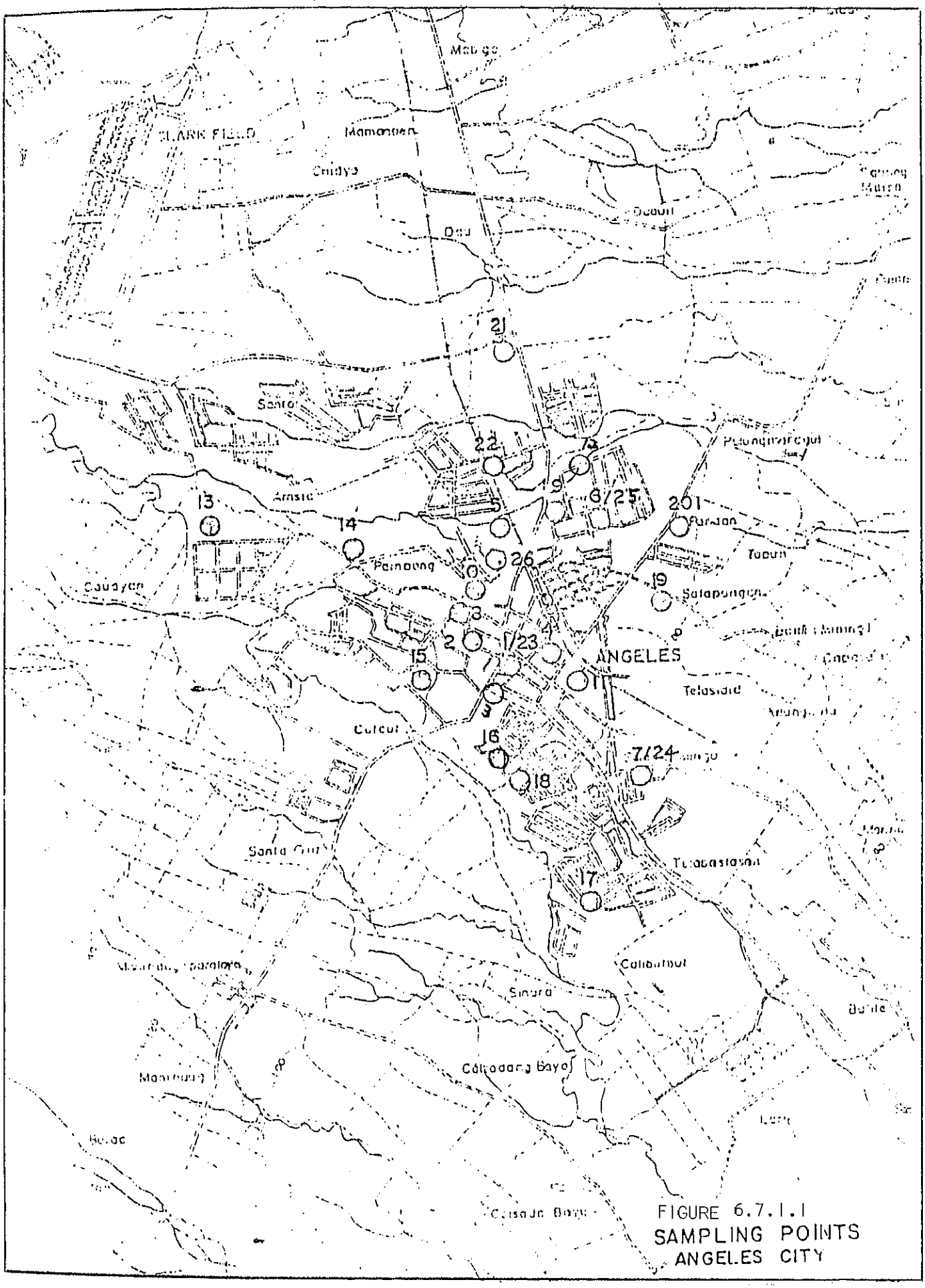


FIGURE 6.7.1.1
SAMPLING POINTS
ANGELES CITY

APPENDIX 6.7.2 WATER QUALITY ANALYSIS - ANGELES CITY

Sample No.	Well No.	Location	* Group	Turb. (FTU)	TDS (mg/l)	pH (-)	EC (μS/cm)	Alk. (mg/l)	Hard. (mg/l)	Acid. (mg/l)	Na (mg/l)	K (mg/l)	Ca (mg/l)	Mg (mg/l)	CO_3 (mg/l)	HCO_3 (mg/l)	Cl (mg/l)	SO_4 (mg/l)	Fe (mg/l)	Mn (mg/l)	E.Coli. (MPN)	NO_3-N (mg/l)	NH_4-N (mg/l)
1	ACWS 1	Mabini	A	0.52	128	6.45	147	75	75	84	12.5	2.0	16.4	8.3	0	91.5	18.6	3	0.03	nil	-	3.15	nil
2	ACWS 2	Mabini	A	0.61	195	6.89	255	133	127	22	13	2.1	30.0	12.6	0	162.3	18.6	4	0.03	0.05	-	1.63	nil
3	ACWS 3	Rizal	A	0.40	147	6.45	140	85	97	42	10	2.0	30.0	5.3	0	103.7	18.6	1	0.08	nil	-	2.46	nil
4	ACWS 4	Kuliot	A	0.38	154	6.45	190	95	97	53	13	2.0	26.8	7.3	0	115.9	18.6	2.5	0.05	nil	-	3.95	nil
5	ACWS 5	Balagtas	A	0.48	154	6.45	130	105	97	37	12.5	2.1	20.8	10.9	0	128.1	13.9	1.5	0.03	nil	-	3.95	nil
6	ACWS 6	Pandan	A	0.43	179	6.08	185	110	90	26	22.5	2.0	24.0	7.3	0	134.2	18.6	3.0	0.05	nil	-	6.15	nil
7	ACWS 7	San Joaguin	A	0.43	192	6.85	268	122	112	15	20.0	1.7	24.0	12.6	0	148.8	18.6	5.0	0.05	nil	-	1.14	nil
8	ACWS 8	Pampang Road	A	2.08	147	6.32	150	95	90	33	17.5	1.7	12.0	14.6	0	115.9	13.9	1.5	0.10	nil	-	3.91	nil
9	ACWS 10	McArthur	A	0.41	154	6.15	159	95	82	24	20.0	2.0	20.8	7.3	0	115.9	13.9	1.5	0.15	0.10	-	4.18	nil
10	ACWS 12	Loudrdes N.E.	A	0.50	128	6.09	160	85	75	22	13	2.1	20.8	5.6	0	103.7	13.9	1	0.10	0.10	-	4.58	nil
11	ACWS 14	Ang Elementary School	A	0.52	125	6.52	155	75	75	29	10	2	24	3.6	0	91.5	11.6	3	0.10	0.10	-	2.46	nil
12		Abacan River (Balibago Brdg.)	D	332.	122	7.88	150	66	75	11	8	4.2	20.8	5.6	0	80.5	18.6	7	0.80	0.30	-	6.47	0.07
13	ACWS 50	Timog Park Subd., Cutcut	B	0.56	154	7.09	180	104	97	9	10.5	2	24	8.9	0	126.88	18.6	3	0.12	0.10	-	2.38	nil
14	ACWS 31	Pampang (BPW #17994)	C	0.81	115	6.25	140	70	75	11	6.5	2.3	24	3.6	0	85.4	13.9	3	0.08	nil	-	7.43	nil
15	ACWS 34A	Nepo Subd., Cutcut	C	18.15	160	6.84	260	66	97	15	8.0	2.6	20.8	10.9	0	80.5	18.6	32	0.56	0.10	-	0.80	nil
16	ACWS 36	Villa Teresa Subd.	B	0.62	122	6.58	158	75	75	22	10.5	2.3	15.0	9.1	0	91.5	23.2	4.0	0.12	nil	-	4.65	nil
17	ACWS 37	L & S Subd., Domingo	B	0.42	179	6.41	210	104	112	15	15.5	2.1	18.0	16.3	0	126.9	27.9	14.0	0.10	0.10	-	1.32	nil
18	ACWS 64	Villa Angelina Subd.	C	1.89	102	6.70	142	70	67	15	8	2.2	14.8	7.3	0	85.4	9.3	6.5	0.25	0.10	-	2.95	nil
19	ACWS 16	Mining (BPW #17991)	C	90.0	256	6.65	419	123	127	24	20	5.3	44.8	3.6	0	150.1	41.8	11.0	0.65	0.50	-	3.19	nil
20	ACWS 19A	Pandan (near BPW #17992)	C	5.99	173	5.76	237	85	97	33	10.5	5.2	26.8	7.3	0	103.7	27.9	16.0	0.35	0.10	-	8.17	nil
21	ACWS 26	Balibago (BLVS #1)	B	10.55	160	7.61	220	84	90	20	10	3.1	18	10.9	0	102.5	13.9	11.5	0.30	0.30	-	3.02	nil
22	ACWS 29	Balibago (BLVS #4)	B	0.35	144	7.68	210	104	90	20	8	2.2	24	7.3	0	126.9	13.9	3	0.11	0.10	-	2.34	nil
23	ACWS 1	Mabini St.	E	-																	+	-	-
24	ACWS 7	San Jaguin	E	-																	0	-	-
25	ACWS 6	Pandan	E	-																	0	-	-
26	Faucet	City Engineer's Office	E	-																	0	-	-

*: Category; A - Deep wells in the city water supply system
B - Deep wells in private/public system
C - Shallow wells
D - River
E - Water taps on the service pipe

Philippine National Standards for Drinking Water

Water Quality: Physical, Chemical and Radiological Requirements

Parameter		Maximum Permissible level*
Turbidity		5 units
Color		5 units (s) **
Odor		Unobejctionable
Threshold odor number		Note more than 3
Taste		Unobjectionable
Total Solids		500 (s)
pH		6.5 - 8.5
Phenolic substances		0.001
Radioactive Subs.	Gross Alpha	3 pCi/1
	Gross Beta	30pCi/1
Trace Elements	Arsenic	0.05
	Barium	1.0
	Cadmium	0.01
	Chromium	0.05
	Copper	1.0
	Cyanide	0.05
	Fluoride	0.6
	Iron	1.0
	Lead	0.05
	Manganese	0.5 (s)
	Mercury	0.002
	Selenium	0.01
	Zinc	5.0 (s)
Organic Cehmicals :	Synthetic Detergents (MBAS)	0.5
	Oil & Grease	Nil
Persistent Pesticides :	Aldrin	0.001
	DDT	0.05
	Dieldrin	0.001
	Chlordane	0.003
	Endrin	0.0002
	Heptachlor	0.0001
	Lindane	0.004
	Toxaphane	0.005
	Methoxychlor	0.1
	2,4 —E	0.1
	2, 4, 5 — T	0.01
PCB		Nil
Other Chemicals :	Calcium	75
	Chloride	200 (s)
	Magnesium	50 (s)
	Nitrate (NO_3)	30
	Sulfate	200 (s)
	Hydrogen sulfide	0.05 (s)

* All units are in mg/ℓ unless, otherwise stated.

** (s) – Secondary standards; compliance with the standard and analysis are not obligatory.

Bacteriological Quality Standards

Minimum Requirements on Bacteriological Quality

a) Chlorinated or Otherwise Disinfected Supplies

Efficient treatment culminating in chlorination or some other form of disinfection should yield a water free or any coliform organism however polluted the original raw water may have been. In practice it should not be possible to demonstrate the presence of coliform organisms in any sample of 100mℓ. The efficacy of the purification process and method of sampling should be looked into when a sample of the water entering the distribution system does not conform to this standard. In testing chlorinated water, presumptive positive tubes should always be subjected to appropriate confirmatory tests.

b) Non-disinfected Supplies

Where supplies of this sort exist, no water entering the distribution system should be considered satisfactory if it yields E coli in 100mℓ. If E. coli is absent, the presence of not more than 3 coliform organisms per 100mℓ may be tolerated in occasional samples from established non-disinfected pipes supplies, provided that they have been regularly and frequently tested and that the catchment area and storage conditions are found to be satisfactory. If repeated samples show the presence of coliform organisms, steps should then be taken to discover and, if possible, remove the source of pollution. If the number of coliform organisms increases to more than 3 per 100mℓ, the supply should be considered unsuitable for use without disinfection.

c) Individual or Small Community Supplies

Where supply of waters are individual wells, bores and springs everything possible should be done to prevent pollution of the water. It should be possible to reduce the coliform count of water from even a shallow well to less than 10 per 100mℓ. Persistent failure to achieve this, particularly if E. coli is repeatedly found, should, as a general rule lead to chlorination or boiling of the water for domestic consumption.

APPENDIX 7.2.1 Data on the Unit Cost for Estimation of Project Cost

(1) Deep Well Construction : Peso

Depth (m)	Casing size (m/m)	Cost
200	250	940,000
200	300	1,160,000
250	150	640,000

BREAKDOWN OF COSTS IN %

	Local Component			F E C		
	Material	Labor		Direct	Indirect	Total
		Skilled	Unskilled			
Equipment	17	-	-	-	20	37
Civil Works	33	8	5	-	17	63
Total	50	8	5	-	37	100

(2) Deep Well Pump Station (Electric Motor Drive) : Thousand Peso

KW	Cost
7	450
15	560
22	640
29	720
37	790
44	840
51	890
59	960
66	1,020
74	1,080

BREAKDOWN OF COSTS IN %

	Local Component			F E C		
	Material	Labor		Direct	Indirect	Total
		Skilled	Unskilled			
Equipment	9	-	-	42	5	56
Civil Works	21	9	5	-	9	44
Total	30	9	5	42	14	100

(3) Booster Pump Station

$$C = (72.16 - 13.68 \log Q) \times Q^{(0.42 + 0.1 \log Q)} \times H^{0.305(\log Q - 0.7)^{(6/H - 0.25)}}$$

where,

C = cost for electric motor drive (thousand peso)

Q = design capacity (l/sec)

H = total dynamic head (m)

BREAKDOWN OF COSTS IN %

	Local Component			F E C		
	Material	Labor		Direct	Indirect	Total
		Skilled	Unskilled			
Equipment	11	-	-	53	2	66
Civil Works	17	9	6	-	2	34
Total	28	9	6	53	4	100

(4) Pipeline Cost

Following pipe materials are presently available in the Philippines:

- GI (galvanized iron),
- PE (poly-ethylene),
- PB (poly-butylene),
- PVC (poly-vinyl-chloride),
- SP (steep pipe),
- CI (cost iron), and
- AC (asbestos cement).

