REFERENCES

Abramson, M. "Rate Design in the 70 s." Journal of American Water Works Association. Vol. 64 No.8, August 1972.

Affi, H.H. and Bassie V.L. Water Pricing Theory and Practice in Illinois. University of Illinois, Bureau of Economic and Business Research.

Afifi, H.H.H. "Economic Evaluation of Water Supply Pricing in Illinois," Journal AWWA. Vol. 61 No.1, January 1969.

Arthur, F.V. "Optimal Plant Size with Arbitary Increasing Time Path of Demand," Investment of Capacity Expansion. Cambridge: M.I.T. Press, 1965.

Athikomrungsarit, C. "Benefits and Costs of Providing Potable Water to Small Communities in Thailand." Master's Thesis. Asian Institution of Technology, 1971.

AWWA Committee. Water Rates Manual. New York: American Water Works Association, 1972.

Banker, R.F. and Benson, R.B. "Utility Water Rate Structuring." Journal AWWA. Vol.63 No.4, April 1971.

Barish, N.N. Economic Analysis for Engineering and Managerial Decision Making. New York: McGraw-Hill Company, 1962.

Beenhakker, H.L. Replacement and Expansion Investments. Rotterdam University Press. 1975.

Camp, Dresser and McKee Water Supply and Distribution Metropolitan Bangkok Thailand, Summary Report, Master Plan Vol.1 - 5, Bangkok, 1970

Chantaluckana, C. Statistics. Thai Wattana Panich Co. Ltd., 1977

Chenery, H.B. "Over capacity and the Acceleration Principle." Econometrica. Vol.64, 1952.

Chilton, C.H. Cost Engineering in the Process Industries. New York: McGraw-Hill Company, 1960.

Clark, R.M. "Cost and Pricing Relationships in Water Supply." Journal of the Environmental Engineering Division, ASCE. Vol.102 No.EE2, 1976.

Csallany, S.C. "Relationship between Water Use and Population in the Embarras River Basin, Illinois." Journal AWWA. Vol.57 No.3, 1965.

Degarmo, E.P. Engineering Economy. New York: MacMillan, 1967.

Eagner, E.G. and Lanoix, J.N. Water Supply for Rural Areas and Small Communities. Geneva: W.H.O., 1958.

Ferry. D.J. Cost Planning of Buildings. London: Crosby Lockwood, 1972.

Flack, J.E. and Hanke, S.H. "Effects of Metering Urban Water" Journal AWWA Vol.60 No.12, 1968.

Flack, J.E. and Martinez, F.F. "Urban Water Use Study" ASCE Water Resources Engineering Conference Denver Colorado, Mar.16 - 20, 1966.

Fredric, E.J. "Population Forecasting by Sanitary Engineers" Journal of Sanitary Engineering Division, ASCE Vol.90 No.SA1

Geyer, J.C., Linaweaver Jr., F.P. and Wolff, J.B. A Study of Residential Water Use by Department of Environmental Engineering Science, The John Hopkins University, Baltimore

Gilbert, W.G. "Relation of Operation and Maintenance to Treatment Plant Efficiency" Journal of Water Pollution Control Federation Vol.48 No.7

Goolsby, W. "Optimal Pricing and Investment in Community Water Supply" Journal AWWA Vol.67 No.5

Gysi, M. "The Long Run Effects of Water Pricing Policies." Technical Report No.25.

Hanke, S.H. "Demand for Water under Dynamic Conditions." Water Resources Research Vol.6 No.5.

"Water Rates : An Assessment of Current Issues." Journal AWWA Vol.67 No.5

Hamdy, H.H.A. "Economic Evaluation of Water Pricing Policy in Illinois." Journal AWWA Vol.61 No.1

Hanson, J.L. A Textbook of Economics.

Heaney, J.P. and Gemmell, R.S. "Production Cost Factor in Rate - Making" Journal AWWA Vol.61 No.2

Herberich, W.J. "Formulation of Water Rates for Baltimore County Md." Journal AWWA Vol.67 No.5, 1975.

Hinomoto, H. "Unit and Total Cost Function for Water Treatment Based on Koenig's Data" Water Resources Research Vol.7 No.5, 1971.

Hirshleifer, J., de Haven, J.J. and Milliman, J.W. Water Supply Economics, Technology and Policy Chicago: The University of Chicago Press, 1969.

Howe, C.W. "Water Pricing in Residential Areas." Journal AWWA Vol.60 No.5, 1968.

Howe, C.W. and Linaweaver Jr., F.P. "The Impact of Price on Residential Water Demand and Its Relation to System Design and Price Structure." Water Resources Research Vol.3 No.1, 1967.

Howson, L.R. "Review of Ratemaking Theories" Journal AWWA Vol.58 No.7, 1966.

Illinois State Water Survey "Cost of Water Treatment in Illinois," Technical Literature No.11 Urbana: Illinois State Water Survey, 1968.

James, L.D. and Lee, R.R. Economics of Water Resources Planning. New York: McGraw-Hill Company, 1971.

Kally, E. "Determination of Water Supply Investment Priorities in Developing Countries," Journal AWWA. Vol.57 No.8, 1965.

Keller, C.W. . "Design of Water Rates," Journal AWWA. Vol.58 No.3, 1966 . "Analysis of Unaccounted for Water," Journal AWWA. Vol.68 No.3, 1976.

Koenig, L. "The Cost of Water Treatment by Coagulation, Sedimentation and Rapid Sand Filtration," Journal AWWA. Vol.59 No.3, 1967

Kruger. "The Water Supplies of Some Provinces" Master Plan and Feasibility Reports Unpublished Reports Submitted to PWD by J.Kruger A/S Consulting Engineer. Copenhagen, Denmark,1969

Kuiper, E. Water Resources Project Economics. Butter - Worth & Co. Ltd.,1971

Lauria, D.T. "The Location, Timing and Scale of Water Supply Investments in Developing Countries" Doctoral Dissertation. University of North Carolina, 1970

Leeds, Hill and Jewett, Inc. Unit Costs for Treatment of Water and Waste Water, Report for Santa Ana Watershed Planning Agency San Francisco ,1970

Liddle, R.T. and Hodgson, G.W. "Transport of Chemicals by Pipeline : An Exploratory Study" The Engineering Journal. Vol.50 No.11,1967

Linaweaver Jr., F.P. and Clark, C.S. "Costs of Water Transmission" Journal AWWA. Vol.56 No.12,1964

Linaweaver Jr., F.P. and Geyer, J.C. "Use of Peak Demands in Determination of Residential Rates." Journal AWWA. Vol.56 No.4,1964

LLoyd, D.F. "Cost Comparison of Unmetered and Metered Systems at Idaho Falls." Journal AWWA. Vol.52. No.4.

Luthin, J.C. "Special Consideration in Design of Water Rates," Journal AWWA. Vol.55 No.3, 1963

Mann, P.C. "A New Focus in Water Supply Economics Urban Water Pricing." Journal AWWA. Vol.62 No.9, 1970

Manne, A.S. Investments for Capacity Expansion : Size, Location and Time Phasing

Marglin, S.A. 1967. Public Investment Criteria : Benefit - Cost Analysis for Planned Economic Growth. Cambridge: M.I.T. Press, 1967

McCracken, D.D. A Guide To Fortran IV Programming. John Wiley & Sons Inc, 1965

Milliman, J.W. "New Price Policies for Municipal Water Service," Journal AWWA. Vol.56 No.2, 1964

Murrill, W.P. and Smith, C.L. . Fortran IV Programming for Engineers and Scientists International Textbook Company, 1968

Neufville, R. and Stafford, J.H. 19 . System Analysis for Engineers and Managers. Plymouth. McGraw-Hill Company, 1974.

Orlob, G.T. and Lindorf, M.R. 1958. "Cost of Water Treatment in California" Journal AWWA. Vol.50 No.1. 1958

Overseas Technical Cooperation Agency. 1974 Kingdom of Thailand Chieng Mai Water Supply Expansion Project. Unpublished Feasibility Reports by Tokyo Engineering Consultant Co. Ltd., Japan, 1973

Paine, N. and White, J.K. "Water Transport Cost," Journal of the Institution of Water Engineers. Vol.23 No.7, 1969

Patterson, W.L. "Demand Rate for Water Services" Journal AWWA. Vol.53 No.11, 1961

"Practical Water Rate Determination" Journal AWWA. Vol.54 No.8, 1962

Pulver, H.E. Construction Estimates and Costs. McGraw - Hill Book Company, 1969

Rutherford, J.L. "Water Usage Studies in Northeastern Thailand", Unpublished Paper No.1 Submitted to SED, Department of Health, Bangkok, 1968

Saunders, R.J. and Warford, J.J. Village Water Supply Economics and Policy in the Developing World. The John Hopkins University Press, 1976

Scarato, R.F. "Time Capacity Expansion of Urban Water System," Water Resources Research Vol.15 No.5, 1969

Seidel, H.F. and Baumann, E.R. "A Statistical Analysis of Water Works Data for 1955" Journal AWWA. Vol.42 No.12, 1957

Shouvanavirakul, P. "Demand for Potable Water in Small Communities of Thailand" Master's Thesis. Asian Institution of Technology, 1970

Srinivisan, T.N. "Geometric Rate of Growth Demand", Investment of Capacity Expansion Cambridge M.I.T. Press, 1967.

Tantarznon, A, Water Demand for People in Nakhon Chieng Mai Municipality. Master's Thesis. Department of Sanitary Engineering, Graduate School, Chulalongkorn University, 1969.

Thuesen, H.G. Engineering Economy New Jersey: Prentice Hall, 1959.

Tyteca, D. "Cost Functions for Wastewater Conveyance Systems" Journal WPCF. Vol. 48 No.9, 1976.

Turvey, R. Public Enterprise, Penguin Book, 1968.

U.S. Agency for International Development. Report on Water Demand Study, Community Water Supply Branch, International Program in Sanitary Engineering Design, University of North Carolina, 1969.

U.S. Public Health Service. 1970. Guidelines and Criteria for Community Water Supplies in Developing Countries. (PASA TCR 3-67), Rockville, Md.: Agency for International Development and U.S. Public Health Service, 1970

Water Resources Planning Subcommittee. Providing of Potable Water for Pattaya-Bang Lamung, Feasibility Reoort Submitted to Prime Minister by WRPS, NESDB, Bangkok, 1975.

Wolff, J.B. Peak Demands in Residential Areas", Journal AWWA. Vol.53 No.10, 1961

Yamane, T. Statistics : An Introductory Analysis. A Harper International Edition, 1970.

Yeomans, K.A. Applied Statistics. Penguin Books Ltd, 1970.