Among these materials, the use of CI pipe is limited due to its high cost and AC pipe is also rare by safety reason.

Followings are comparison of unit cost at the 1985 price level.

(Unit: ₱/m)

Diameter	GI	PE	PB	PVC	SP
13	20.8	13.8	9.1	-	-
19	24.7	19.9	13.6	-	-
25	32.3	25.3	22.0	-	-
38	59.2	41.5	44.7	-	-
50	87.5	61.4	76.4	33.9	-
63	117.7	-	-	48.0	-
75	180.3	-	-	81.3	-
100	230.8	-	-	122.4	235.0
150	-	-	-	256.9	250.0
200	-	-	-	506.5	290.0
250	-	-	-	-	315.0
300	-	-	-	-	425.0
400	-	-	-	-	520.0
500	-	-	-	-	700.0
600	-	-	-	-	890.0

Based on the above comparison, SP is advantageous for the diameter of 200 mm and above than PVC. Thus, for the cost estimates of major transmission and distribution pipes, SP is considered for diameter of 200 mm and above, while PVC for diameter of less than 150 mm taking into account the transportation cost and easy installation.

Diameter (mm)	Unit Cost (₱/m)
150 (PVC)	410
200(SP)	520
250(")	630
300(")	760
350(")	900
400(")	970
450(")	1,160
500(")	1,330
600(")	1,600
700(")	1,910

Source : LWUA Design Depart

BREAKDOWN OF COSTS IN %

	Local Component			F E C		
	Material	Labor		Direct	Indirect	Total
		Skilled	Unskilled			
Equipment	23	-	-	4	27	54
Civil Works	17	7	4	-	18	46
Total	40	7	4	4	45	100

(5) Valve In-place Cost

Diameter (mm)	Gate Valve (₱)	Butterfly Valve (₱)
50	1,700	-
75	2,900	-
100	3,900	-
150	5,300	-
200	6,700	-
250	11,200	-
300	-	34,800
350	-	74,400
400	-	95,200
450	-	125,900
500	-	174,000
600	-	243,600
700	-	313,200

Source : LWUA Design Depart

BREAKDOWN OF COSTS IN %

	Local Component			F E C		
	Material	Labor		Direct	Indirect	Total
		Skilled	Unskilled			
Equipment	9	-	-	63	5	77
Civil Works	12	3	6	-	2	23
Total	21	3	6	63	7	100

(6) Internal Network

Population Density (Person/ha)	Total Length of Pipeline (m/ha)	Unit Cost (₱/ha) Diameter (100/150)	Diameter (75/100)
50	64	18,300	14,900
60	67	19,300	15,700
75	72	20,900	16,800
100	80	23,100	18,700
150	90	25,700	21,000
200	100	28,300	-
250	108	30,400	-
300	116	32,500	-

BREAKDOWN OF COSTS IN %

	Local Component			F E C		
	Material	Labor		Direct	Indirect	Total
		Skilled	Unskilled			
Equipment	22	-	-	7	27	56
Civil Works	17	7	4	-	16	44
Total	39	7	4	7	43	100

(7) In-place of Service Connections

Diameter (inch)	Without Meter ₱/unit	With Meter ₱/unit	Meters ₱/unit
1/2	450	810	400
5/8 - 3/4	520	1,280	880

SERVICE CONNECTION WITHOUT METER

BREAKDOWN OF COSTS IN %

	Local Component			F E C		
	Material	Labor		Direct	Indirect	Total
		Skilled	Unskilled			
Equipment	9	-	-	60	2.5	71.5
Civil Works	17	3	6	-	2.5	28.5
Total	26	3	6	60	5	100

SERVICE CONNECTION WITHOUT METER
BREAKDOWN OF COSTS IN %

	Local Component			F E C		
	Material	Labor		Direct	Indirect	Total
		Skilled	Unskilled			
Equipment	4	-	-	83	2	89
Civil Works	6	1	3	-	1	11
Total	10	1	3	83	3	100

(8) Fire Hydrant In-place Cost

Type	Size (mm)	Unit Cost (₱)
Commercial	150	16,800
Residential	100	9,400

BREAKDOWN OF COSTS IN %

	Local Component			F E C		
	Material	Labor		Direct	Indirect	Total
		Skilled	Unskilled			
Equipment	8	-	-	57	5	70
Civil Works	10	8	10	-	2	30
Total	18	8	10	57	7	100

(9) Elevated Tank/Ground Reservoir

Elevated Tank: $C = 0.615\ H^{1.144} V^{0.749}$

Ground Reservoir: $C = 20.05\ V^{0.639}$

where, C = cost (thousand peso)

H = overflow elevation above ground level

V = storage volume (cu.m)

BREAKDOWN OF COSTS IN %

	Local Component			F E C		
	Material	Labor		Direct	Indirect	Total
		Skilled	Unskilled			
Equipment	4	-	-	3	2	9
Civil Works	53	5	7	-	26	91
Total	57	5	7	3	28	100

(10) Gas Chlorinator In-place Cost

Type	Water Flow Condition	Maximum Chlorine Feed (kg/day)	Unit cost 1/ (₱)
I-A	constant	22	98,100
I-B	constant	45	119,100
II-A	Variable	22	147,700
II-B	Variable	45	169,300

1/ Empty gas cylinders and automatic switchover include

TYPE I-A, I-B
BREAKDOWN OF COSTS IN %

	Local Component			F E C		
	Material	Labor		Direct	Indirect	Total
		Skilled	Unskilled			
Equipment	15	-	-	41	5	61
Civil Works	25	6	3	-	5	39
Total	40	6	3	41	10	100

TYPE II-A, II-B
BREAKDOWN OF COSTS IN %

	Local Component			F E C		
	Material	Labor		Direct	Indirect	Total
		Skilled	Unskilled			
Equipment	21	-	-	53	2	76
Civil Works	12	6	2	-	4	24
Total	33	6	2	53	6	100

(11) Administration & Operation Building

Future Service Population	Administration Bldg. (Thousand Peso)	Operation Center (Thousand Peso)
30,000	1,000	810
40,000	1,110	890
50,000	1,220	990
60,000	1,320	1,090
70,000	1,410	1,180
80,000	1,500	1,280
100,000	1,610	1,380
110,000	1,820	1,590

ADMINISTRATION BUILDING
BREAKDOWN OF COSTS IN %

	Local Component			F E C		
	Material	Labor		Direct	Indirect	Total
		Skilled	Unskilled			
Equipment	20	-	-	-	16	36
Civil Works	42	7	5	-	10	64
Total	62	7	5	-	26	100

OPERATION CENTER
BREAKDOWN OF COSTS IN %

	Local Component			F E C		
	Material	Labor		Direct	Indirect	Total
		Skilled	Unskilled			
Equipment	14	-	-	30	6	50
Civil Works	26	10	5	-	9	50
Total	40	10	5	30	15	100

(12) Energy Cost

$$C = N_p(h)(Pu)(Em)^{-1}$$

where,

C = cost (thousand peso)

N_p = pump power demand (kw)

h = hours of operation

P_u = unit power cost (₱/kwH)

E_m = motor efficiency (0.85)

(13) Chemical Cost

$$C = (\text{Annual Water Demand}) \cdot D \cdot U_{CL} \times 10^{-3}$$

where,

C = annual cost for chlorine (₱)

D = chlorine dosage (mg/l)

U_{CL} = unit cost of chlorine gas (₱/kg)

(14) Minimum Cost Diameter

Following cost function is applied to determine the most economical diameter of pipelines that are not simulated by the network analysis.

$$Dmin. = 187.7\ Q^{0.486}\ C^{-0.315}\ (Ec/Oe)^{0.17}$$

where,

Dmin. = minimum cost diameter

Q = water flow (l/sec)

C = "C" value (Hazen William Formula)

Ec = energy cost (₱/kwh)

Oe = overall efficiency

APPENDIX 7.2.2 Excerpt from LWUA Methodology Manual

F. COST COMPARISON

General

Anaylsis and evaluation of alternative are based largely on present-worth cost studies, taking into consideration the salvage valuse after the design period. Cost comparison is based on present worth of net disbursement during the period of 1980-2010 without any escalation factor applied to the 1980 unit prices.

If the differences between net PW cost of an alternative and that of the least-cost alternative is within the limit of cost estimating accuracy (10-15%) further cost comparison shall be made applying escalation factor to 1980 unit prices. For escalation rates, refer to Chapter VII-C: Escalation Rates. Moreover, non-economic parameters may also be influence the selection of the recommended plan.

Construction Cost

Construction cost estimates of the proposed improvements are based on the projected July 1980 unit prices. All estimates on imported materials are based on an exchange rate of ₱7.40 per 1 US dollar. Further, it is assumed that no custom duty will be charged on items imported for the public water supply project. The cost of any facility to be replaced during the design period (1980-2010) is included under the capital cost for the particular year.

Annual Cost

Annual costs are all costs associated with the maintenance, operation, and management of the project. These include labor, power, chemical and maintenance costs. These estimates are carried out for the period 1980-2010. The present-worth cost of annual expenditure is based on uniform and gradient series at a given interest.

Personnel and maintenance costs may abruptly increase as additional facilities are put into operation - e.g., the power cost at a pump station increases in relation to the daily pumpage of water.

Salvage Value

The salvage values of facilities at the end of the design period 2010 are important in calculating net present worth of the total expenditures. It is assumed that the value of a facility depreciates linearly throughout its service life therefore, a facility with longer service life depreciates less than a facility with shorter service life (Refer to Table VI-1 for service life of different facilities). Moreover, a facility constructed at a later stage has higher salvage value than one constructed at an earlier stage.

TABLE VI-1 SERVICE LIFE CATEGORIES OF FACILITIES

Civil Works	Economic Life	Equipment	Economic Life
Wells	30 years	Wells (pumping engine or motors)	15 years
Springs	50	Springs (vales, pipes)	50
Transmission Mains	50	Transmission (pipes, valves)	50
Storage Facilities	50	Storage (valves, pipes, level gauge, etc.)	50
Disinfection Facilities	50	Disinfection facilities (chlorinators, mechanical equipment and filter equipment, pipes, valves)	15
Distribution Mains	50	Distribution mains (pipes, valves)	50
Internal Network	50	Internal networks (pipes, valves)	50
Service Connections	50	Service connections (meters, pipes)	50
Fire Hydrants	50	Operational buildings (workshop, etc.)	15
Operational Buildings	50	Fire hydrants	30
		Vehicles	7

Net Present Worth

The net present worth cost of an alternative scheme is the difference between the total present worth of capital cost and annual cost minus the present worth of salvage values.

For Construction Cost: $C_n = C_c - C_s$

$$C_c = C \times \frac{1}{(1+i)^n} \qquad C_c = C \times \frac{1}{(1+i)^{nx}} \times \left(1 - \frac{nx - n}{SL}\right)$$

For Annual Cost:

$$C_c = A_c \times \frac{1}{(1+i)^n}$$

where,

C_n = net present worth comparable cost

C_c = present worth of construction cost

C_s = present worth of salvage value (design year)

C = construction cost

SL = service life

i = discount rate

nx = number of years between design year and base year

n = number of years between year of construction and base year

A_c = annual cost

APPENDIX 7.3.1 Cost Estimates of Water Source Alternatives

(Unit : ₱x1,000)

Required Facilities	Unit Cost (₱)	Alternative S-1		Alternative S-2		Alternative S-3	
		Q'ty	Cost	Q'ty	Cost	Q'ty	Cost
Water Sources							
Deep Well	940,000	18	16,920	11	10,340	-	-
Deep Well Pump	640,000	18	11,520	11	7,040	-	-
River Water Intake							
Booster Pump (226 l/s, H=25m)	-	-	-	1	3,694	-	-
Booster Pump (600 l/s, H=40m)	-	-	-	-	-	1	8,414
Sub Total			28,440		21,074		8,414
Transmission Line							
ϕ200 mm	520	4,700 m	2,444	2,700 m	1,404	-	-
ϕ250 mm	630	2,300 m	1,449	2,300 m	1,449	-	-
ϕ300 mm	760	500 m	380	-	-	-	-
ϕ400 mm	970	500 m	485	-	-	-	-
ϕ450 mm	1,160	2,800 m	3,248	-	-	-	-
ϕ600 mm	1,600	-	-	10,000 m	16,000	-	-
ϕ700 mm	1,910	-	-	-	-	10,000	19,100
Sub Total			8,006		18,853		19,100
Treatment Facility							
Slow Sand Filter	-	-	-	3,900 sq.m	8,190	10,280 sq.m	18,504
TOTAL CONSTRUCTION COST			36,846		48,117		46,018
Operation & Maintenance(15 years)							
Energy	0.30/kWH	52,003 MWH	15,610	44,320 MWH	13,296	52,000 MWH	15,600
Maintenance (10% of Construction Cost)			3,685		4,812		4,602
TOTAL			19,295		18,108		20,202
GRAND TOTAL			56,141		66,225		66,220

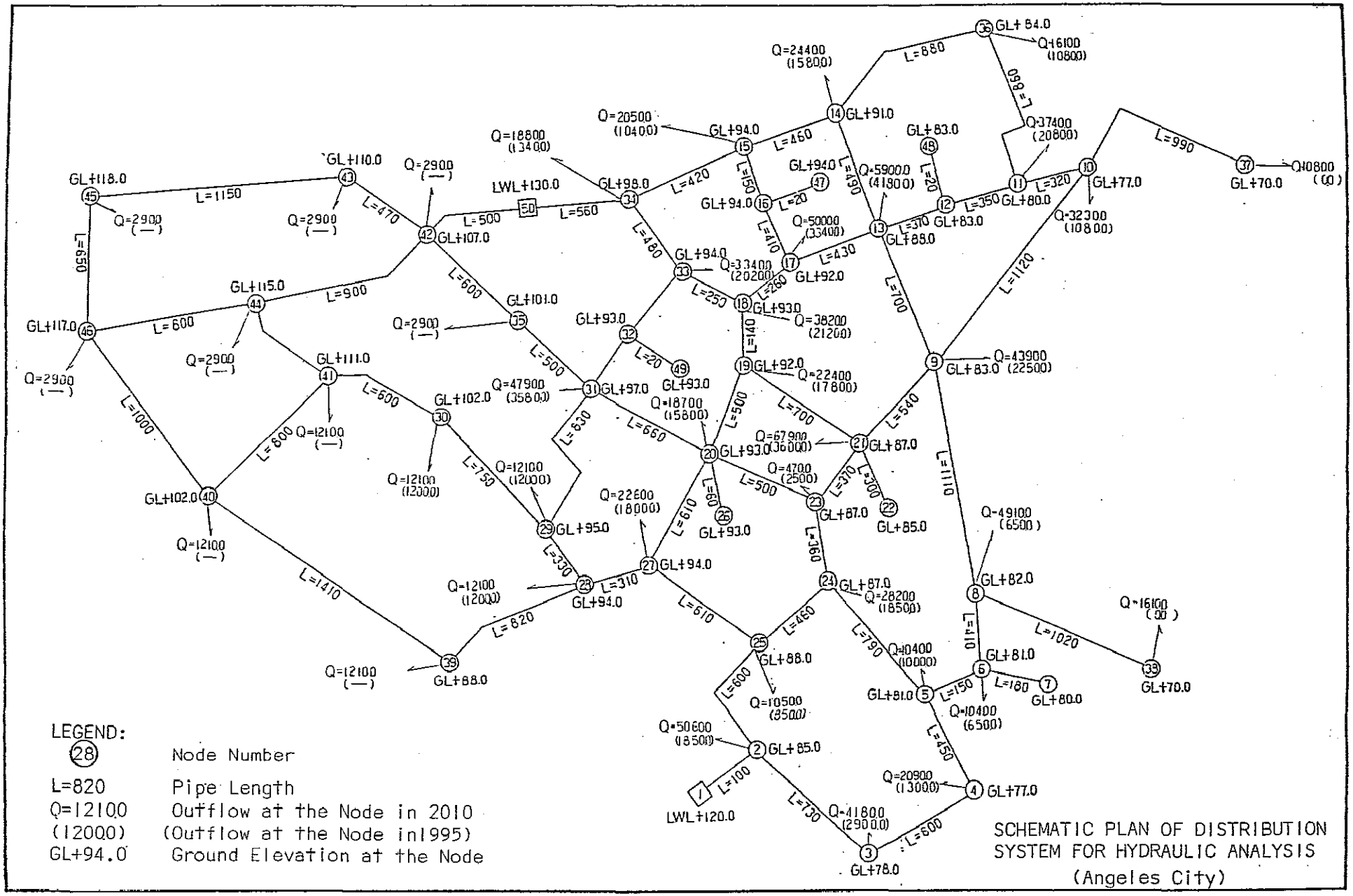
APPENDIX 7.3.2 COMPUTER-AIDED HYDRAULIC ANALYSIS OF DISTRIBUTION SYSTEM (Angeles City)

o List of Computed Cases

Alternative	D-1	(2010)	
	D-2	(2010)	
	D-3	(2010)	Southwest Area
	D-3/D-4	(2010)	Northeast Area
	D-4-A	(1995, 2010)	Southwest Area
	D-4-B	(1995, 2010)	Southwest Area

o Note

This appendix shows the results of Hydraulic Analysis aided by the computer. The distribution network is shown in the figure of following page. The nodes, however, with no flow and 20.00 m in Dynamic Head was treated as a dummy node. Those nodes can be ignored and have no relation to the computation results.


LEGEND:
(28) Node Number
L=820 Pipe Length
Q=12100 Outflow at the Node in 2010
(12000) (Outflow at the Node in1995)
GL+94.0 Ground Elevation at the Node
SCHEMATIC PLAN OF DISTRIBUTION SYSTEM FOR HYDRAULIC ANALYSIS
(Angeles City)

ALTERNATIVE D-1
1 Supply System w/2 Reservoirs, Year2010

<< NODES >>

NODE No.	GROUND ELEV. (m)	FLOW (cu.m/day)	H.G.L. ELEV. (m)	DYNAMIC HEAD (m)	STATIC HEAD (m)
1	120.00	0.00	120.00	0.00	10.00
2	85.00	5060.00	119.83	34.83	45.00
3	78.00	4180.00	116.98	38.98	52.00
4	77.00	2090.00	115.56	38.56	53.00
5	81.00	1040.00	114.77	33.77	49.00
6	81.00	1040.00	114.41	33.41	49.00
7	80.00	-1400.00	116.00	36.00	50.00
8	82.00	4910.00	112.39	30.39	48.00
9	83.00	4390.00	107.86	24.86	47.00
10	77.00	3230.00	104.18	27.18	53.00
11	80.00	3740.00	103.62	23.62	50.00
12	83.00	0.00	104.61	21.61	47.00
13	88.00	5900.00	105.60	17.60	42.00
14	91.00	2440.00	105.40	14.40	39.00
15	94.00	2050.00	106.10	12.10	36.00
16	94.00	0.00	106.19	12.19	36.00
17	92.00	5000.00	106.19	14.19	38.00
18	93.00	3820.00	107.37	14.37	37.00
19	92.00	2240.00	108.01	16.01	38.00
20	93.00	1870.00	111.31	18.31	37.00
21	87.00	6790.00	110.12	23.12	43.00
22	85.00	-2900.00	120.30	35.30	45.00
23	87.00	470.00	113.05	26.05	43.00
24	87.00	2820.00	114.63	27.63	43.00
25	88.00	1050.00	116.17	28.17	42.00
26	93.00	-2700.00	111.75	18.75	37.00
27	94.00	2250.00	114.01	20.01	36.00
28	94.00	1210.00	113.44	19.44	36.00
29	95.00	1210.00	112.88	17.88	35.00
30	102.00	1210.00	112.52	10.52	28.00
31	97.00	4790.00	113.01	16.01	33.00
32	93.00	0.00	111.50	18.50	37.00
33	94.00	3340.00	108.39	14.39	36.00
34	98.00	1880.00	109.70	11.70	32.00
35	101.00	290.00	118.77	17.77	29.00
36	84.00	1610.00	101.69	17.69	46.00
37	70.00	1080.00	98.79	28.79	60.00
38	70.00	1610.00	100.75	30.75	60.00
39	88.00	1210.00	112.86	24.86	42.00
40	102.00	1210.00	112.19	10.19	28.00
41	111.00	1210.00	125.31	14.31	19.00
42	107.00	290.00	125.91	18.91	23.00
43	110.00	290.00	125.86	15.86	20.00
44	115.00	290.00	125.55	10.55	15.00
45	118.00	290.00	125.72	7.72	12.00
46	117.00	290.00	125.46	8.46	13.00
47	94.00	-1600.00	106.42	12.42	36.00
48	83.00	-1600.00	104.84	21.84	47.00
49	93.00	-1300.00	111.65	18.65	37.00
50	130.00	0.00	130.00	0.00	0.00

Iteration Times : 20

ALTERNATIVE D-1
1 Supply System w/2 Reservoirs, Year2010

<< PIPELINE >>

PIPE No.	NODE No. from	to	DIA. (mm)	LENGTH (m)	H-W C	FLOW (cu.m/day)	VEL. (m/sec)	HEADLOSS (m)	(0/00)
1	2	1	600.	100.	130.	-26224.	-1.07	-0.17	-1.72
2	2	1	600.	100.	130.	-26224.	-1.07	-0.17	-1.72
3	2	3	450.	730.	120.	17698.	1.29	2.85	3.90
4	2	25	500.	600.	120.	29591.	1.75	3.66	6.09
5	3	4	450.	600.	120.	13518.	0.98	1.42	2.37
6	4	5	450.	450.	120.	11428.	0.83	0.78	1.74
7	5	6	400.	150.	120.	10020.	0.92	0.36	2.42
8	5	24	200.	790.	110.	367.	0.14	0.14	0.18
9	6	7	150.	180.	110.	-1400.	-0.92	-1.59	-8.81
10	6	8	350.	410.	120.	10380.	1.25	2.03	4.94
11	8	38	150.	1020.	110.	1610.	1.05	11.64	11.41
12	8	9	250.	1110.	120.	3860.	0.91	4.52	4.08
13	9	10	300.	1120.	120.	5553.	0.91	3.68	3.29
14	9	13	250.	700.	120.	3406.	0.80	2.26	3.23
15	9	21	350.	540.	120.	-9488.	-1.14	-2.26	-4.18
16	10	37	150.	990.	110.	1080.	0.71	5.39	5.45
17	10	11	200.	320.	110.	1243.	0.46	0.56	1.74
18	11	36	150.	860.	110.	669.	0.44	1.93	2.25
19	11	12	250.	350.	120.	-3167.	-0.75	-0.99	-2.82
20	12	13	200.	370.	110.	-1567.	-0.58	-0.99	-2.67
21	12	48	150.	20.	110.	-1600.	-1.05	-0.23	-11.28
22	13	14	250.	490.	120.	1111.	0.26	0.20	0.41
23	13	17	350.	430.	120.	-5172.	-0.62	-0.58	-1.36
24	14	36	150.	880.	110.	941.	0.62	3.71	4.22
25	14	15	250.	460.	120.	-2270.	-0.54	-0.70	-1.52
26	15	16	250.	150.	120.	-1379.	-0.33	-0.09	-0.61
27	15	34	200.	420.	110.	-2940.	-1.08	-3.60	-8.57
28	16	17	250.	410.	120.	220.	0.05	0.01	0.02
29	16	47	150.	20.	110.	-1600.	-1.05	-0.23	-11.28
30	17	18	350.	260.	120.	-9951.	-1.20	-1.19	-4.57
31	18	19	350.	140.	120.	-9906.	-1.19	-0.63	-4.53
32	18	33	250.	250.	120.	-3865.	-0.91	-1.02	-4.09
33	19	20	350.	500.	120.	-12146.	-1.46	-3.31	-6.61
34	20	26	200.	60.	110.	-2700.	-0.99	-0.44	-7.32
35	20	27	250.	610.	120.	-4030.	-0.95	-2.69	-4.41
36	20	31	350.	660.	120.	-7286.	-0.88	-1.69	-2.57
37	21	22	150.	300.	110.	-2900.	-1.90	-10.18	-33.93
38	21	23	350.	370.	120.	-13378.	-1.61	-2.93	-7.91
39	23	24	400.	360.	120.	-13848.	-1.28	-1.58	-4.40
40	24	25	450.	460.	120.	-16301.	-1.19	-1.54	-3.35
41	25	27	400.	610.	120.	12340.	1.14	2.17	3.55
42	27	28	350.	310.	120.	6050.	0.73	0.56	1.82
43	28	29	250.	330.	120.	2420.	0.57	0.57	1.72
44	28	39	300.	820.	120.	2420.	0.40	0.58	0.71
45	29	30	250.	750.	120.	1210.	0.29	0.36	0.48
46	31	35	350.	500.	120.	-16397.	-1.97	-5.76	-11.53
47	31	32	250.	300.	120.	4322.	1.02	1.51	5.02
48	32	33	250.	380.	120.	5622.	1.33	3.11	8.17
49	32	49	150.	20.	110.	-1300.	-0.85	-0.15	-7.68
50	33	34	200.	480.	110.	-1584.	-0.58	-1.31	-2.73
51	34	50	200.	560.	110.	-6404.	-2.36	-20.30	-36.24
52	35	42	350.	600.	120.	-16687.	-2.01	-7.14	-11.91
53	39	40	250.	1410.	120.	1210.	0.29	0.67	0.48
54	41	44	250.	500.	120.	-1210.	-0.29	-0.24	-0.48
55	42	43	250.	470.	120.	580.	0.14	0.06	0.12

ALTERNATIVE D-1
1 Supply System w/2 Reservoirs, Year2010

<< PIPELINE >>

PIPE No.	NODE No. from	to	DIA. (mm)	LENGTH (m)	H-W C	FLOW (cu.m/day)	VEL. (m/sec)	HEADLOSS (m)	(0/00)
56	42	44	300.	900.	120.	1790.	0.29	0.36	0.40
57	42	50	400.	500.	120.	-19347.	-1.78	-4.09	-8.17
58	43	45	200.	1150.	110.	290.	0.11	0.14	0.12
59	44	46	200.	800.	110.	290.	0.11	0.09	0.12