APPENDIX A

GENERAL AND WATER QUANTITY

Table 1 General information of water works studied

WW. No.	Name	Boundary of Service			Area (Sq.km)	Sources of Raw Water	Existing Capacity (m^3/d)	Year Started	Region Situated
		A	B	Chang Wat					
1	Khlong Yai	1	S.A.	Trat	0.42	Reservoir	400	1972	East
2	Hod	1	S.A.*1	Chieng Mai	6.00	Chaem River	400	1970	North
3	Pak Tho	1	S.A.	Ratchaburi	1.12	Mae Klong River	400	1969	Central
4	Borabu	1	S.A.	Maha Sara-Kham	25.00	Huay Chieng Kham Reservoir	400	1967	North-East
5	Yaha	1	S.A.	Yala	1.87	Ta Chee Canal	400	1966	South
6	Tha Uthen	1	S.A.	Nakhon Phanom	2.48	Khong River	800	1975	North-East
7	Utumphon Pisai	1	S.A.*2	Si Sa Ket	1.20	Huay Tub Tun Str.	800	1975	North-East
8	Thoen	1	S.A.*3	Lam Pang	11.21	Wang River	800	1975	North
9	Wiset Chai Chan	1	S.A.*4	Ang Thong	1.50	Khun Canal	800	1975	Central
10	Nam Yun	1	S.A.	Ubon Ratcha-thani	16.00	Lam Huay Bon Str.	800	1974	North-East
11	Cha-uat	1	S.A.	Nakhon Si Tham-marat	0.50	Cha-uat Canal	800	1973	South

Table 1 (Continued)

WW. No.	Name	Boundary of Service			Area (Sq.km)	Sources of Raw Water	Existing Capacity (m^3/d)	Year Started	Region Situated
		A	B	Chang Wat					
12	Sikhoraphum	1	S.A.*5	Surin	4.00	Nam Pok Reservoir	800	1972	North East
13	Mae Hong Son	1	M	Mae Hong Son	4.00	Mae Hong Son River	800	1970	North
14	Ruso	1	S.A.	Narathiwat	4.16	Sai buri River	800	1970	South
15	Swang Daen Din	1	S.A.	Sakon Nakhon	4.15	Huay Yang Reservoir	800	1969	North East
16	Kabin Buri	1	M	Prachin Buri	4.48	Prachin Buri River	800	1968	East
17	Doembang Nangbuat	1	S.A.*6	Suphan Buri	10.80	Suphan Buri River	1600	1974	Central
18	Nang Rong	1	S.A.	Buri Ram	1.20	Lamplaimat Str.	1600	1974	North East
19	Song	1	S.A.	Phrae	4.00	Yom River	1600	1972	North
20	Det Udom	1	S.A.*7	Ubon Ratchathani	1.57	Lam Don Yai Str.	1600	1971	North East
21	Chum Phae	1	S.A.	Khon Kaen	15.60	Chern Stream	1600	1971	North East

Table 1 (Continued)

WW No.	Name	Boundary of Service			Area (Sq.km)	Sources of Raw Water	Existing Capacity (m^3/d)	Year Started	Region Situated
		A	B	Chang Wat					
22	Chai Nat	1	M	Chai Nat	6.66	Chao Praya River	1600	1958	Central
23	Bang Mun Nak	1	M	Phichit	2.05	Nan River	1600	1958	North
24	Suphan Buri	1	M	Suphan Buri	9.01	Suphan Buri River	1600	1956	Central
		1	S.A.*8		4.00				
25	Tha Tako	1	S.A.	Nakhon Sawan	2.66	Tha Tako Canal and Phibun Songkran Reservoir	2000	1975	North
26	Watthana Nakhon	1	S.A.	Prachin Buri	4.00	Pra Prong Stream	2000	1975	East
27	Lang Suan	1	M	Chumphon	7.50	Lang Suan River	2000	1967	South
		1	S.A.*9		1.21				
28	Trat	1	M	Trat	2.50	Tha Pra Canal	2000	1962	East
29	Ranong	1	M	Ranong	2.08	Had Sompaen Canal	2000	1961	South
30	Chanthaburi	1	M	Chanthaburi	2.50	Chanthaburi River	2400	1962	East
		1	S.A.*10		2.50				
31	Chumphon	1	M	Chumphon	3.00	Tha Ta Pao Canal	2400	1960	South

Table 1 (Continued)

WW No.	Name	Boundary of Service			Area (Sq.km)	Sources of Raw Water	Existing Capacity (m^3/d)	Year Started	Region Situated
		A	B	Chang Wat					
32	Buri Ram	1	M	Buri Ram	6.00	Huay Chorakae Mak Str. and Irrigation Reservoir	2400	1959	North East
33	Nakohn Nayok	1	M	Nakhon Nayok	3.37	Nakhon Nayok River	2400	1958	Central
34	Si Sa Ket	1	M	Si Sa Ket	3.26	Huay Samran Str. and Huay Kla Reservoir	2400	1958	North East
35	Tak	1	M	Tak	5.26	Ping River	2400	1957	North
36	Chieng Rai	1	M	Chieng Rai	2.26	Kok River	2400	1955	North
37	Pran Buri	2	S.A.*11 S.A.*12	Prachuap Khiri Khan	12.00 1.90	Ban Buen Canal and River Pran Buri	3200	1973	South
38	Surin	1	M	Surin	11.39	Saneng Canal	3200	1958	North
39	Taphan Hin	1	M	Phichit	1.35	Nan River	3200	1958	North

Table 1 (Continued)

WW No.	Name	Boundary of Service			Area (Sq.km)	Sources of Raw Water	Existing Capacity (m^3/d)	Year Started	Region Situated
		A	B	Chang Wat					
40	Pak Phanang	1	M	Nakhon Si Thammarat	2.68	Sukhum Canal	3200	1956	South
41	Cha Choeng Sao	1	M	Chachoengsao	5.52	Chaiyanuchit Canal	4000	1962	East
42	Phatthalung	1	M	Phatthalung	3.06	Lunna Tom Dyke and Tammarn Canal	4000	1956	South
43	Ban Pong	1	M	Ratchaburi	2.91	Mae Klong River	4800	1956	Central
44	Kanchanaburi	1	M	Kanchanaburi	2.08	Kwae Yai River	6400	1956	Central
45	Lampang	1	M	Lampang	9.00	Wang Irrigation Canal	8200	1956	North
46	Phunphin	1	S.A.*13	Surat Thani	3.24	Poom Duang Canal and Ta pee River	9000	1965	South
47	Chieng Mai	1 1	M S.A.*14	Chieng Mai	17.50 17.11	Ping River	12400	1956	North

Table 1 (Continued)

WW No.	Name	Boundary of Service			Area (Sq.km)	Sources of Raw Water	Existing Capacity (m^3/d)	Year Started	Region Situated
		A	B	Chang Wat					
48	Ubon Ratcha-thani	1	M	Ubon Ratcha-thani	6.0	Moon Noi River	14400	1958	North East
49	Khon Kaen	1	M	Khon Kaen	46.0	Huay Kut Kwang Str. and Nam Phong Irriga-tion Canal	18000	1955	North East
50	Udon Thani	1	M	Udon Thani	8.3	Nong Prachak, Nong Samrong, Nong Dae	18200	1955	North East

Note 1. Esterisk * is marked when name of water works is not similar to the names of Sanitary Areas served. The names of Sanitary Areas which is marked above are as following:

1. Tha Kham
2. Kampang
3. Lom rad
4. Sarn Choa Rong Thong
5. Ragang
6. Koa Pra
7. Meung Det
8. Po Praya
9. Pak Nam Lang Suan
10. Chan Thanimit
11. Pran Buri
12. Pak Nam Pran Buri
13. Tha Kham
14. Chang Puek

The extension of distribution pipelines to Chan Thanimit and Chang Puek was initially made in Year 1975.

2. A is stand for 'Number of Service Areas'

B is stand for 'Type of Communities'

M is stand for 'Municipality'

S.A.is stand for 'Sanitary Area'

Table 2 Population in observed areas, person

Yr. / WW No.	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975
1	3942	4007	3956	4320	3930	4008	4180	4360	4430	4122
2	2232	2275	3279	3221	3536	3570	3664	4397	3114	4520
3	3529	3591	3640	3661	3661	3812	3998	4381	4885	4980
4	3014	3875	4006	4180	4133	4200	4265	4513	5328	5359
5	1783	1828	1893	2045	2105	2247	2250	2398	2527	2557
10			Part of Amphoe Det Udom						6541	6818
11	4884	4927	5104	5282	5418	5547	5592	6239	6542	7090
12	3579	3713	3821	3940	3855	3855	3876	4535	4620	4737
13	3963	4027	4138	4209	4319	4392	4469	4524	4689	4720
14	5295	5400	5405	5453	5487	5487	5640	5613	6584	6420
15	6352	6814	6995	7810	8003	7743	9152	9480	8613	8620
16	4375	4811	4620	4681	4712	4789	4804	4913	5038	5017
17	4869	4869	5942	6002	5054	6490	6627	9285	9705	9760
18	4220	4938	5135	5299	6310	5995	6430	6312	7106	7143

Table 2 (Continued)

WW No. \ Yr.	1966	1967	1968	1970	1971	1972	1973	1974	1975	1976
19	10038	10182	10334	10719	11131	11597	11749	11959	12631	12200
20	9429	9797	10264	10558	10983	9109	11800	9847	10085	16917
21	6362	6693	9349	12720	12105	23424	24158	28156	26671	29035
22	5700	5979	6169	11574	11933	12400	12467	12515	12837	14500
23	10806	11195	11112	11268	11278	11327	10624	11277	11151	11209
24	16316	18434	18734	19148	19515	19744	20128	20505	20882	21600
27	4151	4213	4226	4243	4249	4240	4258	4390	4462	8900
28	6356	6803	7111	7296	7566	7873	8353	8854	9912	10020
29	8036	8605	8937	9277	9551	9977	10574	10800	11621	11500
30	15309	16362	16362	18313	19148	20024	20798	21777	22852	24300
31	13180	13480	13558	13899	14001	13260	13449	13579	14065	15100
32	16148	16718	17061	17562	18176	18760	19728	20584	21942	22562
33	8317	8418	8628	8832	9072	9373	9357	9445	9874	9296
34	10938	11146	11529	11736	12189	12400	15748	16211	16467	16909

Table 2 (Continued)

WW No. \ Yr.	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975
35	15734	16247	16839	17514	18099	17139	17684	20000	18685	21300
36	13809	13809	14705	14735	15104	15500	15720	15857	17029	17200
37	10962	12690	11861	14757	14757	14955	17471	16703	18081	19500
38	17029	17316	17626	18121	18412	23733	27995	28709	29642	30292
39	14510	14759	15430	15674	15923	15949	16039	16038	15977	15823
40	14198	14358	14564	14656	14871	15284	15341	15530	15161	16000
41	21577	22517	22935	23227	23470	23769	27072	27367	32416	32900
42	11747	11958	12322	12649	14304	14732	16228	16447	16914	17200
43	19363	20408	20643	20934	21458	21822	22036	22216	23535	24100
44	15101	15877	16226	16478	16963	17508	17994	18385	23426	23900
45	40270	40515	40533	41084	40943	41748	42146	42589	43097	43900
46	6937	7121	9338	9666	10200	12124	12126	12600	14884	14900
47	79694	81579	84105	86638	89272	91264	93351	96196	98319	104000
48	32652	34619	35224	37005	38744	40710	50755	52690	52713	52281
49	26050	28437	29267	30247	31403	32269	60508	64124	67616	71200
50	43440	46686	49217	52300	54808	58707	70110	70552	72281	74658

Table 3 Number of dwellings in observed areas, house

Yr. / WW No.	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975
1	369	374	374	378	391	404	410	420	446	516
2	469	652	752	631	659	693	697	774	769	840
3	686	690	690	690	690	694	789	813	813	860
4	615	615	780	786	791	850	910	831	845	854
5	321	321	323	342	342	345	350	454	455	458
10			Part of Amphoe Det Udom						1236	1207
11	615	615	745	747	751	754	760	819	821	825
12	256	543	551	551	560	560	574	574	596	600
13	807	811	833	861	866	1038	1190	1210	1249	1270
14	914	928	935	935	935	935	935	935	1202	1210
15	1035	1035	1046	1054	1109	1859	1027	1028	1130	1049
16	1238	1241	1257	1258	1297	1315	1330	1370	1401	1410
17	470	476	479	494	509	1901	1910	1910	1510	1720
18	563	586	594	598	625	651	669	690	716	724
19	1944	1955	1960	1961	1976	2012	2031	2046	2052	2070

Table 3 (Continued)