ALTERNATIVE D-2
1 Supply System w/1 Reservoir, Year2010

<< NODES >>

NODE No.	GROUND ELEV. (m)	FLOW (cu.m/day)	H.G.L. ELEV. (m)	DYNAMIC HEAD (m)	STATIC HEAD (m)
1	120.00	0.00	120.00	0.00	0.00
2	85.00	5060.00	119.84	34.84	35.00
3	78.00	4180.00	116.85	38.85	42.00
4	77.00	2090.00	114.51	37.51	43.00
5	81.00	1040.00	113.42	32.42	39.00
6	81.00	1040.00	112.83	31.83	39.00
7	80.00	-1400.00	114.41	34.41	40.00
8	82.00	4910.00	111.09	29.09	38.00
9	83.00	4390.00	108.19	25.19	37.00
10	77.00	3230.00	100.62	23.62	43.00
11	80.00	3740.00	100.39	20.39	40.00
12	83.00	0.00	104.35	21.35	37.00
13	88.00	5900.00	105.64	17.64	32.00
14	91.00	2440.00	105.13	14.13	29.00
15	94.00	2050.00	106.68	12.68	26.00
16	94.00	0.00	106.99	12.99	26.00
17	92.00	5000.00	106.85	14.85	28.00
18	93.00	3820.00	107.24	14.24	27.00
19	92.00	2240.00	107.73	15.73	28.00
20	93.00	1870.00	110.39	17.39	27.00
21	87.00	6790.00	111.02	24.02	33.00
22	85.00	-2900.00	121.20	36.20	35.00
23	87.00	470.00	113.98	26.98	33.00
24	87.00	2820.00	115.67	28.67	33.00
25	88.00	1050.00	117.80	29.80	32.00
26	93.00	-2700.00	110.83	17.83	27.00
27	94.00	2260.00	113.95	19.95	26.00
28	94.00	1210.00	113.38	19.38	26.00
29	95.00	1210.00	111.41	16.41	25.00
30	102.00	1210.00	110.17	8.17	18.00
31	97.00	4790.00	109.14	12.14	23.00
32	93.00	0.00	108.65	15.65	27.00
33	94.00	3340.00	107.96	13.96	26.00
34	98.00	1880.00	109.29	11.29	22.00
35	101.00	290.00	108.24	7.24	19.00
36	84.00	1610.00	99.53	15.53	36.00
37	70.00	1080.00	95.23	25.23	50.00
38	70.00	1610.00	99.45	29.45	50.00
39	88.00	1210.00	111.97	23.97	32.00
40	102.00	1210.00	109.64	7.64	18.00
41	111.00	1210.00	123.81	12.81	9.00
42	107.00	290.00	127.26	20.26	13.00
43	110.00	290.00	127.06	17.06	10.00
44	115.00	290.00	124.64	9.64	5.00
45	118.00	290.00	126.51	8.51	2.00
46	117.00	290.00	124.26	7.26	3.00
47	94.00	-1600.00	107.22	13.22	26.00
48	83.00	-1600.00	104.57	21.57	37.00
49	93.00	-1300.00	108.80	15.80	27.00
50	105.00	-2900.00	127.01	22.01	15.00
51	0.00	0.00	128.24	128.24	120.00
52	0.00	0.00	107.26	107.26	120.00

Iteration Times : 18

ALTERNATIVE D-2
1 Supply System w/1 Reservoir, Year2010

<< PIPELINE >>

PIPE No.	NODE No. from	to	DIA. (mm)	LENGTH (m)	H-W C	FLOW (cu.m/day)	VEL. (m/sec)	HEADLOSS (m)	(D/DD)
1	2	1	700.	100.	130.	-37650.	-1.13	-0.16	-1.58
2	2	1	700.	100.	130.	-37650.	-1.13	-0.16	-1.58
3	2	3	400.	730.	120.	13324.	1.23	2.99	4.10
4	2	25	700.	600.	130.	56916.	1.71	2.04	3.40
5	3	4	350.	600.	120.	9144.	1.10	2.34	3.91
6	4	5	350.	450.	120.	7054.	0.85	1.09	2.42
7	5	6	350.	150.	120.	9196.	1.11	0.59	3.95
8	5	24	250.	790.	120.	-3183.	-0.75	-2.25	-2.85
9	6	7	150.	180.	110.	-1400.	-0.92	-1.59	-8.81
10	6	8	350.	410.	120.	9556.	1.15	1.74	4.24
11	8	38	150.	1020.	110.	1610.	1.05	11.64	11.41
12	8	9	250.	1110.	120.	3036.	0.72	2.90	2.61
13	9	10	250.	1120.	120.	5073.	1.20	7.57	6.76
14	9	13	350.	700.	120.	8798.	1.06	2.55	3.64
15	9	21	400.	540.	120.	-15225.	-1.40	-2.83	-5.24
16	10	37	150.	990.	110.	1080.	0.71	5.39	5.45
17	10	11	200.	320.	110.	763.	0.28	0.23	0.70
18	11	36	150.	850.	110.	435.	0.28	0.87	1.01
19	11	12	200.	350.	110.	-3412.	-1.26	-3.95	-11.29
20	12	13	200.	370.	110.	-1812.	-0.67	-1.29	-3.50
21	12	48	150.	20.	110.	-1600.	-1.05	-0.23	-11.28
22	13	14	250.	490.	120.	1841.	0.43	0.51	1.03
23	13	17	150.	430.	110.	-754.	-0.49	-1.20	-2.80
24	14	36	150.	880.	110.	1175.	0.77	5.61	6.37
25	14	15	200.	460.	110.	-1775.	-0.65	-1.55	-3.37
26	15	16	200.	150.	110.	-1355.	-0.50	-0.31	-2.04
27	15	34	200.	420.	110.	-2470.	-0.91	-2.61	-6.21
28	16	17	150.	410.	110.	245.	0.16	0.14	0.35
29	16	47	150.	20.	110.	-1600.	-1.05	-0.23	-11.28
30	17	18	350.	260.	120.	-5509.	-0.66	-0.40	-1.53
31	18	19	350.	140.	120.	-8568.	-1.03	-0.49	-3.46
32	18	33	150.	250.	110.	-761.	-0.50	-0.71	-2.85
33	19	20	350.	500.	120.	-10808.	-1.30	-2.66	-5.33
34	20	26	200.	60.	110.	-2700.	-0.99	-0.44	-7.32
35	20	27	450.	610.	120.	-21969.	-1.60	-3.55	-5.83
36	20	31	450.	660.	120.	11991.	0.87	1.25	1.90
37	21	22	150.	300.	110.	-2900.	-1.90	-10.18	-33.93
38	21	23	400.	370.	120.	-19115.	-1.76	-2.96	-7.99
39	23	24	450.	360.	120.	-19585.	-1.43	-1.70	-4.71
40	24	25	500.	460.	120.	-25587.	-1.51	-2.13	-4.63
41	25	27	500.	610.	120.	30279.	1.78	3.85	6.32
42	27	28	350.	310.	120.	6050.	0.73	0.56	1.82
43	28	29	200.	330.	110.	2420.	0.89	1.97	5.98
44	28	39	250.	820.	120.	2420.	0.57	1.41	1.72
45	29	30	200.	750.	110.	1210.	0.45	1.24	1.66
46	31	35	350.	500.	120.	6001.	0.72	0.90	1.79
47	31	32	200.	300.	110.	1200.	0.44	0.49	1.63
48	32	33	250.	380.	120.	2501.	0.59	0.69	1.82
49	32	49	150.	20.	110.	-1300.	-0.85	-0.15	-7.68
50	33	34	200.	480.	110.	-1601.	-0.59	-1.33	-2.78
51	34	50	200.	560.	110.	-5951.	-2.19	-17.72	-31.63
52	35	52	350.	600.	120.	5711.	0.69	0.98	1.63
53	39	40	200.	1410.	110.	1210.	0.45	2.34	1.66
54	41	44	200.	500.	110.	-1210.	-0.45	-0.83	-1.66
55	42	43	200.	470.	110.	580.	0.21	0.20	0.42

ALTERNATIVE D-2
1 Supply System w/1 Reservoir, Year2010

<< PIPELINE >>

PIPE No.	NODE No. from	to	DIA. (mm)	LENGTH (m)	H-W C	FLOW (cu.m/day)	VEL. (m/sec)	HEADLOSS (m)	(0/00)
56	42	44	200.	900.	120.	1790.	0.66	2.62	2.91
57	42	50	350.	500.	120.	3051.	0.37	0.26	0.51
58	42	51	350.	600.	120.	-5711.	-0.69	-0.98	-1.63
59	43	45	150.	1150.	110.	290.	0.19	0.55	0.48
60	44	46	150.	800.	110.	290.	0.19	0.38	0.48

ALTERNATIVE D-3
2 Supply Systems w/3 Reservoirs, Southwest Area, Year2010

<< NODES >>

NODE No.	GROUND ELEV. (m)	FLOW (cu.m/day)	H.G.L. ELEV. (m)	DYNAMIC HEAD (m)	STATIC HEAD (m)
1	120.00	0.00	120.00	0.00	10.00
2	85.00	5060.00	119.84	34.84	45.00
3	78.00	4180.00	117.05	39.05	52.00
4	77.00	2090.00	115.68	38.68	53.00
5	81.00	1040.00	114.92	33.92	49.00
6	81.00	1040.00	114.56	33.56	49.00
7	80.00	-1400.00	116.15	36.15	50.00
8	82.00	4910.00	112.53	30.53	48.00
9	83.00	4390.00	108.01	25.01	47.00
10	77.00	3230.00	104.29	27.29	53.00
11	80.00	3740.00	103.71	23.71	50.00
12	83.00	0.00	104.68	21.68	47.00
13	88.00	5900.00	105.64	17.64	42.00
14	91.00	2440.00	105.43	14.43	39.00
15	94.00	2050.00	106.12	12.12	36.00
16	94.00	0.00	106.21	12.21	36.00
17	92.00	5000.00	106.20	14.20	38.00
18	93.00	3820.00	107.37	14.37	37.00
19	92.00	2240.00	108.00	16.00	38.00
20	93.00	1870.00	111.31	18.31	37.00
21	87.00	6790.00	110.32	23.32	43.00
22	85.00	-2900.00	120.50	35.50	45.00
23	87.00	470.00	113.29	26.29	43.00
24	87.00	2820.00	114.90	27.90	43.00
25	88.00	1050.00	116.50	28.50	42.00
26	93.00	-2700.00	111.75	18.75	37.00
27	94.00	2260.00	114.87	20.87	36.00
28	94.00	1210.00	114.65	20.65	36.00
29	95.00	1210.00	114.09	19.09	35.00
30	102.00	1210.00	113.73	11.73	28.00
31	97.00	4790.00	112.74	15.74	33.00
32	93.00	0.00	111.31	18.31	37.00
33	94.00	3340.00	108.34	14.34	36.00
34	98.00	1880.00	109.68	11.68	32.00
35	101.00	290.00	118.01	17.01	29.00
36	84.00	1610.00	101.75	17.75	46.00
37	70.00	1080.00	98.90	28.90	60.00
38	70.00	1610.00	100.90	30.90	60.00
39	88.00	0.00	108.00	20.00	42.00
40	102.00	0.00	122.00	20.00	28.00
41	111.00	0.00	131.00	20.00	19.00
42	107.00	0.00	127.00	20.00	23.00
43	110.00	0.00	130.00	20.00	20.00
44	115.00	0.00	135.00	20.00	15.00
45	118.00	0.00	138.00	20.00	12.00
46	117.00	0.00	137.00	20.00	13.00
47	94.00	-1600.00	106.44	12.44	36.00
48	83.00	-1600.00	104.90	21.90	47.00
49	93.00	-1300.00	111.47	18.47	37.00
50	130.00	0.00	130.00	0.00	0.00

Iteration Times : 19

ALTERNATIVE D-3
2 Supply Systems w/3 Reservoirs, Southwest Area, Year2010

<< PIPELINE >>

PIPE No.	NODE No. from	to	DIA. (mm)	LENGTH (m)	H-W C	FLOW (cu.m/day)	VEL. (m/sec)	HEADLOSS (m)	(0/00)
1	2	1	600.	100.	130.	-25400.	-1.04	-0.16	-1.62
2	2	1	600.	100.	130.	-25400.	-1.04	-0.16	-1.62
3	2	3	450.	730.	120.	17473.	1.27	2.78	3.81
4	2	25	500.	600.	120.	28267.	1.67	3.34	5.56
5	3	4	450.	600.	120.	13293.	0.97	1.38	2.30
6	4	5	450.	450.	120.	11203.	0.82	0.75	1.67
7	5	6	400.	150.	120.	10022.	0.92	0.36	2.42
8	5	24	200.	790.	110.	141.	0.05	0.02	0.03
9	6	7	150.	180.	110.	-1400.	-0.92	-1.59	-8.81
10	6	8	350.	410.	120.	10382.	1.25	2.03	4.94
11	8	38	150.	1020.	110.	1610.	1.05	11.64	11.41
12	8	9	250.	1110.	120.	3862.	0.91	4.53	4.08
13	9	10	300.	1120.	120.	5583.	0.91	3.72	3.32
14	9	13	250.	700.	120.	3492.	0.82	2.37	3.39
15	9	21	350.	540.	120.	-9603.	-1.16	-2.31	-4.28
16	10	37	150.	990.	110.	1080.	0.71	5.39	5.45
17	10	11	200.	320.	110.	1273.	0.47	0.58	1.82
18	11	35	150.	860.	110.	674.	0.44	1.95	2.27
19	11	12	250.	350.	120.	-3141.	-0.74	-0.97	-2.78
20	12	13	200.	370.	110.	-1541.	-0.57	-0.96	-2.59
21	12	48	150.	20.	110.	-1600.	-1.05	-0.23	-11.28
22	13	14	250.	490.	120.	1129.	0.27	0.20	0.42
23	13	17	350.	430.	120.	-5077.	-0.61	-0.57	-1.31
24	14	36	150.	880.	110.	936.	0.61	3.68	4.18
25	14	15	250.	450.	120.	-2248.	-0.53	-0.69	-1.50
26	15	16	250.	150.	120.	-1375.	-0.32	-0.09	-0.60
27	15	34	200.	420.	110.	-2922.	-1.08	-3.56	-8.48
28	16	17	250.	410.	120.	224.	0.05	0.01	0.02
29	16	47	150.	20.	110.	-1600.	-1.05	-0.23	-11.28
30	17	18	350.	260.	120.	-9852.	-1.19	-1.17	-4.49
31	18	19	350.	140.	120.	-9913.	-1.19	-0.64	-4.54
32	18	33	250.	250.	120.	-3759.	-0.89	-0.97	-3.88
33	19	20	350.	500.	120.	-12153.	-1.46	-3.31	-6.62
34	20	26	200.	60.	110.	-2700.	-0.99	-0.44	-7.32
35	20	27	250.	610.	120.	-4685.	-1.10	-3.56	-5.83
36	20	31	350.	660.	120.	-6638.	-0.80	-1.43	-2.16
37	21	22	150.	300.	110.	-2900.	-1.90	-10.18	-33.93
38	21	23	350.	370.	120.	-13493.	-1.62	-2.97	-8.03
39	23	24	400.	360.	120.	-13963.	-1.29	-1.61	-4.47
40	24	25	450.	460.	120.	-16642.	-1.21	-1.60	-3.48
41	25	27	400.	610.	120.	10575.	0.97	1.63	2.67
42	27	28	350.	310.	120.	3630.	0.44	0.22	0.71
43	28	29	250.	330.	120.	2420.	0.57	0.57	1.72
44	29	30	250.	750.	120.	1210.	0.29	0.36	0.48
45	31	35	350.	500.	120.	-15622.	-1.88	-5.27	-10.54
46	31	32	250.	300.	120.	4193.	0.99	1.42	4.75
47	32	33	250.	380.	120.	5493.	1.30	2.98	7.83
48	32	49	150.	20.	110.	-1300.	-0.85	-0.15	-7.68
49	33	34	200.	480.	110.	-1606.	-0.59	-1.34	-2.80
50	34	50	200.	560.	110.	-6408.	-2.36	-20.32	-36.28
51	35	50	350.	1100.	120.	-15912.	-1.91	-11.99	-10.90

ALTERNATIVE D-3, D-4(Recommended Plan):-A(Single P.):-B(Parallel P.)
2 Supply Systems w/2 or 3 Reservoirs, Northeast Area, Year2010

<< NODES >>

NODE No.	GROUND ELEV. (m)	FLOW (cu.m/day)	H.G.L. ELEV. (m)	DYNAMIC HEAD (m)	STATIC HEAD (m)
1	120.00	0.00	140.00	20.00	10.00
2	85.00	0.00	105.00	20.00	45.00
3	78.00	0.00	98.00	20.00	52.00
4	77.00	0.00	97.00	20.00	53.00
5	81.00	0.00	101.00	20.00	49.00
6	81.00	0.00	101.00	20.00	49.00
7	80.00	0.00	100.00	20.00	50.00
8	82.00	0.00	102.00	20.00	48.00
9	83.00	0.00	103.00	20.00	47.00
10	77.00	0.00	97.00	20.00	53.00
11	80.00	0.00	100.00	20.00	50.00
12	83.00	0.00	103.00	20.00	47.00
13	88.00	0.00	108.00	20.00	42.00
14	91.00	0.00	111.00	20.00	39.00
15	94.00	0.00	114.00	20.00	36.00
16	94.00	0.00	114.00	20.00	36.00
17	92.00	0.00	112.00	20.00	38.00
18	93.00	0.00	113.00	20.00	37.00
19	92.00	0.00	112.00	20.00	38.00
20	93.00	0.00	113.00	20.00	37.00
21	87.00	0.00	107.00	20.00	43.00
22	85.00	0.00	105.00	20.00	45.00
23	87.00	0.00	107.00	20.00	43.00
24	87.00	0.00	107.00	20.00	43.00
25	88.00	0.00	108.00	20.00	42.00
26	93.00	0.00	113.00	20.00	37.00
27	94.00	0.00	114.00	20.00	36.00
28	94.00	0.00	114.00	20.00	36.00
29	95.00	0.00	115.00	20.00	35.00
30	102.00	0.00	122.00	20.00	28.00
31	97.00	0.00	117.00	20.00	33.00
32	93.00	0.00	113.00	20.00	37.00
33	94.00	0.00	114.00	20.00	36.00
34	98.00	0.00	118.00	20.00	32.00
35	101.00	0.00	121.00	20.00	29.00
36	84.00	0.00	104.00	20.00	46.00
37	70.00	0.00	90.00	20.00	60.00
38	70.00	0.00	90.00	20.00	60.00
39	88.00	1210.00	111.25	23.25	42.00
40	102.00	1210.00	120.73	18.73	28.00
41	111.00	1210.00	120.80	9.80	19.00
42	107.00	290.00	120.94	13.94	23.00
43	110.00	290.00	121.41	11.41	20.00
44	115.00	290.00	124.25	9.25	15.00
45	118.00	290.00	129.93	11.93	12.00
46	117.00	290.00	126.63	9.63	13.00
47	94.00	0.00	114.00	20.00	36.00
48	83.00	0.00	103.00	20.00	47.00
49	93.00	0.00	113.00	20.00	37.00
50	130.00	0.00	150.00	20.00	0.00
51	130.00	0.00	130.00	0.00	0.00

Iteration Times : 21

ALTERNATIVE D-3, D-4(Recommended Plan):-A(Single P.):-B(Parallel P.)
2 Supply Systems w/2 or 3 Reservoirs, Northeast Area, Year2010

<< PIPELINE >>

PIPE No.	NODE No. from	to	DIA. (mm)	LENGTH (m)	H-W C	FLOW (cu.m/day)	VEL. (m/sec)	HEADLOSS (m)	(0/00)
1	39	40	150.	1410.	110.	-1210.	-0.79	-9.48	-6.72
2	40	46	200.	1000.	110.	-2402.	-0.88	-5.90	-5.90
3	40	41	75.	800.	110.	-18.	-0.05	-0.06	-0.08
4	41	44	150.	500.	110.	-1228.	-0.80	-3.45	-6.91
5	42	43	100.	470.	110.	-149.	-0.22	-0.47	-1.00
6	42	44	75.	900.	110.	-141.	-0.37	-3.31	-3.67
7	43	45	100.	1150.	110.	-439.	-0.65	-8.52	-7.41
8	44	46	200.	800.	110.	-1659.	-0.61	-2.38	-2.97
9	45	51	250.	10.	120.	-5080.	-1.20	-0.07	-6.77
10	45	46	250.	650.	120.	4351.	1.03	3.31	5.09

ALTERNATIVE D-4-A (Recommended Plan, Single Pipeline Alignment)
2 Supply Systems w/2 Reservoirs, Southwest Area, Year1995

<< NODES >>

NODE No.	GROUND ELEV. (m)	FLOW (cu.m/day)	H.G.L. ELEV. (m)	DYNAMIC HEAD (m)	STATIC HEAD (m)
1	120.00	0.00	120.00	0.00	0.00
2	85.00	1850.00	119.86	34.86	35.00
3	78.00	2900.00	119.36	41.36	42.00
4	77.00	1300.00	119.19	42.19	43.00
5	81.00	1000.00	119.16	38.16	39.00
6	81.00	650.00	119.16	38.16	39.00
7	80.00	-1400.00	120.75	40.75	40.00
8	82.00	650.00	119.15	37.15	38.00
9	83.00	2250.00	116.94	33.94	37.00
10	77.00	1080.00	109.63	32.63	43.00
11	80.00	2080.00	111.38	31.38	40.00
12	83.00	0.00	114.81	31.81	37.00
13	88.00	4180.00	115.79	27.79	32.00
14	91.00	1580.00	105.60	14.60	29.00
15	94.00	1040.00	108.88	14.88	26.00
16	94.00	0.00	109.59	15.59	26.00
17	92.00	3340.00	114.05	22.05	28.00
18	93.00	2120.00	114.26	21.26	27.00
19	92.00	1780.00	114.57	22.57	28.00
20	93.00	1560.00	116.27	23.27	27.00
21	87.00	3600.00	117.80	30.80	33.00
22	85.00	-2900.00	127.98	42.98	35.00
23	87.00	250.00	118.49	31.49	33.00
24	87.00	1850.00	118.88	31.88	33.00
25	88.00	850.00	119.31	31.31	32.00
26	93.00	-2700.00	116.71	23.71	27.00
27	94.00	1800.00	117.25	23.25	26.00
28	94.00	1200.00	116.14	22.14	26.00
29	95.00	1200.00	114.20	19.20	25.00
30	102.00	1200.00	112.98	10.98	18.00
31	97.00	3580.00	116.14	19.14	23.00
32	93.00	0.00	109.83	16.83	27.00
33	94.00	2020.00	109.63	15.63	26.00
34	98.00	1340.00	109.99	11.99	22.00
35	101.00	0.00	121.00	20.00	19.00
36	84.00	1080.00	100.81	16.81	36.00
37	70.00	0.00	90.00	20.00	50.00
38	70.00	0.00	90.00	20.00	50.00
39	88.00	0.00	108.00	20.00	32.00
40	102.00	0.00	122.00	20.00	18.00
41	111.00	0.00	131.00	20.00	9.00
42	107.00	0.00	127.00	20.00	13.00
43	110.00	0.00	130.00	20.00	10.00
44	115.00	0.00	135.00	20.00	5.00
45	118.00	0.00	138.00	20.00	2.00
46	117.00	0.00	137.00	20.00	3.00
47	94.00	-1600.00	109.82	15.82	26.00
48	83.00	-1600.00	115.03	32.03	37.00
49	93.00	-1300.00	109.99	16.99	27.00
50	105.00	-2900.00	114.67	9.67	15.00

Iteration Times : 36

ALTERNATIVE D-4-A (Recommended Plan, Single Pipeline Alignment)
2 Supply Systems w/2 Reservoirs, Southwest Area, Year1995

<< PIPELINE >>

PIPE No.	NODE No. from	to	DIA. (mm)	LENGTH (m)	H-W C	FLOW (cu.m/day)	VEL. (m/sec)	HEADLOSS (m)	(0/00)
1	2	1	700.	100.	130.	-34958.	-1.05	-0.14	-1.38
2	2	3	400.	730.	120.	5108.	0.47	0.51	0.69
3	2	25	700.	600.	130.	28000.	0.84	0.55	0.92
4	3	4	350.	600.	120.	2207.	0.27	0.17	0.28
5	4	5	350.	450.	120.	907.	0.11	0.02	0.05
6	5	6	350.	150.	120.	-99.	-0.01	0.00	0.00
7	6	7	150.	180.	110.	-1400.	-0.92	-1.59	-8.81
8	6	8	350.	410.	120.	650.	0.08	0.01	0.03
9	9	13	350.	700.	120.	5740.	0.69	1.16	1.65
10	9	21	400.	540.	120.	-7990.	-0.74	-0.86	-1.59
11	10	11	150.	320.	110.	-1080.	-0.71	-1.74	-5.45
12	11	12	200.	350.	110.	-3160.	-1.16	-3.43	-9.80
13	12	13	200.	370.	110.	-1560.	-0.57	-0.98	-2.65
14	12	48	150.	20.	110.	-1600.	-1.05	-0.23	-11.28
15	14	36	150.	880.	110.	1080.	0.71	4.79	5.45
16	14	15	200.	460.	110.	-2660.	-0.98	-3.28	-7.12
17	15	16	200.	150.	110.	-2140.	-0.79	-0.71	-4.76
18	15	34	200.	420.	110.	-1560.	-0.57	-1.11	-2.65
19	16	17	100.	410.	110.	-540.	-0.80	-4.46	-10.87
20	16	47	150.	20.	110.	-1600.	-1.05	-0.23	-11.28
21	17	18	350.	260.	120.	-3880.	-0.47	-0.21	-0.80
22	18	19	350.	140.	120.	-6720.	-0.81	-0.31	-2.21
23	18	33	100.	250.	110.	720.	1.06	4.63	18.52
24	19	20	350.	500.	120.	-8500.	-1.02	-1.71	-3.41
25	20	26	200.	60.	110.	-2700.	-0.99	-0.44	-7.32
26	20	27	450.	610.	120.	-10960.	-0.80	-0.98	-1.61
27	20	31	450.	660.	120.	3580.	0.26	0.13	0.20
28	21	22	150.	300.	110.	-2900.	-1.90	-10.18	-33.93
29	21	23	400.	370.	120.	-8690.	-0.60	-0.69	-1.86
30	23	24	450.	360.	120.	-8940.	-0.65	-0.40	-1.10
31	24	25	500.	460.	120.	-10790.	-0.64	-0.43	-0.93
32	25	27	450.	610.	120.	16360.	1.19	2.06	3.38
33	27	28	250.	310.	120.	3600.	0.85	1.11	3.58
34	28	29	200.	330.	110.	2400.	0.88	1.94	5.89
35	29	30	200.	750.	110.	1200.	0.44	1.22	1.63
36	32	33	250.	380.	120.	1300.	0.31	0.21	0.54
37	32	49	150.	20.	110.	-1300.	-0.85	-0.15	-7.68
38	34	50	200.	560.	110.	-2900.	-1.07	-4.68	-8.36

ALTERNATIVE D-4-A (Recommended Plan, Single Pipeline Alignment)
2 Supply Systems w/2 Reservoirs, Southwest Area, Year2010