WW No. \ Yr.	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975
20	1001	1054	1088	1128	1326	1457	1550	1469	1304	1324
21	3213	3213	2272	2704	2760	2775	2794	3014	3088	3164
22	1058	1087	1150	1865	1908	1992	1353	2270	1430	1550
23	1825	1851	2069	1920	1945	1947	1951	1990	1965	1969
24	3095	3479	3522	3622	3353	3441	3531	3600	3706	3780
27	767	768	785	785	799	800	803	810	964	2960
28	1345	1357	1378	1409	1530	1729	1816	1860	2139	2220
29	1096	1167	1210	1245	1286	1327	1385	1410	1495	1520
30	3123	3273	3273	3408	3557	3815	3971	4070	4200	4350
31	2346	2372	2416	2416	2571	2674	2703	2900	2804	3000
32	2495	2547	2639	2729	2800	2947	3020	3090	3926	3931
33	1572	1615	1657	1678	1708	1752	1521	1790	1579	1640
34	1962	1986	2030	2066	2617	2640	2660	2680	2966	2967
35	2731	2950	3059	3113	3148	3379	3406	3540	3465	3600
36	2679	2735	2794	2831	2892	2960	2998	3080	3107	3170

Table 3 (Continued)

WW No. \ Yr.	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975
37	1983	1650	1837	2082	2102	2117	2117	3219	3219	2508
38	3554	3622	3749	3244	3982	4976	5070	5160	6094	6276
39	2187	2189	2227	2246	2259	2283	2294	2300	2320	2325
40	2813	2830	2845	2858	2105	2896	2900	2910	3032	3040
41	3633	3768	3841	4144	4255	4401	4596	4600	5355	5460
42	1888	1911	1966	2018	3037	3113	3205	3350	3168	3310
43	2751	2791	2856	3017	3025	3062	3140	3210	3471	3544
44	3425	3502	3882	3988	3291	3351	3481	3620	4625	4760
45	6765	6820	6878	7001	7188	7371	7456	7570	7701	7800
46	1050	1078	1550	1611	1800	1323	1373	1560	1493	1680
47	11177	11388	11467	11790	12000	12255	12500	12800	12611	21200
48	5371	5485	5710	6894	6559	6845	7405	7440	7858	7858
49	4371	4844	5169	5372	5511	5485	10285	10500	12060	13567
50	7866	8741	9534	10000	10240	10770	10950	11400	15423	15509

Table 4 Number of connections in observed areas

WW No. \ Yr.	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975
1	-	-	-	-	-	-	49	154	196	228
2	-	-	-	-	54	77	109	128	157	192
3	-	-	-	201	268	312	369	426	511	576
4	-	97	126	157	179	224	250	270	277	287
5	-	10	42	62	78	100	118	131	143	155
10	-	-	-	-	-	-	-	-	31	92
11	-	-	-	-	-	-	-	133	197	292
12	-	-	-	-	-	189	230	268	300	338
13	-	-	-	-	34	78	131	155	226	296
14	-	-	-	-	11	34	53	60	68	82
15	-	-	-	153	207	256	304	345	395	449
16	-	-	275	348	391	475	525	578	619	645
17	-	-	-	-	-	-	-	-	305	478
18	-	-	-	-	-	-	-	-	259	376
19	-	-	-	-	-	-	48	107	174	350

Table 4 (Continued)

WW No. \ Yr.	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975
20	-	-	-	-	-	53	120	165	204	260
21	-	-	-	-	-	225	393	488	586	708
22	579	642	713	768	843	965	1030	1085	1148	1229
23	592	641	702	759	782	832	862	927	974	1023
24	1107	1274	1456	1618	1769	1918	2108	2228	2337	2533
27	-	102	152	174	207	240	266	305	327	360
28	469	536	610	721	869	1043	1200	1379	1619	1750
29	487	570	712	842	909	983	1030	1123	1231	1355
30	1141	1307	1469	1644	1793	1981	2111	2262	2386	2495
31	667	732	823	971	1138	1392	1613	1778	1888	2000
32	683	772	886	1037	1182	1385	1533	1658	1945	2194
33	442	496	571	672	763	809	906	992	1063	1133
34	542	633	691	819	885	1048	1177	1308	1432	1552
35	884	1032	1201	1341	1478	1605	1923	2050	2155	2236
36	617	722	885	1102	1281	1434	1582	1750	1893	2085

Table 4 (Continued)

WW No. \ Yr.	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975
37	-	-	-	-	-	-	-	274	462	703
38	1152	1294	1469	1549	1765	1985	2253	2437	2652	2818
39	877	934	1029	1102	1135	1224	1309	1376	1449	1541
40	525	572	622	654	691	738	793	856	943	984
41	955	1060	1311	1666	1790	2047	2325	2467	2592	2743
42	601	664	755	794	904	1025	1197	1301	1427	1586
43	1061	1171	1349	1470	1619	1754	1926	2131	2264	2480
44	734	909	1053	1221	1419	1673	1931	2138	2284	2517
45	1607	1792	2021	2262	2641	2964	3342	3576	3858	4176
46	183	216	256	307	432	584	638	703	757	774
47	2248	2592	3010	3848	4409	5051	5628	6023	6501	6962
48	1832	2328	2765	2971	3325	3715	4332	4739	4837	5070
49	2118	2654	2944	3385	3736	4101	4544	5083	5549	5895
50	2785	3172	3205	3750	4292	4767	5127	5722	5915	6377

Table 5 Annual production in observed water works from 1966 to 1975, m^3/yr

WW No. \ Yr.	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975
1	-	-	-	-	-	-	5370	59530	89973	101340
2	-	-	-	-	6845	17920	25615	33355	37405	46270
3	-	-	-	-	45192	79550	88830	117590	133320	152140
4	-	-	40187	43265	54838	65612	78229	59200	47818	62750
5	-	2623	N.A.	N.A.	16981	N.A.	N.A.	23304	23054	26107
10	-	-	-	-	-	-	-	-	10217	23637
11	-	-	-	-	-	-	-	27408	44237	58161
12	-	-	-	-	-	28676	53910	82151	96202	97516
13	-	-	-	-	5910	17603	46213	72882	103043	125800
14	-	-	-	-	3861	11697	18220	17498	18285	21967
15	-	-	-	26822	45680	60386	73897	88022	95588	117971
16	-	-	105343	149340	182642	186270	202566	196947	197563	209476
17	-	-	-	-	-	-	-	-	46436	88280
18	-	-	-	-	-	-	-	-	80216	129357
19	-	-	-	-	-	-	8852	25890	33000	47880

Table 5 (Continued)

WW No. \ Yr.	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975
20	-	-	-	-	-	3245	24458	36030	38189	50036
21	-	-	-	-	-	59290	192750	221700	283794	324535
22	167344	194243	185415	223170	231970	315902	336622	381307	372152	394070
23	93849	113799	104936	126074	135135	143101	154716	154200	169335	304260
24	264475	335691	419118	397413	483120	488764	459720	693553	619426	691550
27	-	24250	37125	41486	51649	69776	78203	124030	150600	174100
28	149722	123581	143462	205892	285283	347180	382053	469104	524756	566097
29	181712	167760	353937	411027	412430	426900	456120	541618	523334	508674
30	333974	384669	486390	592455	654905	712445	896480	1039570	1105825	1175217
31	236113	243980	284138	349324	423899	446830	541500	591975	592472	654650
32	159212	223938	382175	369558	388720	513385	721274	877960	973102	986249
33	92818	119017	159237	200133	223672	232969	279159	321840	322955	365840
34	147435	167113	219575	271769	283788	363806	484772	613656	754975	768160
35	217853	345606	490780	600093	593379	649440	622746	656712	648910	738158
36	235997	304746	414877	632236	712668	852661	833906	939661	1149324	1354043

Table 5 (Continued)

WW No. \ Yr.	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975
37	-	-	-	-	-	-	-	76972	164727	382720
38	357221	425315	492475	524122	675577	960880	1089900	982042	864682	1051769
39	175878	223668	234755	259451	252266	271580	295822	283065	296180	288166
40	126245	149997	239067	455927	264188	314659	355760	452820	466996	449060
41	215632	256750	526685	861608	797531	977008	975010	961096	1148520	1373550
42	140792	155264	209134	223113	289202	481948	485899	444850	442307	531855
43	199440	293232	600593	627336	762031	798966	816984	827516	845388	850140
44	232010	286644	880088	517819	549054	585742	750260	834531	963672	1098675
45	690613	747681	905579	1046929	1096658	1579163	1551436	1792216	1929907	2135183
46	793885	766080	946754	1295786	1042228	1426500	2098500	2430450	2250972	2140791
47	691560	794080	1017780	2111670	2695690	3237700	3614500	3895500	4894700	5620420
48	670796	778166	1288345	1546061	1584550	2426869	3016920	4246570	5211127	5317308
49	1033453	1240893	1676601	2327258	2854652	2920020	3381390	4032730	4082280	4429810
50	875927	923928	1178357	1468005	2098190	2448473	2444286	2694483	2579377	4209040

N.A. mean no data are available.

Table 6 Annual sale in observed water works from 1966 to 1975, m^3/yr

WW No. \ Yr.	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975
1	-	-	-	-	-	-	2259	43206	59707	70228
2	-	-	-	-	3803	13361	20536	27448	31242	37992
3	-	-	-	-	45192	73649	80830	105395	106237	136087
4	-	-	38622	41555	49552	60730	73612	56740	40144	56192
5	-	2358	9718	16512	13300	20461	21325	15215	19136	21718
10	-	-	-	-	-	-	-	-	2038	14363
11	-	-	-	-	-	-	-	17042	34509	43127
12	-	-	-	-	-	17691	48020	57167	76997	76997
13	-	-	-	-	1595	11923	32236	62334	89282	102139
14	-	-	-	-	399	8095	13706	11934	14176	13629
15	-	-	-	22885	36135	51311	64287	76519	84578	95710
16	-	-	91875	141392	132806	162444	153653	166448	174427	185576
17	-	-	-	-	-	-	-	-	30753	61410
18	-	-	-	-	-	-	-	-	49165	101325
19	-	-	-	-	-	-	2438	10463	16866	29412
20	-	-	-	-	-	2816	22338	27202	29272	42492

Table 6 (Continued)

Yr. / VW No.	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975
21	-	-	-	-	-	57386	181505	219173	241676	284579
22	136544	192743	189514	221570	228994	210551	246627	283523	304485	323398
23	79546	86681	94988	107904	113939	112132	131198	138582	146389	246374
24	255013	284246	358864	364853	416572	428217	446480	506284	515843	579606
27	-	21226	33477	39925	49490	62576	60058	70196	85661	101455
28	149722	126656	146279	205072	280256	346272	372070	446942	507339	552711
29	160211	166268	228664	337781	331454	346610	386184	411037	454682	414694
30	329743	381914	483664	584746	644909	686990	826380	953087	1004476	1050510
31	216308	235991	279834	348904	414101	437364	520123	573625	573301	633370
32	155156	219029	372411	330560	366177	446815	673089	819785	849213	731637
33	86744	118789	153791	191788	214694	232368	217180	308478	301250	342100
34	123631	134981	185076	210653	197989	270944	290363	342323	409634	447291
35	213379	348575	495113	538646	528579	638520	612922	640872	625856	684299
36	226801	282337	415290	446119	480626	505344	608319	741304	928331	1035859
37	-	-	-	-	-	-	-	40606	133225	350068

Table 6 (Continued)

Yr. / VU No.	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975
38	311935	294849	305990	413268	453615	599055	694638	797546	740019	804973
39	163647	199470	224174	244642	226906	251215	275558	259791	253908	264772
40	117191	145127	205093	221562	210805	266491	315069	387114	406197	382059
41	207265	220099	551445	686676	617302	746282	727803	736064	865720	1067217
42	124212	143528	189902	196554	196458	245186	302996	346542	360617	431281
43	196872	251134	384973	471380	649621	752744	561634	567059	572540	616891
44	176905	267195	365662	455842	541054	422399	495848	598815	669139	712429
45	674977	804603	884060	983900	1077026	1335037	1339433	1599599	1733669	1894166
46	61001	59227	27101	165759	151478	191214	200887	345784	285672	321904
47	669625	814162	963205	1922149	2220169	2671359	2994101	3348606	4062341	4190546
48	547780	697247	1054344	1186415	1327054	1703466	1962459	2153178	2088216	2090473
49	968076	1196931	1112165	1347429	1495547	1480232	1546492	2337982	2548391	3044671
50	873977	1020147	877285	1385985	1178379	1168502	1327447	1405833	1193790	1515045