<< NODES >>

NODE No.	GROUND ELEV. (m)	FLOW (cu.m/day)	H.G.L. ELEV. (m)	DYNAMIC HEAD (m)	STATIC HEAD (m)
1	120.00	0.00	120.00	0.00	0.00
2	85.00	5060.00	119.86	34.86	35.00
3	78.00	4180.00	116.90	38.90	42.00
4	77.00	2090.00	114.58	37.58	43.00
5	81.00	1040.00	113.51	32.51	39.00
6	81.00	1040.00	112.91	31.91	39.00
7	80.00	-1400.00	114.50	34.50	40.00
8	82.00	4910.00	111.15	29.15	38.00
9	83.00	4390.00	108.14	25.14	37.00
10	77.00	3230.00	100.70	23.70	43.00
11	80.00	3740.00	99.89	19.89	40.00
12	83.00	0.00	103.95	20.95	37.00
13	88.00	5900.00	105.32	17.32	32.00
14	91.00	2440.00	104.54	13.54	29.00
15	94.00	2050.00	105.38	11.38	26.00
16	94.00	0.00	105.91	11.91	26.00
17	92.00	5000.00	106.65	14.65	28.00
18	93.00	3820.00	107.12	14.12	27.00
19	92.00	2240.00	107.75	15.75	28.00
20	93.00	1870.00	111.03	18.03	27.00
21	87.00	6790.00	111.11	24.11	33.00
22	85.00	-2900.00	121.28	36.28	35.00
23	87.00	470.00	114.17	27.17	33.00
24	87.00	2820.00	115.93	28.93	33.00
25	88.00	1050.00	118.14	30.14	32.00
26	93.00	-2700.00	111.47	18.47	27.00
27	94.00	2260.00	113.71	19.71	26.00
28	94.00	1210.00	112.58	18.58	26.00
29	95.00	1210.00	110.61	15.61	25.00
30	102.00	1210.00	109.37	7.37	18.00
31	97.00	4790.00	110.50	13.50	23.00
32	93.00	0.00	108.59	15.59	27.00
33	94.00	3340.00	107.09	13.09	26.00
34	98.00	1880.00	106.45	8.45	22.00
35	101.00	290.00	110.26	9.26	19.00
36	84.00	1610.00	98.99	14.99	36.00
37	70.00	1080.00	95.31	25.31	50.00
38	70.00	1610.00	99.51	29.51	50.00
39	88.00	1210.00	108.00	20.00	32.00
40	102.00	1210.00	122.00	20.00	18.00
41	111.00	1210.00	131.00	20.00	9.00
42	107.00	290.00	127.00	20.00	13.00
43	110.00	290.00	130.00	20.00	10.00
44	115.00	290.00	135.00	20.00	5.00
45	118.00	290.00	138.00	20.00	2.00
46	117.00	290.00	137.00	20.00	3.00
47	94.00	-1600.00	106.13	12.13	26.00
48	83.00	-1600.00	104.18	21.18	37.00
49	93.00	-1300.00	108.75	15.75	27.00
50	105.00	-2900.00	111.13	6.13	15.00

Iteration Times : 19

ALTERNATIVE D-4-A (Recommended Plan, Single Pipeline Alignment)
2 Supply Systems w/2 Reservoirs, Southwest Area, Year2010

<< PIPELINE >>

PIPE No.	NODE No. from	to	DIA. (mm)	LENGTH (m)	H-W C	FLOW (cu.m/day)	VEL. (m/sec)	HEADLOSS (m)	(0/00)
1	2	1	700.	100.	130.	-35107.	-1.06	-0.14	-1.39
2	2	1	700.	100.	130.	-35107.	-1.06	-0.14	-1.39
3	2	3	400.	730.	120.	13261.	1.22	2.96	4.06
4	2	25	700.	600.	130.	51894.	1.56	1.72	2.87
5	3	4	350.	600.	120.	9081.	1.09	2.31	3.86
6	4	5	350.	450.	120.	6991.	0.84	1.07	2.38
7	5	6	350.	150.	120.	9260.	1.11	0.60	4.00
8	5	24	250.	790.	120.	-3309.	-0.78	-2.42	-3.06
9	6	7	150.	180.	110.	-1400.	-0.92	-1.59	-8.81
10	6	8	350.	410.	120.	9620.	1.16	1.76	4.29
11	8	38	150.	1020.	110.	1610.	1.05	11.64	11.41
12	8	9	250.	1110.	120.	3100.	0.73	3.01	2.71
13	9	10	250.	1120.	120.	5026.	1.19	7.44	6.64
14	9	13	350.	700.	120.	9296.	1.12	2.82	4.03
15	9	21	400.	540.	120.	-15612.	-1.44	-2.97	-5.49
16	10	37	150.	990.	110.	1080.	0.71	5.39	5.45
17	10	11	150.	320.	110.	716.	0.47	0.81	2.54
18	11	36	150.	860.	110.	442.	0.29	0.89	1.04
19	11	12	200.	350.	110.	-3465.	-1.28	-4.07	-11.62
20	12	13	200.	370.	110.	-1865.	-0.69	-1.37	-3.69
21	12	48	150.	20.	110.	-1600.	-1.05	-0.23	-11.28
22	13	14	250.	490.	120.	2327.	0.55	0.78	1.60
23	13	17	150.	430.	110.	-796.	-0.52	-1.33	-3.10
24	14	35	150.	880.	110.	1168.	0.77	5.55	6.30
25	14	15	200.	460.	110.	-1281.	-0.47	-0.85	-1.84
26	15	16	200.	150.	110.	-1806.	-0.67	-0.52	-3.48
27	15	34	200.	420.	110.	-1525.	-0.56	-1.07	-2.54
28	16	17	100.	410.	110.	-206.	-0.30	-0.75	-1.82
29	16	47	150.	20.	110.	-1600.	-1.05	-0.23	-11.28
30	17	18	350.	260.	120.	-6001.	-0.72	-0.47	-1.79
31	18	19	350.	140.	120.	-9866.	-1.19	-0.63	-4.50
32	18	33	100.	250.	110.	45.	0.07	0.03	0.11
33	19	20	350.	500.	120.	-12106.	-1.46	-3.29	-6.57
34	20	26	200.	60.	110.	-2700.	-0.99	-0.44	-7.32
35	20	27	450.	610.	120.	-18854.	-1.37	-2.68	-4.39
36	20	31	450.	660.	120.	7579.	0.55	0.54	0.81
37	21	22	150.	300.	110.	-2900.	-1.90	-10.18	-33.93
38	21	23	400.	370.	120.	-19502.	-1.80	-3.07	-8.29
39	23	24	450.	360.	120.	-19972.	-1.45	-1.76	-4.88
40	24	25	500.	460.	120.	-26101.	-1.54	-2.21	-4.80
41	25	27	450.	610.	120.	24744.	1.80	4.43	7.26
42	27	28	250.	310.	120.	3630.	0.86	1.13	3.64
43	28	29	200.	330.	110.	2420.	0.89	1.97	5.98
44	29	30	200.	750.	110.	1210.	0.45	1.24	1.66
45	31	35	150.	500.	110.	290.	0.19	0.24	0.48
46	31	32	200.	300.	110.	2499.	0.92	1.90	6.34
47	32	33	250.	380.	120.	3800.	0.90	1.50	3.96
48	32	49	150.	20.	110.	-1300.	-0.85	-0.15	-7.68
49	33	34	150.	480.	110.	505.	0.33	0.64	1.33
50	34	50	200.	560.	110.	-2900.	-1.07	-4.68	-8.36

ALTERNATIVE D-4-B (Parallel Pipeline Alignment of Recommended Plan)
2 Supply Systems w/2 Reservoirs, Southwest Area, Year1995

<< NODES >>

NODE No.	GROUND ELEV. (m)	FLOW (cu.m/day)	H.G.L. ELEV. (m)	DYNAMIC HEAD (m)	STATIC HEAD (m)
1	120.00	0.00	120.00	0.00	0.00
2	85.00	1850.00	119.86	34.86	35.00
3	78.00	2900.00	114.76	36.76	42.00
4	77.00	1300.00	111.58	34.58	43.00
5	81.00	1000.00	111.09	30.09	39.00
6	81.00	650.00	111.03	30.03	39.00
7	80.00	-1400.00	112.62	32.62	40.00
8	82.00	650.00	110.86	28.86	38.00
9	83.00	2250.00	109.10	26.10	37.00
10	77.00	1080.00	86.56	9.56	43.00
11	80.00	2080.00	88.30	8.30	40.00
12	83.00	0.00	102.23	19.23	37.00
13	88.00	4180.00	106.21	18.21	32.00
14	91.00	1580.00	105.53	14.53	29.00
15	94.00	1040.00	110.47	16.47	26.00
16	94.00	0.00	111.82	17.82	26.00
17	92.00	3340.00	111.22	19.22	28.00
18	93.00	2120.00	111.63	18.63	27.00
19	92.00	1780.00	112.14	20.14	28.00
20	93.00	1580.00	113.53	20.53	27.00
21	87.00	3600.00	112.08	25.08	33.00
22	85.00	-2900.00	122.25	37.25	35.00
23	87.00	250.00	114.49	27.49	33.00
24	87.00	1850.00	115.67	28.67	33.00
25	88.00	850.00	117.05	29.05	32.00
26	93.00	-2700.00	113.97	20.97	27.00
27	94.00	1800.00	115.11	21.11	26.00
28	94.00	1200.00	114.00	20.00	26.00
29	95.00	1200.00	112.06	17.06	25.00
30	102.00	1200.00	110.84	8.84	18.00
31	97.00	3580.00	112.99	15.99	23.00
32	93.00	0.00	111.59	18.59	27.00
33	94.00	2020.00	110.48	16.48	26.00
34	98.00	1340.00	113.18	15.18	22.00
35	101.00	0.00	121.00	20.00	19.00
36	84.00	1080.00	100.73	16.73	36.00
37	70.00	0.00	90.00	20.00	50.00
38	70.00	0.00	90.00	20.00	50.00
39	88.00	0.00	108.00	20.00	32.00
40	102.00	0.00	122.00	20.00	18.00
41	111.00	0.00	131.00	20.00	9.00
42	107.00	0.00	127.00	20.00	13.00
43	110.00	0.00	130.00	20.00	10.00
44	115.00	0.00	135.00	20.00	5.00
45	118.00	0.00	138.00	20.00	2.00
46	117.00	0.00	137.00	20.00	3.00
47	94.00	-1600.00	112.05	18.05	26.00
48	83.00	-1600.00	102.45	19.45	37.00
49	93.00	-1300.00	111.75	18.75	27.00
50	105.00	-2900.00	117.86	12.86	15.00

Iteration Times : 18

ALTERNATIVE D-4-B (Parallel Pipeline Alignment of Recommended Plan)
2 Supply Systems w/2 Reservoirs, Southwest Area, Year1995

<< PIPELINE >>

PIPE No.	NODE No. from	to	DIA. (mm)	LENGTH (m)	H-W C	FLOW (cu.m/day)	VEL. (m/sec)	HEADLOSS (m)	(0/00)
1	2	1	700.	100.	130.	-34946.	-1.05	-0.14	-1.38
2	2	3	250.	730.	120.	5166.	1.22	5.10	6.99
3	2	25	500.	600.	130.	27931.	1.65	2.81	4.69
4	3	4	200.	600.	110.	2266.	0.83	3.18	5.29
5	4	5	200.	450.	110.	966.	0.36	0.49	1.09
6	5	6	250.	150.	120.	1083.	0.26	0.06	0.39
7	5	24	150.	790.	110.	-1116.	-0.73	-4.58	-5.79
8	6	7	150.	180.	110.	-1400.	-0.92	-1.59	-8.81
9	6	8	300.	410.	120.	1834.	0.30	0.17	0.42
10	8	9	200.	1110.	110.	1184.	0.44	1.76	1.59
11	9	13	300.	700.	120.	6279.	1.03	2.89	4.13
12	9	21	300.	540.	120.	-7345.	-1.20	-2.98	-5.52
13	10	11	150.	320.	110.	-1080.	-0.71	-1.74	-5.45
14	11	12	150.	350.	110.	-3160.	-2.07	-13.92	-39.77
15	12	13	150.	370.	110.	-1560.	-1.02	-3.98	-10.76
16	12	48	150.	20.	110.	-1600.	-1.05	-0.23	-11.28
17	13	14	200.	490.	110.	1100.	0.41	0.68	1.39
18	13	17	100.	430.	110.	-551.	-0.83	-5.02	-11.67
19	14	36	150.	880.	110.	1080.	0.71	4.79	5.45
20	14	15	150.	460.	110.	-1560.	-1.02	-4.95	-10.76
21	15	16	150.	150.	110.	-1417.	-0.93	-1.35	-9.01
22	15	34	150.	420.	110.	-1182.	-0.77	-2.70	-6.44
23	16	17	100.	410.	110.	183.	0.27	0.60	1.47
24	16	47	150.	20.	110.	-1600.	-1.05	-0.23	-11.28
25	17	18	300.	260.	120.	-3718.	-0.61	-0.41	-1.56
26	18	19	300.	140.	120.	-5838.	-0.96	-0.50	-3.61
27	19	20	350.	500.	120.	-7618.	-0.92	-1.39	-2.79
28	20	26	200.	60.	110.	-2700.	-0.99	-0.44	-7.32
29	20	27	400.	610.	120.	-10419.	-0.96	-1.58	-2.60
30	20	31	350.	660.	120.	3922.	0.47	0.54	0.81
31	21	22	150.	300.	110.	-2900.	-1.90	-10.18	-33.93
32	21	23	300.	370.	120.	-8045.	-1.32	-2.42	-6.53
33	23	24	350.	360.	120.	-8295.	-1.00	-1.17	-3.26
34	24	25	400.	450.	120.	-11252.	-1.04	-1.38	-3.00
35	25	27	450.	610.	120.	15819.	1.15	1.93	3.17
36	27	28	250.	310.	120.	3600.	0.85	1.11	3.58
37	28	29	200.	330.	110.	2400.	0.88	1.94	5.89
38	29	30	200.	750.	110.	1200.	0.44	1.22	1.63
39	31	32	100.	300.	110.	342.	0.50	1.40	4.66
40	32	33	200.	380.	110.	1642.	0.61	1.11	2.92
41	32	49	150.	20.	110.	-1300.	-0.85	-0.15	-7.68
42	33	34	100.	480.	110.	-378.	-0.56	-2.69	-5.61
43	34	50	200.	560.	110.	-2900.	-1.07	-4.68	-8.36

ALTERNATIVE D-4-B (Parallel Pipeline Alignment of Recommended Plan)
2 Supply Systems w/2 Reservoirs, Southwest Area, Year2010

<< NODES >>

NODE No.	GROUND ELEV. (m)	FLOW (cu.m/day)	H.G.L. ELEV. (m)	DYNAMIC HEAD (m)	STATIC HEAD (m)
1	120.00	0.00	120.00	0.00	0.00
2	85.00	5060.00	119.86	34.86	35.00
3	78.00	4180.00	116.94	38.94	42.00
4	77.00	2090.00	114.11	37.11	43.00
5	81.00	1040.00	112.81	31.81	39.00
6	81.00	1040.00	112.07	31.07	39.00
7	80.00	-1400.00	113.65	33.65	40.00
8	82.00	4910.00	110.19	28.19	38.00
9	83.00	4390.00	106.99	23.99	37.00
10	77.00	3230.00	99.48	22.48	43.00
11	80.00	3740.00	98.61	18.61	40.00
12	83.00	0.00	103.15	20.15	37.00
13	88.00	5900.00	104.66	16.66	32.00
14	91.00	2440.00	103.14	12.14	29.00
15	94.00	2050.00	104.64	10.64	26.00
16	94.00	0.00	105.25	11.25	25.00
17	92.00	5000.00	106.35	14.35	28.00
18	93.00	3820.00	107.03	14.03	27.00
19	92.00	2240.00	107.89	15.89	28.00
20	93.00	1670.00	111.38	18.38	27.00
21	87.00	6790.00	110.51	23.51	33.00
22	85.00	-2900.00	120.69	35.69	35.00
23	87.00	470.00	114.11	27.11	33.00
24	87.00	2820.00	115.84	28.84	33.00
25	88.00	1050.00	118.27	30.27	32.00
26	93.00	-2700.00	111.82	18.82	27.00
27	94.00	2260.00	113.76	19.76	26.00
28	94.00	1210.00	112.63	18.63	26.00
29	95.00	1210.00	110.66	15.66	25.00
30	102.00	1210.00	109.42	7.42	18.00
31	97.00	4790.00	110.70	13.70	23.00
32	93.00	0.00	109.42	16.42	27.00
33	94.00	3340.00	107.04	13.04	25.00
34	98.00	1880.00	105.53	7.53	22.00
35	101.00	290.00	110.46	9.46	19.00
36	84.00	1610.00	97.68	13.68	36.00
37	70.00	1080.00	94.09	24.09	50.00
38	70.00	1610.00	98.56	28.56	50.00
39	88.00	1210.00	108.00	20.00	32.00
40	102.00	1210.00	122.00	20.00	18.00
41	111.00	1210.00	131.00	20.00	9.00
42	107.00	290.00	127.00	20.00	13.00
43	110.00	290.00	130.00	20.00	10.00
44	115.00	290.00	135.00	20.00	5.00
45	118.00	290.00	138.00	20.00	2.00
46	117.00	290.00	137.00	20.00	3.00
47	94.00	-1600.00	105.48	11.48	26.00
48	83.00	-1600.00	103.38	20.38	37.00
49	93.00	-1300.00	109.57	16.57	27.00
50	105.00	-2900.00	110.21	5.21	15.00

Iteration Times : 17

ALTERNATIVE D-4-B (Parallel Pipeline Alignment of Recommended Plan)
2 Supply Systems w/2 Reservoirs, Southwest Area, Year2010

<< PIPELINE >>

PIPE No.	NODE No. from	to	DIA. (mm)	LENGTH (m)	H-W C	FLOW (cu.m/day)	VEL. (m/sec)	HEADLOSS (m)	(0/00)
1	2	1	700.	100.	130.	-35109.	-1.06	-0.14	-1.39
2	2	3	250.	730.	120.	3819.	0.90	2.92	4.00
3	2	25	500.	600.	120.	18941.	1.12	1.59	2.65
4	2	1	700.	100.	130.	-35109.	-1.06	-0.14	-1.39
5	2	3	350.	730.	120.	9253.	1.11	2.92	4.00
6	2	25	600.	600.	130.	33144.	1.36	1.59	2.65
7	3	4	200.	600.	110.	2133.	0.79	2.84	4.73
8	3	4	300.	600.	120.	6759.	1.11	2.84	4.73
9	4	5	200.	450.	110.	1632.	0.60	1.30	2.88
10	4	5	300.	450.	120.	5171.	0.85	1.30	2.88
11	5	6	250.	150.	120.	4280.	1.01	0.74	4.93
12	5	24	150.	790.	110.	-894.	-0.59	-3.03	-3.84
13	5	6	250.	150.	120.	4280.	1.01	0.74	4.93
14	5	24	200.	790.	110.	-1905.	-0.70	-3.03	-3.84
15	6	7	150.	180.	110.	-1400.	-0.92	-1.59	-8.81
16	6	8	300.	410.	120.	6636.	1.09	1.88	4.57
17	6	8	200.	410.	120.	2285.	0.84	1.88	4.57
18	8	9	200.	1110.	110.	1634.	0.60	3.21	2.89
19	8	38	150.	1020.	110.	1610.	1.05	11.64	11.41
20	8	9	150.	1110.	110.	767.	0.50	3.21	2.89
21	9	13	300.	700.	120.	5580.	0.91	2.32	3.32
22	9	21	300.	540.	120.	-8037.	-1.32	-3.52	-6.52
23	9	10	250.	1120.	120.	5051.	1.19	7.51	6.70
24	9	13	250.	700.	120.	3455.	0.81	2.32	3.32
25	9	21	300.	540.	120.	-8037.	-1.32	-3.52	-6.52
26	10	11	150.	320.	110.	741.	0.49	0.87	2.71
27	10	37	150.	990.	110.	1080.	0.71	5.39	5.45
28	11	12	150.	250.	110.	-1725.	-1.13	-4.54	-12.97
29	11	36	150.	850.	110.	451.	0.30	0.93	1.08
30	11	12	150.	350.	110.	-1725.	-1.13	-4.54	-12.97
31	12	13	150.	370.	110.	-925.	-0.61	-1.51	-4.09
32	12	48	150.	20.	110.	-1600.	-1.05	-0.23	-11.28
33	12	13	150.	370.	110.	-925.	-0.61	-1.51	-4.09
34	13	14	200.	490.	110.	1701.	0.63	1.52	3.11
35	13	17	100.	430.	110.	-311.	-0.46	-1.68	-3.91
36	13	14	150.	490.	110.	798.	0.52	1.52	3.11
37	13	17	150.	430.	110.	-903.	-0.59	-1.68	-3.91
38	14	36	150.	880.	110.	1159.	0.76	5.46	6.20
39	14	15	150.	460.	110.	-818.	-0.54	-1.50	-3.26
40	14	15	100.	460.	110.	-282.	-0.42	-1.50	-3.26
41	15	16	150.	150.	110.	-927.	-0.61	-0.62	-4.10
42	15	34	150.	420.	110.	-648.	-0.42	-0.89	-2.12
43	15	16	150.	150.	110.	-927.	-0.61	-0.62	-4.10
44	15	34	150.	420.	110.	-648.	-0.42	-0.89	-2.12
45	16	17	100.	410.	110.	-253.	-0.37	-1.09	-2.67
46	16	47	150.	20.	110.	-1600.	-1.05	-0.23	-11.28
47	17	18	300.	260.	120.	-4915.	-0.80	-0.68	-2.62
48	17	18	200.	260.	110.	-1551.	-0.57	-0.68	-2.62
49	18	19	300.	140.	120.	-7798.	-1.28	-0.86	-6.17
50	18	19	200.	140.	110.	-2461.	-0.91	-0.86	-6.17
51	18	33	100.	250.	110.	-27.	-0.04	-0.01	-0.04
52	19	20	350.	500.	120.	-12499.	-1.50	-3.49	-6.97
53	20	26	200.	60.	110.	-2700.	-0.99	-0.44	-7.32
54	20	27	400.	610.	120.	-12994.	-1.20	-2.39	-3.91
55	20	31	350.	660.	120.	4454.	0.54	0.68	1.03

ALTERNATIVE D-4-B (Parallel Pipeline Alignment of Recommended Plan)
2 Supply Systems w/2 Reservoirs, Southwest Area, Year2010

<< PIPELINE >>

PIPE No.	NODE No. from--to		DIA. (mm)	LENGTH (m)	H-W C	FLOW (cu.m/day)	VEL. (m/sec)	HEADLOSS (m)	(O/OO)
56	20	27	300.	610.	120.	-6098.	-1.00	-2.39	-3.91
57	20	31	300.	660.	120.	2969.	0.49	0.68	1.03
58	21	22	150.	300.	110.	-2900.	-1.90	-10.18	-33.93
59	21	23	300.	370.	120.	-9982.	-1.63	-3.60	-9.74
60	21	23	300.	370.	120.	-9982.	-1.63	-3.60	-9.74
61	23	24	350.	360.	120.	-10217.	-1.23	-1.73	-4.80
62	23	24	350.	360.	120.	-10217.	-1.23	-1.73	-4.80
63	24	25	400.	460.	120.	-15291.	-1.41	-2.43	-5.28
64	24	25	350.	460.	120.	-10762.	-1.29	-2.43	-5.28
65	25	27	450.	610.	120.	24982.	1.82	4.51	7.39
66	27	28	250.	310.	120.	3630.	0.86	1.13	3.64
67	28	29	200.	330.	110.	2420.	0.89	1.97	5.98
68	29	30	200.	750.	110.	1210.	0.45	1.24	1.66
69	31	32	100.	300.	110.	326.	0.48	1.28	4.27
70	31	35	150.	500.	110.	290.	0.19	0.24	0.48
71	31	32	200.	300.	110.	2018.	0.74	1.28	4.27
72	32	33	200.	380.	110.	2480.	0.91	2.38	6.26
73	32	49	150.	20.	110.	-1300.	-0.85	-0.15	-7.68
74	32	33	150.	380.	110.	1164.	0.76	2.38	6.26
75	33	34	100.	480.	110.	277.	0.41	1.51	3.15
76	34	50	200.	560.	110.	-2900.	-1.07	-4.68	-8.36

APPENDIX 7.3.3 Cost Estimates of Alterntive Water Supply Systems

(1) Water Sources (Common Facilities)

- o Replacement of Pumps at existing wells
  5 pumps x 320,000 ₱/pump = ₱ 1,600,000
- o Reconstruction of one existing well
  940,000 ₱/well + 640,000 ₱/pump = ₱ 1,580,000
- o Pump installation at test well ₱ 640,000
- o 16 new well construction
  16 wells x (940,000 ₱/well + 640,000 ₱/well)
  = ₱25,280,000

TOTAL ₱29,100,000

(2) Transmission Line

(Unit : ₱x1,000)

Pipe	Unit Cost	Alternative D-1		Alternative D-2		Alternative D-3		Alternative D-4	
	(₱)	Q'ty	Cost	Q'ty	Cost	Q'ty	Cost	Q'ty	Cost
ϕ200 mm	520	4,500 m	2,340	3,500 m	1,820	5,500 m	2,860	4,500 m	2,340
ϕ250 mm	630	500 m	315	1,000 m	630	500 m	315	1,000 m	630
ϕ350 mm	900	500 m	450	1,000 m	900	500 m	450	1,000 m	900
ϕ400 mm	970	1,000 m	970	1,500 m	1,455	500 m	485	500 m	485
ϕ500 mm	1,330	500 m	665	500 m	665	500 m	665	500 m	665
TOTAL		7,000 m	4,740	7,500 m	5,470	7,500 m	4,775	7,500 m	5,020

(3) Reservoir

Costs were estimated based on the cost functions adopted in the LWUA Methodology Manual.

Alternative D-1

Ground Reservoir : Q = 3,525 cu.m ₱ 3,705,000
Q = 9,531 cu.m ₱ 6,996,000
TOTAL ₱10,701,000

Alternative D-2

Ground Reservoir	:	Q = 13,056 cu.m	₱ 8,554,000

Alternative D-3

Elevated Tank (H=15 m)	:	Q = 458 cu.m x 2 ₱ 1,339,000 x 2=	₱ 2,678,000
Ground Reservoir	:	Q = 4,026 cu.m	₱ 4,034,000
		Q = 8,175 cu.m	₱ 6,342,000
		TOTAL	₱13,054,000

Alternative D-4

Elevated Tank	:	Same as Alt.D-3	₱ 2,678,000
Ground Reservoir	:	Q = 12,201 cu.m	₱ 8,192,000
		TOTAL	₱10,870,000

(4) Booster Pump Station

Costs were estimated based on the cost functions adopted in the LWUA Methodology Manual.