Table 7 Amount of sales and losses in Year 1975

WW No.	Annual Sales (m^3/Yr)				Annual Losses (m^3/Yr)				
	Total	Household Sale	Fountain Sale	Without Charge	Back wash &Blow-off	Interior Usage	Pipe leakage	Unknown leakage	Total
1	70228	70228	-	-	5020	10257	-	15835	31112
2	37992	37992	-	-	1720	3100	545	2913	8278
3	139373	136087	2547	739	6163	1575	155	4874	12767
4	56192	56192	-	-	1128	1499	-	3931	6558
5	21858	21718	-	140	941	2148	275	885	4249
10	14403	14363	40	-	2290	5703	1730	991	10714
11	43336	43127	-	209	1300	2893	6245	4387	14825
12	76997	76997	-	-	7510	5500	-	7509	20519
13	102880	102139	741	-	6039	800	735	15346	22920
14	14371	13629	-	742	2420	1887	167	3122	7596
15	96772	95710	897	165	3525	2187	-	2024	7736
16	186219	185576	-	643	18707	3860	-	690	23257
17	61493	61410	83	-	2600	2024	18171	3992	26787
18	104509	101325	1388	1796	5850	14230	-	4768	24848

Table 7 (Continued)

WW No.	Annual Sales (m^3/Yr)				Annual Losses (m^3/Yr)				
	Total	Household Sale	Fountain Sale	Without Charge	Back Wash &Blow-off	Interior Usage	Pipe leakage	Unknown leakage	Total
19	29412	29412	-	-	4320	2150	1950	10048	18468
20	42492	42492	-	-	1650	2155	-	3739	7544
21	290125	284579	1246	4300	23710	6000	-	4700	34410
22	323703	323398	-	305	8390	9141	2240	50596	70367
23	249579	246374	3163	42	11700	5442	790	36749	54681
24	584066	579606	-	4460	32160	8500	7612	59212	107484
27	152189	101455	50734	-	7480	3430	2600	8401	21911
28	554602	552711	-	1891	8928	2012	-	555	11495
29	414694	414694	-	-	39510	10050	39856	4564	93980
30	1051384	1050510	-	874	34440	13460	1858	74075	123833
31	638677	633330	5034	313	9050	3646	3277	-	15973
32	756087	731637	17151	7299	2890	29500	-	197772	230162
33	345400	342100	-	3300	11546	4844	4050	-	20440
34	462147	447291	1596	13260	100647	41104	-	164262	306013

Table 7 (Continued)

WW No.	Annual Sales (m^3/Yr)				Annual Losses (m^3/Yr)				
	Total	Household Sale	Fountain Sale	Without Charge	Back Wash &Blow-off	Interior Usage	Pipe leakage	Unknown leakage	Total
35	684488	684299	-	189	15160	721	1485	36304	53670
36	1036004	1035859	-	145	43088	21070	40629	213252	318039
37	353035	350068	2528	439	6700	8281	200	14504	29685
38	814320	804973	1377	7970	44620	26000	-	166829	237449
39	264987	264772	-	215	7600	8850	550	6179	23179
40	382059	382059	-	-	20500	9600	2950	33951	67001
41	1067876	1067217	574	85	42750	22000	24300	216624	305674
42	431731	431281	-	450	31198	10200	8700	50026	100124
43	620011	616891	-	3120	13400	16795	15884	184050	230129
44	775030	712429	10601	52000	97200	29500	101181	95764	323645
45	1897123	1894166	2357	600	85240	11720	9588	131512	238060
46	325938	325757	31	150	42910	48250	-	5768	96928
47	4191418	4190546	872	-	125400	23279	-	920323	1069002
48	2090473	2090473	-	-	37320	48000	8400	2065415	2159135
49	3058574	3044671	13903	-	116200	330200	-	924896	1371296
50	1531797	1515045	16192	560	230422	12800	219323	2214698	2677243

Table 8 Amount of Sales and Losses expressed in percentage of total sale in Year 1975

WW No.	Annual Sales			Annual Losses				
	Household Sale	Fountain Sale	Without Charge	Black Wash & Blow off	Interior Usage	Pipe leakage	Unknown leakage	Total
1	100	-	-	7.1	14.6	-	22.5	44.3
2	100	-	-	4.5	8.2	1.4	7.7	21.8
3	97.6	1.8	0.5	4.4	1.1	0.1	3.5	9.2
4	100	-	-	2.0	2.7	-	7.0	11.7
5	99.2	-	-	4.3	9.8	1.3	4.0	19.4
10	99.7	0.3	-	15.9	39.6	12.0	6.9	74.4
11	99.6	-	0.5	3.0	6.7	14.4	10.1	34.2
12	100	-	-	9.8	7.1	-	9.8	26.6
13	99.4	0.6	-	5.9	0.8	0.7	14.9	22.3
14	94.8	-	5.2	16.9	13.2	1.2	21.8	53.1
15	98.9	0.9	0.2	3.6	2.3	-	2.1	8.0
16	99.7	-	0.3	10.0	2.1	-	0.4	12.5
17	99.9	0.1	-	4.2	3.3	29.5	6.5	43.6

Table 8 (Continued)

WW No.	Annual Sales			Annual Losses				
	Household Sale	Fountain Sale	Without Charge	Black Wash & Blow off	Interior Usage	Pipe leakage	Unknown leakage	Total
18	97.0	1.3	1.7	5.6	13.6	-	4.6	23.8
19	100	-	-	14.7	7.3	6.6	34.2	62.8
20	100	-	-	3.9	5.1	-	8.8	17.8
21	98.1	0.4	1.5	8.2	2.1	-	1.6	11.9
22	99.9	-	0.1	2.6	2.8	0.7	15.6	21.7
23	98.7	1.3	0.0	4.7	2.2	0.3	14.7	21.9
24	99.2	-	0.8	5.5	1.5	1.3	10.1	18.4
27	66.7	33.3	-	4.9	2.3	1.7	5.5	14.4
28	99.7	-	0.3	1.6	0.4	-	0.1	2.1
29	100	-	-	9.5	2.4	9.6	1.1	2.3
30	99.9	-	0.1	3.3	1.3	0.2	7.0	11.8
31	99.2	0.8	0.1	1.4	0.6	0.5	-	2.5
32	96.8	2.3	1.0	0.4	3.9	-	26.2	30.4
33	99.0	-	1.0	3.3	1.4	1.2	-	5.9

Table 8 (Continued)

WW No.	Annual Sales			Annual Losses				
	Household Sale	Fountain Sale	Without Charge	Balck Wash & Blow off	Interior Usage	Pipe leakage	Unknown leakage	Total
34	96.8	0.4	2.9	21.8	8.9	-	35.5	66.2
35	100	-	0.0	2.2	0.1	0.2	5.3	7.8
36	100	-	0.0	4.2	2.0	3.9	20.6	30.7
37	99.2	0.7	0.1	1.9	2.3	0.1	4.1	8.4
38	98.9	0.2	1.0	5.5	0.3	-	20.5	29.2
39	100	-	0.1	2.9	3.3	0.2	2.3	8.7
40	100	-	-	5.4	2.5	0.8	8.9	17.5
41	100	0.1	0.0	4.0	0.2	2.3	20.3	28.6
42	99.9	-	0.1	7.2	2.4	2.0	11.6	23.2
43	99.5	-	0.5	2.2	2.7	2.6	29.7	37.1
44	91.9	1.4	6.7	12.5	3.8	13.1	12.4	41.8
45	99.8	0.1	0.0	4.5	0.6	0.5	6.9	12.5
46	99.9	0.0	0.1	13.1	14.8	-	1.8	29.7
47	100	0.0	0.0	3.0	0.5	-	22.0	25.5

Table 8 (Continued)

WW No.	Annual Sales			Annual Losses				
	Household Sale	Fountain Sale	Without Charge	Black Wash & Blow off	Interior Usage	Pipe leakage	Unknown leakage	Total
48	100	-	-	1.8	2.3	0.4	98.8	103.3
49	99.5	0.5	-	3.8	10.8	-	30.2	44.8
50	98.9	1.1	0.0	15.0	0.8	14.3	144.6	174.8

Table 9 Ratio of annual production to annual household sale

WW No. \ Yr.	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975
1	-	-	-	-	-	-	2.377	1.379	1.510	1.443
2	-	-	-	-	1.800	1.341	1.247	1.215	1.197	1.219
3	-	-	-	-	1.000	1.080	1.100	1.116	1.255	1.118
4	-	-	1.041	1.041	1.107	1.087	1.063	1.043	1.191	1.117
5	-	1.112	N.A.	N.A.	1.277	N.A.	N.A.	1.532	1.205	1.202
10	-	-	-	-	-	-	-	-	5.013	1.646
11	-	-	-	-	-	-	-	1.608	1.282	1.349
12	-	-	-	-	-	1.621	1.123	1.437	1.249	1.266
13	-	-	-	-	3.705	1.476	1.342	1.169	1.154	1.232
14	-	-	-	-	9.677	1.445	1.329	1.466	1.290	1.612
15	-	-	-	1.175	1.264	1.177	1.149	1.150	1.130	1.233
16	-	-	1.147	1.056	1.375	1.147	1.318	1.183	1.132	1.129
17	-	-	-	-	-	-	-	-	1.510	1.438
18	-	-	-	-	-	-	-	-	1.632	1.277
19	-	-	-	-	-	-	3.631	2.474	1.957	1.628

Table 9 (Continued)

WW No. \ Yr.	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975
20	-	-	-	-	-	1.152	1.095	1.325	1.305	1.178
21	-	-	-	-	-	1.033	1.062	1.012	1.174	1.140
22	1.226	1.008	0.978	1.007	1.013	1.500	1.365	1.345	1.222	1.219
23	1.180	1.313	1.105	1.168	1.186	1.276	1.179	1.113	1.157	1.235
24	1.037	1.181	1.168	1.089	1.160	1.141	1.030	1.370	1.201	1.193
27	-	1.142	1.109	1.039	1.044	1.115	1.302	1.767	1.758	1.716
28	1.0	0.976	0.981	1.004	1.018	1.003	1.027	1.050	1.034	1.024
29	1.134	1.009	1.548	1.217	1.244	1.232	1.181	1.318	1.318	1.227
30	1.013	1.007	1.006	1.014	1.015	1.037	1.085	1.091	1.101	1.119
31	1.092	1.034	1.015	1.001	1.024	1.022	1.041	1.032	1.033	1.034
32	1.026	1.022	1.026	1.118	1.062	1.149	1.072	1.071	1.111	1.348
33	1.070	1.002	1.034	1.044	1.042	1.003	1.285	1.043	1.072	1.069
34	1.193	1.238	1.186	1.290	1.433	1.343	1.670	1.793	1.843	1.717
35	1.021	0.991	0.991	1.114	1.123	1.017	1.016	1.025	1.037	1.079
36	1.041	1.079	0.999	1.417	1.483	1.687	1.371	1.268	1.238	1.307

Table 9 (Continued)

Yr. / WU No.	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975
37	-	-	-	-	-	-	-	1.896	1.236	1.093
38	1.145	1.442	1.609	1.268	1.489	1.604	1.569	1.231	1.168	1.306
39	1.075	1.121	1.047	1.061	1.112	1.081	1.074	1.090	1.166	1.088
40	1.041	1.034	1.166	2.058	1.253	1.181	1.129	1.170	1.150	1.175
41	1.040	1.167	0.955	1.254	1.292	1.309	1.340	1.306	1.327	1.287
42	1.133	1.082	1.101	1.135	1.472	1.966	1.604	1.284	1.227	1.233
43	1.013	1.068	1.560	1.331	1.174	1.641	1.455	1.459	1.477	1.378
44	1.311	1.073	1.039	1.036	1.015	1.187	1.513	1.394	1.440	1.542
45	1.023	0.929	1.024	1.064	1.018	1.183	1.158	1.120	1.113	1.127
46	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	1.313
47	1.033	0.974	1.057	1.099	1.214	1.212	1.207	1.163	1.205	1.255
48	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	2.544
49	1.068	1.037	1.508	1.727	1.909	1.973	2.186	1.725	1.602	1.455
50	1.002	0.906	1.343	1.059	1.781	2.095	1.841	1.917	2.161	2.778

N.A. means data are not available.

Table 10 Average water consumption rate in lpcd in observed areas

WW No. \ Yr.	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975
1	-	-	-	-	-	-	12.5	74.0	84.0	105.7
2	-	-	-	-	36.0	92.3	98.2	103.4	134.6	100.6
3	-	-	-	-	87.1	117.7	118.4	125.8	94.8	111.8
4	-	-	163.7	136.4	145.2	150.3	172.1	106.0	63.0	85.5
5	-	113.4	108.2	122.0	75.9	86.1	77.0	60.2	66.0	68.8
10	-	-	-	-	-	-	-	-	34.0	75.7
11	-	-	-	-	-	-	-	46.1	60.2	47.1
12	-	-	-	-	-	37.3	84.7	74.0	90.7	79.1
13	-	-	-	-	25.8	99.0	190.6	294.7	288.3	254.4
14	-	-	-	-	16.9	111.2	117.5	90.8	104.3	85.9
15	-	-	-	55.3	66.3	131.8	65.0	65.9	77.0	87.6
16	-	-	249	299	256.1	257.3	222.0	220.0	214.7	221.5
17	-	-	-	-	-	-	-	-	43.0	62.1
18	-	-	-	-	-	-	-	-	52.4	74.8
19	-	-	-	-	-	-	24.1	45.8	43.1	39.0

Table 10 (Contitued)

WW No. \ Yr.	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975
20	-	-	-	-	-	23.3	67.0	67.4	50.8	35.1
21	-	-	-	-	-	82.8	146.3	131.7	130.8	120.0
22	119.9	149.5	135.8	127.4	119.0	96.0	71.2	129.9	80.9	77.0
23	62.2	61.3	69.0	71.8	70.9	63.5	76.6	72.3	72.6	115.9
24	119.7	115.3	126.9	116.9	110.8	106.6	101.8	109.3	107.3	109.7
27	-	103.9	112.1	116.3	123.2	134.8	116.7	116.3	115.1	256.8
28	185.1	129.1	127.3	150.5	178.7	199.8	184.7	186.5	185.3	191.7
29	122.9	108.4	119.1	147.5	134.5	128.5	134.5	130.9	130.2	110.8
30	161.5	160.1	180.4	181.3	183.1	181.0	204.8	215.7	212.0	206.5
31	158.1	155.4	166.0	171.1	183.1	173.6	177.6	188.8	165.8	172.4
32	96.2	118.4	178.1	135.7	130.7	138.8	184.1	203.4	214.0	159.2
33	101.6	125.9	141.9	148.6	145.1	147.1	106.8	161.5	124.2	156.0
34	112.1	104.1	129.2	124.1	131.6	150.8	114.2	118.6	141.2	138.6
35	114.8	168.0	205.2	195.6	170.4	214.9	168.2	151.6	147.6	141.7
36	195.4	212.2	244.3	213.1	296.8	184.4	200.9	225.4	245.1	250.8

Table 10 (Continued)

WW No. \ Yr.	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975
37	-	-	-	-	-	-	-	37.6	73.1	126.2
38	154.8	130.6	121.4	130.9	152.3	173.4	153.0	161.2	159.2	162.1
39	77.1	86.8	88.1	87.2	77.7	80.5	82.5	74.2	69.7	69.2
40	121.2	137.0	176.5	181.0	118.3	187.5	205.8	232.2	236.0	202.1
41	100.1	95.2	193.0	201.5	171.3	184.9	145.5	137.4	151.2	176.9
42	41.0	94.6	109.9	108.2	126.4	138.5	137.0	148.6	129.7	143.4
43	72.2	80.4	108.2	126.6	155.0	165.0	113.7	105.3	102.2	100.2
44	149.8	177.6	227.6	247.5	202.7	132.4	136.1	151.1	158.5	154.5
45	193.3	207.1	203.4	203.1	196.2	217.9	194.3	217.8	220.0	220.8
46	138.2	113.7	154.7	246.5	169.5	97.9	97.7	166.8	103.7	128.5
47	114.5	120.2	119.5	186.2	185.4	194.6	195.2	202.7	219.6	336.2
48	134.8	130.0	169.4	203.8	176.2	169.4	181.1	175.8	176.3	169.8
49	210.1	210.5	182.8	193.7	192.5	168.1	158.5	206.3	224.4	269.6
50	115.7	165.0	145.3	193.6	140.5	123.2	110.8	108.8	118.6	135.2

Table 11 Utilization factor in observed water works

WW No.	Utilization factor	Years after first operation	WW No.	Utilization factor	Years after first operation
1	0.69	4	29	0.70	15
2	0.32	6	30	1.34	14
3	1.04	7	31	0.75	16
4	0.43	9	32	1.12	17
5	0.18	10	33	0.42	18
10	0.08	2	34	0.88	18
11	0.20	3	35	0.84	19
12	0.33	4	36	1.55	21
13	0.43	6	37	0.33	3
14	0.08	6	38	0.90	18
15	0.40	7	39	0.25	18
16	0.72	8	40	0.38	20
17	0.15	2	41	0.94	14
18	0.22	2	42	0.36	20
19	0.08	4	43	0.49	20
20	0.09	5	44	0.47	20
21	0.56	5	45	0.71	20
22	0.68	18	46	0.65	11
23	0.52	18	47	1.16	20
24	1.18	20	48	1.01	18
27	0.24	9	49	0.67	21
28	0.78	14	50	0.63	21

Table 12 Ratio of served population to bulk population in studied observed areas from year 1966 to year 1975 expressed in percentage

WW No. \ Yr.	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975
1	-	-	-	-	-	-	12.0	36.7	43.9	44.2
2	-	-	-	-	8.2	11.1	15.6	16.5	20.4	22.6
3	-	-	-	29.1	38.8	45.0	46.8	52.4	62.9	67.0
4	-	15.8	16.2	19.8	22.6	26.4	27.5	32.5	32.8	33.6
5	-	3.1	13.0	18.1	22.8	29.0	33.7	28.9	31.4	33.8
10	-	-	-	-	-	-	-	-	2.5	7.6
11	-	-	-	-	-	-	-	16.2	24.0	35.4
12	-	-	-	-	-	33.8	40.1	46.7	50.3	56.3
13	-	-	-	-	3.9	7.5	11.0	12.8	18.1	23.3
14	-	-	-	-	1.2	3.6	5.7	6.4	5.7	6.8
15	-	-	-	14.5	18.7	13.8	29.6	33.6	35.0	42.8
16	-	-	21.9	27.7	30.1	36.1	39.5	42.2	44.2	45.7
17	-	-	-	-	-	-	-	-	20.2	27.8
18	-	-	-	-	-	-	-	-	36.2	51.9

Table 12 (Continued)

WW No. \ Yr.	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975
19	-	-	-	-	-	-	2.4	5.2	8.5	16.9
20	-	-	-	-	-	3.6	7.7	11.2	15.6	19.6
21	-	-	-	-	-	8.1	14.1	16.2	19.0	22.4
22	54.7	59.1	62.0	41.2	44.2	48.4	76.1	47.8	80.3	79.3
23	32.4	34.6	33.9	39.5	40.2	42.7	44.2	46.6	49.6	52.0
24	35.8	36.6	41.3	44.7	52.8	55.7	59.7	61.9	63.0	67.0
27	-	13.3	19.4	22.2	25.9	30.0	33.1	37.7	33.9	12.2
28	34.9	39.5	44.3	51.2	56.8	60.3	66.1	74.1	75.7	78.8
29	44.4	48.8	58.8	67.6	70.7	74.1	74.4	79.6	82.3	89.1
30	36.5	39.9	44.9	48.2	50.4	51.9	53.2	55.6	56.8	57.4
31	28.4	30.9	34.1	40.2	44.3	52.1	59.7	61.3	67.3	66.7
32	27.4	30.3	33.5	38.0	42.2	47.0	50.8	53.7	49.5	55.8
33	28.1	30.7	34.5	40.0	44.7	46.2	59.6	55.4	67.3	69.1
34	27.6	31.9	34.0	39.6	33.8	39.7	44.2	48.8	48.3	52.3
35	32.4	35.0	39.3	43.1	47.0	47.5	56.5	57.9	62.2	62.1

Table 12 (Continued)

WW No. \ Yr.	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975
36	23.0	26.4	31.7	38.9	44.2	48.4	52.8	56.8	60.9	65.8
37	-	-	-	-	-	-	-	8.5	14.4	28.0
38	32.4	35.7	39.2	47.7	44.3	39.9	44.4	47.2	43.5	44.9
39	40.1	42.7	46.2	49.1	50.2	53.6	57.1	59.8	62.5	66.3
40	18.7	20.2	21.9	22.9	32.8	25.5	27.3	29.4	31.1	32.4
41	26.3	28.1	34.1	40.2	42.1	46.5	50.6	53.6	48.4	50.2
42	31.8	34.7	38.4	39.3	29.8	32.9	37.3	38.8	45.0	47.9
43	38.6	42.0	47.2	48.7	53.5	57.3	61.3	66.4	65.2	70.0
44	21.4	26.0	27.1	30.6	43.1	49.9	55.5	59.1	49.4	52.9
45	23.8	26.3	29.4	32.3	36.7	40.2	44.8	47.2	50.1	53.5
46	17.4	20.0	16.5	19.1	24.0	44.1	46.5	45.1	50.7	46.0
47	20.1	22.8	26.2	32.6	36.7	41.2	45.0	47.1	51.6	32.8
48	34.1	44.2	48.4	43.1	50.7	54.3	58.5	63.7	61.6	64.5
49	48.5	54.8	57.0	63.0	67.8	74.8	44.2	48.4	46.0	43.5
50	35.4	36.3	33.6	37.5	41.9	44.3	46.8	50.2	38.4	41.1

APPENDIX B

CONSTRUCTION COSTS

Table 1 Year of construction, type design capacity bidded and adjusted cost for 30 observed waterworks projects.