Alternative D-1

Q = 52,448 cu.m/day = 610 l/sec H = 50m		₱ 8,863,000
Q = 19,347 cu.m/day = 230 l/sec H = 40m		₱ 4,106,000
	TOTAL	₱12,969,000

Alternative D-2

Q = 75,300 cu.m/day = 880 l/sec H = 50m		₱11,814,000
Q = 5,711 cu.m/day = 70 l/sec H = 20m		₱ 1,532,000
	TOTAL	₱13,346,000

Alternative D-3

Q = 50,800 cu.m/day = 590 l/sec H = 50m		₱ 8,638,000
Q = 22,320 cu.m/day = 290 l/sec H = 40m		₱ 4,856,000
	TOTAL	₱13,494,000

Alternative D-4

Q = 70,214 cu.m/day = 820 l/sec H = 50m		₱11,171,000
	TOTAL	₱11,171,000

(5) Energy Consumption

Unit Cost : 0.3 ₱/KWH, Operation Period : 15 years

Alternative D-1

Deep Well Pump : 4,432.7 MWH/year x 15 years x 0.3 ₱/KWH = ₱19,947,000

Booster Pump : (2,217 MWH/year + 568.6 MWH/year) x 15 years x 0.3 ₱/KWH = ₱12,535,000

TOTAL = ₱32,482,000

Alternative D-2

Deep Well Pump	: Same as Alternative D-1			₱19,947,000
Booster Pump	: 2,904.6 MWH/year x 15 years	x 0.3 ₱/KWH	=	₱13,071,000
		TOTAL	=	₱33,018,000

Alternative D-3

Deep Well Pump	: Same as Alternative D-1			₱19,947,000
Booster Pump	: 2,937.7 MWH/year x 15 years	x 0.3 ₱/KWH	=	₱13,220,000
		TOTAL	=	₱33,167,000

Alternative D-4

Deep Well Pump	: Same as Alternative D-1			₱19,947,000
Booster Pump	: 2,892.9 MWH/year x 15 years	x 0.3 ₱/KWH	=	₱13,018,000
		TOTAL	=	₱32,965,000

(6) Labor

Unit Cost : ₱ 2,000/MM

Alternative D-1 and D-2

₱ 2,000/MM x 2 persons x 15 years = ₱ 720,000

Alternative D-3 and D-4

₱ 2,000/MM x 3 persons x 15 years = ₱ 1,080,000

APPENDIX 8.2.1.A BREAKDOWN OF COST ESTIMATES

(Unit: thousand Pesos)

Angeles		Phase I(Stage 1)		Phase I(Stage 2)		Phase I Total		Phase II Cost	
ITEM	UNIT COST	NUMBER	COST	NUMBER	COST	NUMBER	COST	NUMBER	COST
1 SOURCE FACILITY									
(1)DEEP WELL CONSTRUCTION	940000	1	940	6	5640	7	6580	10	9400
(2)DEEP WELL PUMP w/HOUSE	640000	2	1280	6	3840	8	5120	10	6400
Well Pump	320000	5	1600	0	0	5	1600	0	0
Flow Meter D=150	62000	7	434	6	372	13	806	10	620
SUB-TOTAL			4254		9852		14106		16420
2 TRANSMISSION FACILITIES									
Main Pipes									
D=200 (Steel Pipe)	520	0	0	1500	780	1500	780	3500	1820
D=350 (Steel Pipe)	900	0	0	500	450	500	450	500	450
D=400 (Steel Pipe)	970	0	0	500	485	500	485	500	485
D=500 (Steel Pipe)	1330	0	0	0	0	0	0	2800	3724
SUB-TOTAL		0	0	0	1715	0	1715		6479
3 DISTRIBUTION FACILITIES									
(1)Reservoir			4202	0	0		4202		6210
(2)Pump Facility (Eqip.)			1301		3765		5066		4246
-do- (Civil)			2228		0		2228		2187
(3)Chlrntn Facility 22kg/d	98100	7	687	1	98	8	785	3	294
(4)Elevated Tank	1339000	0	0	0	0	0	0	2	2678
(5)Electric Sub-station		1	2757						5131
(6)Distribution pipes									
1)Main Pipes									
D=150 (PVC Pipe)	410	1440	590	300	123	1740	713	6190	2538
D=200 (Steel Pipe)	520	2370	1233	1080	562	3450	1795	2100	1092
D=250 (Steel Pipe)	630	380	239	310	195	690	434	4170	2627
D=350 (Steel Pipe)	900	2800	2520	410	369	3210	2889	0	0
D=400 (Steel Pipe)	970	1640	1591	0	0	1640	1591	0	0
D=450 (Steel Pipe)	1160	2240	2599	0	0	2240	2599	0	0
D=500 (Steel Pipe)	1330	460	612	0	0	460	612	0	0
D=700 (Steel Pipe)	1910	700	1337	0	0	700	1337	100	191
2)Valves									
D=150 (Gate Valve)	5300	5	26	1	5	6	31	21	111
D=200 (Gate Valve)	6700	8	54	4	27	12	81	7	47
D=250 (Gate Valve)	11200	1	11	1	11	2	22	14	157
D=350 (Butterfly Valve)	74400	9	670	1	74	10	744	0	0
D=400 (Butterfly Valve)	95200	5	476	0	0	5	476	0	0
D=450 (Butterfly Valve)	125000	7	882	0	0	7	882	0	0
D=500 (Butterfly Valve)	174000	1	174	0	0	1	174	0	0
D=700 (Butterfly Valve)	313200	2	626	0	0	2	626	0	0
3)Internal Network									
Commercial 100pop/ha	23100	0	0	0	0	0	0	75	1733
Commercial 150pop/ha	25700	0	0	46	1181	46	1181		0
Residential 100pop/ha	18700	140	2618	0	0	140	2618	672	12566
Residential 150pop/ha	21000	0	0	403	8463	403	8463		0
4)Service Conections									
D=1/2	810	3940	3192	14370	11640	18310	14832	17540	14207
D=3/4	1280	20	26	30	40	50	66	30	38
5)Rehabilitation									
Water Meter 1/2''	400	2878	1151	0	0	2878	1151		
Old Laterals			857		0		857		
Service Connect.wo/Metr	480	1440	690	0	0	1440	690		
Service Connect.w/Meter	880	625	550	0	0	625	550		
6)Flow Meter D=400	215000	1	215	0	0	1	215	1	215
7)Fire Protection									
D=150	16800	0	0	0	0	0	0	95	1596
D=100	9400	0	0	0	0	0	0	430	4042
SUB-TOTAL			34114		26553		60667		61906
4 1)Administration Bldg.								1	1820
2)Operation Center		1	1590			1	1590	1	1090
SUB-TOTAL		1	1590	0	0	1	1590	2	2910
5 Land Acquisition	120	2000	348	2000	240	4000	588	9300	1116
Vehicle	300000	2	600	4	1200	6	1800	4	1200
Stored Material & Equip.			438		519		957		964
SUB-TOTAL			1386		1959		3345		3280
6 Replacement of Equipment			0		0		0		26093
T O T A L			41344		40079		81423		117088
7 Leak Detection	240	4128	990	0	0	4128	990		0
GRAND TOTAL			42334		40079		82413		117088

(Unit: thousand Pesos)

Angeles		1988		1989		1990		1991	
ITEM	UNIT COST	NO	COST	NO	COST	NO	COST	NO	COST
1 SOURCE FACILITY									
(1)DEEP WELL CONSTRUCTION	940000		0	1	940		0	2	1880
(2)DEEP WELL PUMP w/HOUSE	640000		0	2	1280		0	2	1280
Well Pump	320000		0		0	5	1600	0	0
Flow Meter D=150	62000		0	2	124	5	310	2	124
SUB-TOTAL			0		2344		1910		3284
2 TRANSMISSION FACILITIES									
Main Pipes					0		0		0
D=200 (Steel Pipe)	520		0		0		0		0
D=350 (Steel Pipe)	900		0		0		0	500	450
D=400 (Steel Pipe)	970		0		0		0	500	485
D=500 (Steel Pipe)	1330		0		0		0		0
SUB-TOTAL			0		0		0		935
3 DISTRIBUTION FACILITIES									
(1)Reservoir				4292	4202				
(2)Pump Facility (Eqip.)					651		650		753
-do- (Civil)					2228				
(3)Chlrntn Facility 22kg/d	98100			2	196	5	491	1	98
(4)Elevated Tank	1339000				0	0	0	0	0
(5)Electric Sub-station				1	2757				
(6)Distribution pipes		1988		1989		1990		1991	
1)Main Pipes									
D=150 (PVC Pipe)	410		0	240	98	1200	492	300	123
D=200 (Steel Pipe)	520		0	1490	775	880	458	1080	562
D=250 (Steel Pipe)	630		0	380	239	0	0	310	195
D=350 (Steel Pipe)	900		0	1500	1350	1300	1170	410	369
D=400 (Steel Pipe)	970		0	910	883	730	708	0	0
D=450 (Steel Pipe)	1160		0	1580	1833	660	766	0	0
D=500 (Steel Pipe)	1330		0	460	612		0	0	0
D=700 (Steel Pipe)	1910		0	700	1337		0		0
2)Valves									
D=150 (Gate Valve)	5300		0	1	5	4	21	1	5
D=200 (Gate Valve)	6700		0	5	34	3	20	4	27
D=250 (Gate Valve)	11200		0	1	11	0	0	1	11
D=350 (Butterfly Valve)	74400		0	5	372	4	298	1	74
D=400 (Butterfly Valve)	95200		0	3	286	2	190	0	0
D=450 (Butterfly Valve)	125900		0	5	630	2	252	0	0
D=500 (Butterfly Valve)	174000		0	1	174		0	0	0
D=700 (Butterfly Valve)	313200		0	2	626		0	0	0
3)Internal Network									
Commercial 100pop/ha	23100		0		0		0		0
Commercial 150pop/ha	25700		0		0		0	10	257
Residential 100pop/ha	18700		0	70	1309	70	1309		0
Residential 150pop/ha	21000		0		0		0	81	1701
4)Service Conections									
D=1/2	810		0	1970	1596	1970	1596	2874	2328
D=3/4	1280		0	10	13	10	13	6	8
5)Rehabilitation									
Water Meter 1/2''	400	2878	1151	0	0	0	0		
Old Laterals					429		428		
Service Connect.wo/Metr	480	480	230	480	230	480	230		
Service Connect.w/Meter	880	209	184	208	183	208	183		
6)Flow Meter D=400	215000	0	0	1	215	0	0	0	0
7)Fire Protection									
D=150	16800								
D=100	9400								
SUB-TOTAL			1565		23274		9275		6511
4 1)Administration Bldg.									
2)Operation Center				1	1590				
SUB-TOTAL			0	1	1590		0		0
5 Land Acquisition	120	2900	348		0		0	2000	240
Vehicle	300000	2	600		0		0	1	300
Stored Material & Equip.			30		246		162		136
SUB-TOTAL			978		246		162		676
6 Replacement of Equipment									
T O T A L			2543		27454		11347		11406
7 Leak Detection	240	1376	330	1376	330	1376	330		0
GRAND TOTAL			2873		27784		11677		11406

(Unit: thousand Pesos)

Angeles		1992		1993		1994		1995	
ITEM	UNIT COST	NO	COST	NO	COST	NO	COST	NO	COST
1 SOURCE FACILITY									
(1)DEEP WELL CONSTRUCTION	940000	1	940	1	940	1	940	1	940
(2)DEEP WELL PUMP w/HOUSE	640000	1	640	1	640	1	640	1	640
Well Pump	320000	0	0	0	0	0	0	0	0
Flow Meter D=150	62000	1	62	1	62	1	62	1	62
SUB-TOTAL			1642	3	1642	3	1642	3	1642
2 TRANSMISSION FACILITIES									
Main Pipes			0		0		0		0
D=200 (Steel Pipe)	520	500	260	500	260	500	260		0
D=350 (Steel Pipe)	900		0		0		0		0
D=400 (Steel Pipe)	970		0		0		0		0
D=500 (Steel Pipe)	1330		0		0		0		0
SUB-TOTAL			260		260		260		0
3 DISTRIBUTION FACILITIES									
(1)Reservoir									
(2)Pump Facility (Eqip.)			753		753		753		753
-do- (Civil)									
(3)Chlrntn Facility 22kg/d	98100		0		0	0	0		0
(4)Elevated Tank	1330000	0	0	0	0	0	0		0
(5)Electric Sub-station									
(6)Distribution pipes		1992		1993		1994		1995	
1)Main Pipes									
D=150 (PVC Pipe)	410		0		0		0		0
D=200 (Steel Pipe)	520		0		0		0		0
D=250 (Steel Pipe)	630		0		0		0		0
D=350 (Steel Pipe)	900		0		0		0		0
D=400 (Steel Pipe)	970		0		0		0		0
D=450 (Steel Pipe)	1160		0		0		0		0
D=500 (Steel Pipe)	1330		0		0		0		0
D=700 (Steel Pipe)	1910		0		0		0		0
2)Valves									
D=150 (Gate Valve)	5300		0		0		0		0
D=200 (Gate Valve)	6700		0		0		0		0
D=250 (Gate Valve)	11200		0		0		0		0
D=350 (Butterfly Valve)	74400		0		0		0		0
D=400 (Butterfly Valve)	95200		0		0		0		0
D=450 (Butterfly Valve)	125000		0		0		0		0
D=500 (Butterfly Valve)	174000		0		0		0		0
D=700 (Butterfly Valve)	313200		0		0		0		0
3)Internal Network									
Commercial 100pop/ha	23100		0		0		0		0
Commercial 150pop/ha	25700	9	231	9	231	9	231	9	231
Residential 100pop/ha	18700		0		0		0		0
Residential 150pop/ha	21000	81	1701	81	1701	80	1680	80	1680
4)Service Conections									
D=1/2	810	2874	2328	2874	2328	2874	2328	2874	2328
D=3/4	1280	6	8	6	8	6	8	6	8
5)Rehabilitation									
Water Meter 1/2''	400								
Old Laterals									
Service Connect.wo/Metr	480								
Service Connect.w/Meter	880								
6)Flow Meter D=400	215000	0	0	0	0	0	0	0	0
7)Fire Protection									
D=150	16800								
D=100	9400								
SUB-TOTAL			5021		5021		5000		5000
4 1)Administration Bldg.									
2)Operation Center									
SUB-TOTAL			0		0		0		0
5 Land Acquisition	120		0		0		0		0
Vehicle	300000	1	300	1	300	1	300		0
Stored Material & Equip.			97		97		96		93
SUB-TOTAL			397		397		396		93
6 Replacement of Equipment									
T O T A L			7320		7320		7298		6735
7 Leak Detection	240								
GRAND TOTAL			7320		7320		7298		6735