Details / WW No	Year of Construction	Type of Projects	Design Capacity, m^3/day	Biddes Cost, 1,000 ฿	Cost adjusted to 1975 Baseyr 1,000 ฿
1	1971	New	400	4,230.0	5,899.7
2	1969	New	400	2,290.0	3,153.9
6	1975	New	800	6,421.0	6,421.0
7	1974	New	800	6,897.0	7,089.1
8	1974	New	800	4,936.0	5,073.5
9	1974	New	800	4,900.0	5,036.5
10	1973	New	800	5,400.0	6,578.9
11	1972	New	800	3,790.0	5,147.6
12	1970	New	800	4,609.0	6,368.3
13	1969	New	800	4,650.0	6,404.3
14	1969	New	800	3,535.0	4,868.6
17	1973	New	1600	4,486.0	6,256.8
18	1973	New	1600	8,680.0	10,574.9
19	1971	New	1600	4,486.0	6,256.8
21	1970	New	1600	5,507.0	7,609.0
22	1970	Expansion	800	3,671.0	5,072.2
25	1975	New	2000	10,240.0	10,240.0
26	1974	New	2000	10,722.0	11,020.6

Table 1 (Continued)

Details / WW No	Year of Construction	Type of Projects	Design Capacity, m^3/day	Bidded Cost, 1,000 ฿	Cost adjusted to 1975 Baseyr 1,000 ฿
27	1972	Expansion	1600	7,200.4	9,779.7
30	1975	Expansion	5000	27,500.0	27,500.0
31	1975	Expansion	4000	17,024.3	17,024.3
35	1974	Expansion	2000	7,365.0	7,570.1
36	1975	Expansion	2000	12,060.0	12,060.0
37	1972	Expansion	3200	13,570.0	18,431.0
38	1974	Expansion	4000	13,000.0	13,362.0
39	1972	Expansion	1600	5,800.0	7,877.7
42	1969	Expansion	3200	8,607.0	11,854.1
44	1974	Expansion	4000	10,375.0	10,663.9
46	1971	Expansion	5000	14,300.0	19,944.7
50	1974	Expansion	10000	29,000.0	29,807.6

Table 2 Break down of construction costs for 30 Observed waterworks projects.

Item / WW No	Process part		Non -pro.	Pipe Lines Systems		Admin	Total
	Intake special structures	Other components in WW.	Part in WW.	Raw Trans Sys.	Distri Pipe Sys.	Expense	
1	1352.6	1444.9	1109.8	90.2	771.6	1130.6	5899.7
2	–	1201.3	770.6	172.5	563.7	445.8	3153.9
6	–	2573.2	1096.0	65.8	1539.2	1146.8	6421.0
7	1089.5	1963.8	694.4	1527.7	590.0	1223.7	7089.1
8	308.4	1716.1	470.2	–	1698.6	880.2	5073.5
9	459.8	1744.0	1316.2	–	742.2	774.3	5036.5
10	362.1	1931.0	1533.5	274.3	1461.0	1017.0	6578.9
11	–	2129.1	1210.8	29.2	949.5	829.0	5147.6
12	–	2497.8	920.6	618.6	1143.1	1188.2	6368.3
13	850.5	1763.7	1079.8	–	1200.5	1509.8	6404.3
14	436.5	2161.5	618.8	18.4	1146.7	486.7	4868.6
17	194.9	3166.3	1736.2	345.4	1888.5	1423.5	8754.8
18	2119.7	2573.7	2307.7	1052.7	1172.9	1348.2	10574.9
19	–	2319.9	1117.6	–	1758.3	1061.0	6256.8
21	–	2608.7	951.6	880.6	2051.3	1116.6	7609.0
22	–	1761.8	1642.8	–	756.6	911.0	5072.2
25	182.7	3976.7	1480.6	720.9	886.5	1348.3	10240.0
26	–	3229.3	1467.9	3598.2	1299.9	1425.3	11020.6
27	679.5	3172.4	1060.9	–	3527.8	1339.5	9779.7

Table 2 (Continued)

Item / WW No	Process Part		Non-pro. Part in WW.	Pipe Lines Systems		Admin Expense	Total
	Intake special structures	Other components in WW.		Raw Trans Sys.	Distri Pipe Sys.		
30	–	7471.6	2190.7	7072.7	6015.3	4749.7	27500.0
31	–	6721.0	2176.5	3907.1	1865.4	2354.3	17024.3
35	–	2764.1	318.1	360.1	2827.4	1300.4	7570.1
36	420.0	3682.3	1702.5	–	4311.0	1944.2	12060.0
37	–	6132.9	1802.4	4125.9	3550.9	2818.9	18431.0
38	–	5540.9	1006.9	–	4418.6	2395.6	13362.0
39	163.0	3439.1	1159.7	–	1947.1	1168.8	7877.7
42	–	4996.6	1355.1	–	3673.8	1828.6	11854.1
44	–	5511.1	900.8	–	2581.0	1671.0	10663.9
46	27.9	7114.5	1224.8	5830.9	2073.6	3673.0	19944.7
50	49.3	10727.8	1706.7	2813.9	9144.4	5365.5	29807.6

Table 3 Break downs of components of process part excluding the intake special structures

Capacity m^3/day	400		800										1600		
Water Works No. / Item	1	2	6	7	8	9	10	11	12	13	14	22	17	18	19
Pump houses	10.6	17.8	5.9	1.7	2.0	9.4	3.3	1.9	10.3	1.2	4.8	1.6	4.7	3.8	8.4
Pump and equipments:															
Low lift	5.0	2.1	3.9	14.4	5.1	7.6	7.1	4.3	10.3	5.9	6.2	9.2	9.1	10.0	3.9
High lift	8.5	4.6	12.8	6.4	6.3	12.6	10.1	9.9	7.7	11.7	16.3	11.6	11.6	21.2	6.5
Others	-	-	8.9	-	-	-	-	-	-	0.5	-	-	10.2	-	-
Chemical feeding apparatus	1.0	1.1	4.9	0.5	-	1.9	1.9	1.0	5.1	2.3	-	14.5	7.1	5.0	6.6
COAG-SED-RSF Units	23.4	27.5	44.7	39.3	44.9	34.1	28.8	34.9	26.9	54.7	31.8	33.8	20.8	25.6	32.5
Clear Water tank	23.2	13.4	-	18.3	21.0	15.5	17.0	11.4	13.3	8.0	12.7	18.8	9.2	11.4	14.4
Elevated tank	7.7	20.6	-	11.9	13.7	13.4	22.8	23.0	20.0	-	22.3	-	13.9	17.1	21.7
Pipe arrangement inside the plants:															
Pipe, fittings and accessories	2.4	5.7	2.5	3.0	2.2	2.7	3.2	3.8	2.8	3.1	1.9	5.2	3.8	2.5	2.9

Table 3 (Continued)

Capacity m^3/day	1600			2000				3200		4000			5000		10000
Water Works No. / Item	21	27	39	25	26	35	36	37	42	31	38	44	30	46	50
Pump houses	10.0	9.0	-	7.5	6.2	1.7	10.0	7.3	3.6	6.3	4.2	6.7	6.1	2.6	3.2
Pumps and equipments:															
Low lift	9.6	8.0	8.1	21.2	9.8	17.4	19.1	8.5	9.5	8.1	7.5	12.3	12.2	11.7	18.0
High lift	9.8	11.6	10.0	11.0	8.8	22.6	10.4	13.1	11.9	11.9	12.2	16.8	14.7	10.2	8.0
Others	-	-	-	-	-	4.6	-	-	-	1.2	1.1	0.7	2.2	-	-
Chemical feeding - apparatus	4.8	4.9	3.6	2.3	1.6	1.7	5.2	3.9	-	1.5	7.7	2.9	1.4	2.5	2.9
COAG-SED-RSF Units	28.6	23.1	21.3	26.1	28.6	33.5	23.6	22.3	27.6	29.3	30.8	31.0	36.9	31.2	37.0
Clear Water tank	12.7	31.5	24.1	17.6	20.2	11.8	17.1	17.1	19.8	14.5	19.1	11.9	14.4	20.6	17.6
Elevated tank	19.1	-	22.2	10.9	13.8	-	-	20.4	15.2	9.8	11.5	-	8.3	7.1	-
Pipe arrangement inside the plants:															
Pipe, fitting and accessories	1.3	5.1	2.3	1.3	3.8	2.4	4.1	2.5	2.5	6.9	3.0	4.3	0.7	3.4	4.7

Table 3 (Continued)

Capacity m^3/day	400		800										1600		
Water Works No. / Item	1	2	6	7	8	9	10	11	12	13	14	22	17	18	19
Valves	3.4	3.5	1.4	1.8	1.4	1.5	0.7	1.3	2.2	2.2	1.6	3.3	2.3	1.9	2.2
Master meters	5.2	3.6	2.6	0.9	1.1	1.1	1.2	2.1	1.3	3.9	0.5	1.9	2.7	0.7	0.9
Electric power-equipment and - installation.	9.7	-	12.4	1.7	2.4	4.2	3.8	6.4	-	6.6	1.8	-	4.5	0.9	-
Total in percentage	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
in 1,000 ฿	1444.9	1201.3	2573.2	1963.8	1716.1	1744.0	1931.0	3129.1	2497.8	1763.7	2161.5	1761.8	3166.3	3573.7	2319.9

Table 3 (Continued)

Capacity m^3/day	1600			2000				3200		4000			5000		10000
Water Works No. / Item	21	27	39	25	26	35	36	37	42	31	38	44	30	46	50
Valves	0.8	1.8	1.2	0.7	1.7	1.6	2.2	1.8	1.1	0.6	0.3	2.0	0.4	2.4	2.6
Master meters	3.3	0.8	0.8	0.3	2.2	1.4	1.6	0.9	3.3	2.1	1.6	2.2	1.6	3.3	1.0
Electric power - equipment and - installation.	-	4.3	5.6	1.1	3.2	1.2	6.7	2.2	5.5	7.8	1.1	9.4	1.1	5.1	5.0
Total in percentage	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
in 1,000 ₿	2608.7	3172.4	3439.1	3976.7	3229.3	2764.1	3682.3	6132.9	4996.6	6721	5540.9	5511.1	7471.7	7114.5	10727.5

Table 4 Break downs of components of non process part

Capacity m^3/day	400		800										1600		
Item \ Water Works No.	1	2	6	7	8	9	10	11	12	13	14	22	17	18	19
Office	10.3	22.5	6.8	11.1	16.4	5.9	13.1	9.2	24.8	16.1	18.3	-	11.6	6.7	6.7
Warchouses	11.6	-	-	-	-	7.5	5.9	-	-	-	-	9.2	8.8	8.1	12.5
Lodging houses	43.2	36.5	34.2	43.7	4.7	18.5	32.9	38.6	30.9	31.1	47	17.3	23.6	18.3	34.3
Yard improvement :															
1.Fence,gate,flag,sign.	6.7	4.6	7.2	12.7	10.9	6.3	11.6	9.4	11.2	9.6	10.5	4.9	3.8	5.0	10.6
2.Earth embankment	-	1.4	5.7	15.5	4.4	23.3	1.2	9.8	16.1	-	-	30.2	27.6	36.7	-
3.Roads in plant	4.4	5.6	4.9	9.3	9.2	3.4	9.5	13.1	11.0	12.1	24.2	1.6	10.6	8.9	10.3
4.Drainage system	-	4.7	7.8	2.1	8.7	30.4	9.0	-	2.8	3.1	-	1.3	0.5	6.3	7.0
Illumination equipment	2.8	7.9	17.7	-	-	1.2	3.6	9.0	-	6.6	-	-	3.5	2.4	6.7
Connecting Pipe tools	-	1.6	2.0	-	3.5	1.2	1.7	1.0	-	1.2	-	0.8	0.8	0.6	1.1
Laboratory instrument	0.7	3.3	1.0	-	-	0.9	0.9	0.6	0.8	2.3	-	2.2	0.7	0.6	-
Stationary	20.3	11.9	12.7	5.6	-	1.4	10.7	9.4	2.3	17.9	-	32.4	8.7	0.6	10.7
Total in percentage	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
in 1,000 ฿	1109.8	770.6	1096.0	644.4	470.2	1316.2	1533.5	1210.8	920.6	1079.8	618.8	1642.8	1736.2	2307.7	1117.6

Table 4 (Continued)

Capacity m^3/day	1600			2000				3200		4000			5000		10000
Water Works No. / Item	21	27	39	25	26	35	36	37	42	31	38	44	30	46	50
Office	18.4	-	9.6	5.0	5.3	-	21.3	12.4	-	6.9	7.7	20.5	8.3	30.2	10.8
Warehouses	-	10.2	12.9	17.3	15.1	-	8.9	14.8	-	16.5	17.9	16.3	7.3	-	14.6
Lodging houses	39.9	44	40.3	32.6	26.3	21.6	19.6	36.3	20.7	25.5	26.3	24.5	29.7	47	33
Yard improvement :															
1.Fence,gate,flog,sign	14.7	4.6	0.9	6.7	7.1	-	14.1	11.9	8.3	5.0	6.8	11.2	15.7	6.9	1.9
2.Earth embankment	2.8	10.6	13.4	12.0	-	14.5	5.3	3.5	42.3	1.7	0.9	0.9	6.9	0.9	4.5
3.Roads in plant	3.0	8.0	6.2	6.8	6.5	3.7	4.8	3.1	3.2	12.8	10.1	4.7	11.3	4.5	13.9
4.Drainage system	2.2	2.0	-	2.5	20.4	60.1	7.3	2.2	3.0	16.6	18.9	-	12.6	8.1	19.3
Illumination equipment	5.3	3.2	12.3	1.4	3.6	-	2.1	5.4	10.3	1.1	2.8	7.8	2.5	-	19.3
Connecting Pipe tools	1.3	1.2	1.1	1.5	1.4	-	16.6	4.1	0.9	1.1	1.6	6.2	-	-	0.2
Laboratory instrument	0.8	7.2	1.3	3.1	0.8	-	-	-	-	0.6	1.1	1.3	2.1	-	0.2
Stationary	11.5	15.4	2.1	11.1	13.6	-	-	6.3	11.3	12.3	5.9	6.6	3.7	2.4	1.2
Total in percentage	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
in 1,000 ฿	951.6	1060.9	1159.7	1480.6	1451.9	318.1	1702.5	1802.4	1355.1	2170.5	1006.9	900.8	2190.7	1224.8	1706.4

Table 5 Break down of component of pipe line Systams

Water Works No. / Item	400		800										1600		
	1	2	6	7	8	9	10	11	12	13	14	22	17	18	19
1.Transmission Pipe system :															
A/C-Pipes	49.8	73.6	-	81.7	-	-	74.0	51.7	56.1	-	40.0	-	62.9	76.6	-
G/S and other pipes	4.4	-	88.4	-	-	-	-	21.9	-	-	-	-	-	1.4	-
Fittings and accessories	6.8	12.5	5.0	6.2	-	-	5.3	6.3	16.0	-	9.3	-	7.3	6.9	-
Pipe appurtenance	3.7	2.2	-	2.9	-	-	8.0	1.1	3.7	-	46.1	-	10.7	5.3	-
Supporters	-	-	-	-	-	-	3.8	-	-	-	-	-	10.6	2.6	-
Laying expenditure	35.3	14.6	6.4	9.2	-	-	8.9	19.0	24.2	-	3.8	-	8.5	7.2	-
Total in percentage	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
in 1,000 ₿	90.2	172.5	65.8	1527.7	-	-	274.3	29.2	618.6	-	18.4	-	345.4	1052.7	-

Table 5 (Continued)

Water Works No. / Item	400		800										1600		
	1	2	6	7	8	9	10	11	12	13	14	33	17	18	19
2. Distribution pipe System :															
A/C - pipes	21.6	41.4	54.0	54.9	57.0	53.0	47.3	46.5	31.5	42.7	43.9	31.1	31.6	37.9	46.4
G/S and Other pipes	29.6	9.0	7.3	8.5	14.2	6.7	7.1	2.7	15.6	10.7	14.6	13.1	10.3	7.7	2.8
Fittings and - accessories	13.2	11.3	10.8	7.0	7.3	5.9	15.7	9.6	12.7	15.0	9.8	12.3	9.6	4.7	13.5
Pipe apurtenance	14.6	8.8	5.3	18.4	6.2	215	17.1	23.6	8.1	10.4	8.6	8.2	5.6	18.9	6.3
Supporters	-	-	3.3	2.6	5.1	0.6	1.3	3.4	-	5.7	-	-	1.4	6.2	-
Laying expenditure	21.0	29.5	17.3	8.6	10.2	11.4	11.5	14.2	32.1	12.0	21.4	35.2	41.5	15.0	31.0
Spare pipes and fittings	-	-	2.0	-	-	-	-	-	-	3.5	1.7	-	-	9.6	-
Total in percentage	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
in 1,000 ₿	711.6	563.7	1539.2	590.0	1698.6	742.2	1461.0	949.5	1143.1	1200.5	1146.7	756.6	1888.5	1172.9	1758.3

Table 5 (Continued)

Water Works No. / Item	1600			2000				3200		4000			50000		10000
	21	27	39	25	26	35	36	37	42	31	38	44	30	46	50
1. Transmission pipe system:															
A/C - pipes	76.2	-	-	46.9	82.5	61.6	-	56.4	-	62.7	-	-	71.6	62.2	79.2
G/S and other pipes	-	-	-	13.3	1.2	10.5	-	3.2	-	9.9	-	-	4.1	8.1	6.5
Fittings and accessories	6.2	-	-	2.6	4.0	5.7	-	11.5	-	5.9	-	-	7.7	8.2	3.5
Apurtenance	5.5	-	-	2.9	2.7	8.8	-	3.7	-	1.9	-	-	4.1	2.5	3.5
Supporters	-	-	-	7.9	1.2	-	-	3.9	-	8.0	-	-	2.9	4.2	0.2
Laying expenditure	12.1	-	-	26.4	8.4	13.4	-	21.3	-	11.6	-	-	9.6	14.8	7.1
Total in percentage	100	-	-	100	100	100	-	100	-	100	-	-	100	100	100
in 1,000 ฿	880.0	-	-	720.9	3598.2	360.1	-	4125.9	-	3907.1	-	-	7072.7	5830.9	2813.9

Table 5 (Continued)

Water Works No. / Item	1600			2000				3200		4000			5000		10000
	21	27	39	25	26	35	36	37	42	31	38	44	30	46	50
2. Distribution pipe system:															
A/C - pipes	53.5	55.1	34.7	38.6	60.1	62.0	63.0	46.4	56.3	44.2	55.1	48.2	45.5	35.5	61.2
G/S and other pipes	3.6	12.0	12.9	-	-	3.5	10.7	5.0	5.4	5.6	8.9	17.0	9.8	13.1	11.6
Fittings and accessories	10.7	8.2	3.9	5.8	6.3	7.8	6.5	11.5	14.0	6.9	7.0	5.9	16.6	11.8	7.9
Apurtenance	7.1	14.6	24.4	10.2	15.1	14.2	4.0	7.2	8.8	9.7	4.9	11.0	7.0	9.3	6.9
Supporters	-	-	14.6	20.1	10.0	2.8	1.7	3.8	-	-	7.4	2.5	1.0	9.0	-
Laying expenditure	10.4	10.1	9.5	25.3	8.5	9.7	8.9	26.1	15.5	26.2	21.6	16.9	12.1	23.9	12.4
Spare pipes and fittings	14.7	-	-	-	-	-	5.2	-	-	-	-	-	-	3.2	-
Total in percentage	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
in 1,000 ¥	2051.3	3527.8	1947.1	886.5	1299.9	2827.4	4311.0	3550.9	3673.8	1865.4	4418.6	2581.0	6015.3	2073.6	9114.4

Table 6 Ratio of costs of some other facilities to process facilities

WW No.	$I/_P$	$P/_P$	$N/_P$	$R/_P$	$D/_P$	$A/_P$
1	0.94	1.0	0.77	0.06	0.53	0.78
2	–	1.0	0.64	0.14	0.47	0.37
6	–	1.0	0.43	0.03	0.60	0.45
7	0.55	1.0	0.35	0.78	0.30	0.62
8	0.18	1.0	0.27	–	0.99	0.51
9	0.26	1.0	0.75	–	0.43	0.44
10	0.19	1.0	0.79	0.14	0.76	0.53
11	–	1.0	0.57	0.01	0.45	0.39
12	–	1.0	0.37	0.25	0.46	0.48
13	0.48	1.0	0.61	–	0.68	0.86
14	0.20	1.0	0.29	0.01	0.53	0.23
17	0.06	1.0	0.55	0.11	0.6	0.45
18	0.82	1.0	0.90	0.41	0.46	0.52
19	–	1.0	0.48	–	0.76	0.46
21	–	1.0	0.36	0.34	0.77	0.43
22	–	1.0	0.93	–	0.43	0.52
25	0.46	1.0	0.37	0.18	0.22	0.34
26	–	1.0	0.45	1.11	0.40	0.44
27	0.21	1.0	0.33	–	1.11	0.42
30	–	1.0	0.29	0,95	0.81	0.64

Table 6 (Continued)

WW No.	$I/_P$	$P/_P$	$N/_P$	$R/_P$	$D/_P$	$A/_P$
31	–	1.0	0.32	0.58	0.28	0.35
35	–	1.0	0.12	0.13	1.02	0.47
36	0.11	1.0	0.40	–	1.17	0.53
37	–	1.0	0.29	0.67	0.58	0.46
38	–	1.0	0.18	–	0.78	0.43
39	0.05	1.0	0.34	–	0.57	0.34
42	–	1.0	0.27	–	0.74	0.37
44	–	1.0	0.16	–	0.47	0.30
46	0.01	1.0	0.17	0.82	0.30	0.52
50	0.01	1.0	0.16	0.26	0.85	0.5

Abbreviation in Table 6

I = Intake special structures.

P = Components in process part which is related to scale.

N = Components in non process part.

R = Raw water transmission pipe systems.

D = Distribution pipe systems.

A = Administrative expense.

COSTS OF SOME WATER WORKS STRUCTURES.

1. COAG - SEDI - RFS Unit. Concrete water - tight structures, no machine installed.

Capacity (m^3/hr)	Cost (₱)	Capacity (m^3/hr)	Cost (₱
20	319,000	160	1,262,000
40	578,000	200	1,660,000
80	717,000	250	2,760,000
100	1,040,000	500	4,400,000

2. Clear Water Tank Underground water - tight structures.

SIZE (m^3)	COST (₱)	SIZE (m^3)	COST (₱)
100	80,000	1,000	790,000
200	178,000	1,500	930,000
300	195,000	2,000	1,420,000
500	317,000	3,000	1,832,000

3. Elevated Tank. Intze shape

SIZE (m^3)	TOP HEIGHT (m)	BOTTOM HEIGHT (m)	COST (₱)
50	20.10	18.15	257,000
120	21.7	17.9	433,000
250	25.7	20.8	659,000

4. Houses

4.1 Pump houses, warehouses

Average cost = 800 - 1200 ฿/m^2 of floor area.

4.2 Office

Average cost = 1800 - 2400 ฿/m^2 of floor area.

4.3 Lodging house

Average cost = 1100 - 1400 ฿/m^2 of floor area.

Example of Estimation of Construction works

1. Brief details of Tha Tako Waterworks Project.

1.1 The objective of the project is to provide the potable water for the people at Tha Tako Sanitary Area, Amphoe Tha Tako Changwat Nakhon Swan.

1.2 The project begins in 1975 fiscal year.

1.3 Tha Tako Sanitary Area is 45 kilometres far from centre of Changwat Nakhon Swan. Its area is 266 square kilometres. Population in year 1974 is 7040.

1.4 Design Capacity of water works is 2,000 cubic metre per day. It will meet demand in year 1985 for population of approximately 9850.

1.5 Tha Tako Canal and Phibun Songkram Reservoir is served as raw water sources.

1.6 Area of intake pumping station nearby Tha Tako Canal is 2 Rai 1 Ngan 20 Wa (3680 square metres).

Area of intake pumping station nearby Phibun Songkram Reservoir is 1 Rai 30 Wa (1720 square metres).

Area of the treatment plant and headquater is 5 Rai 2 Ngan 8 Wa (8832 square metres).

1.7 Total length of distribution pipe lines is about 6 kilometres.

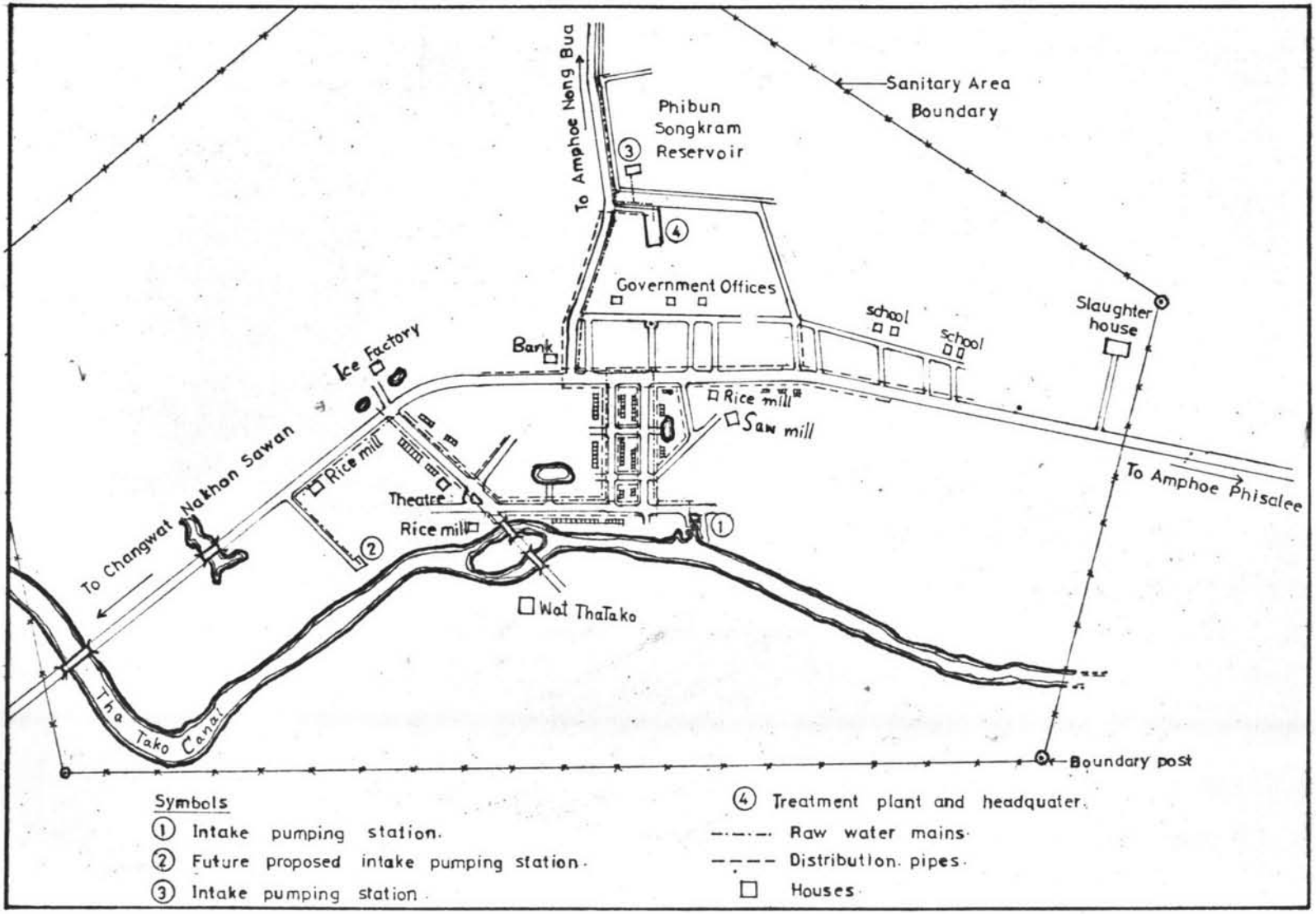

FIGURE 1 Tha Tako Sanitary Area

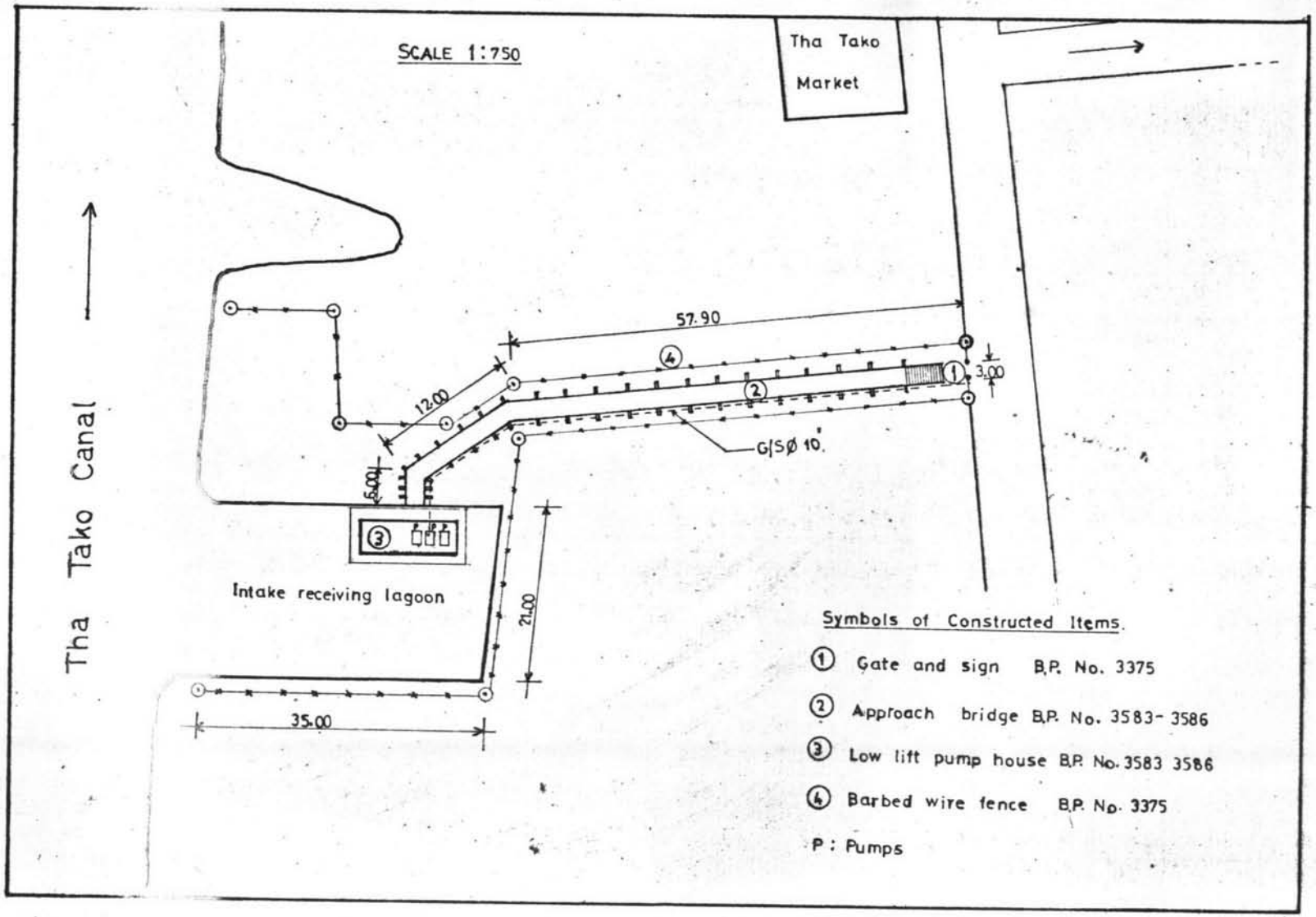

FIGURE 2. Intake pumping station nearby Tha Tako Canal

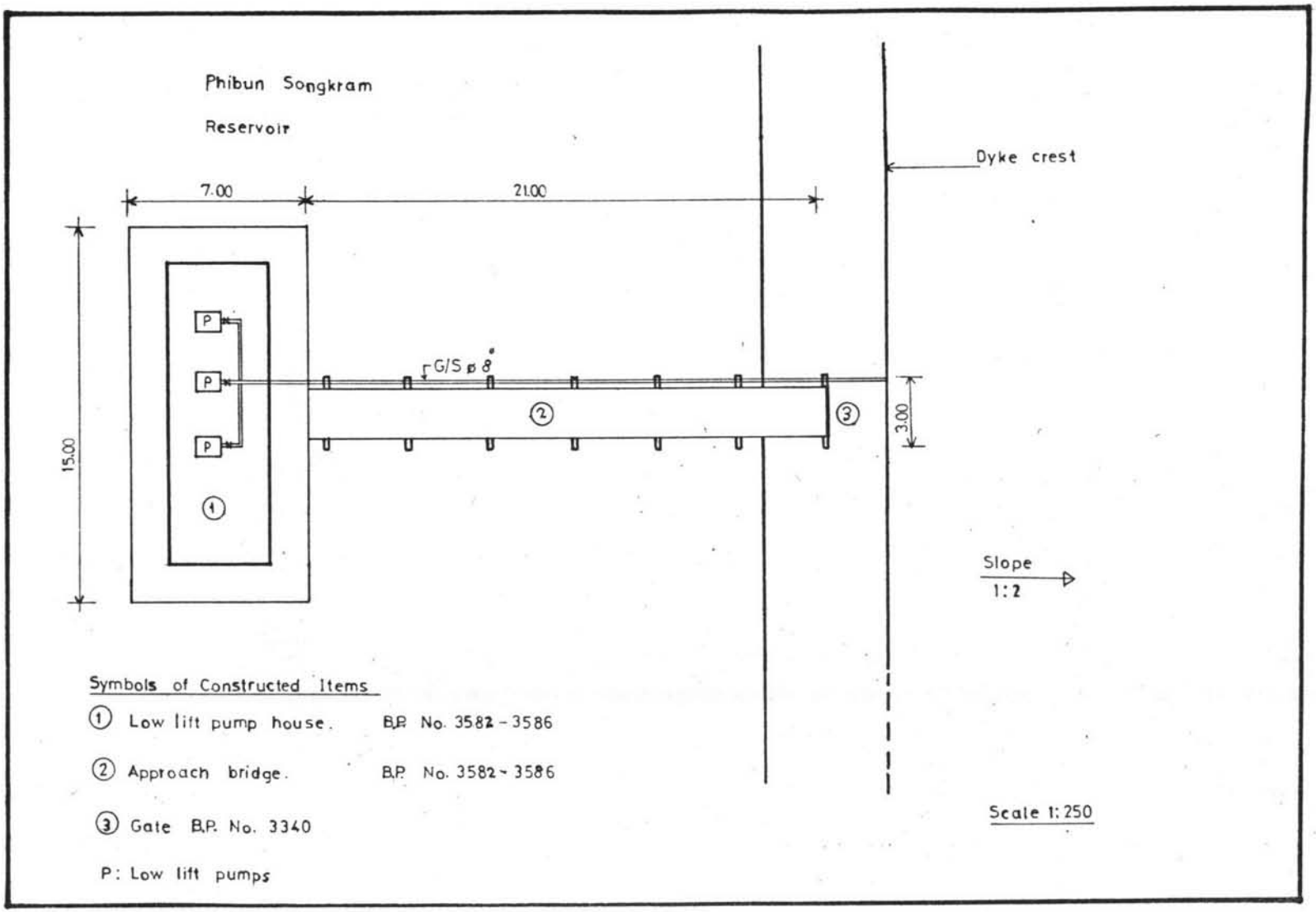

FIGURE 3 Intake pumping station at Phibun. Songkram Reservoir.

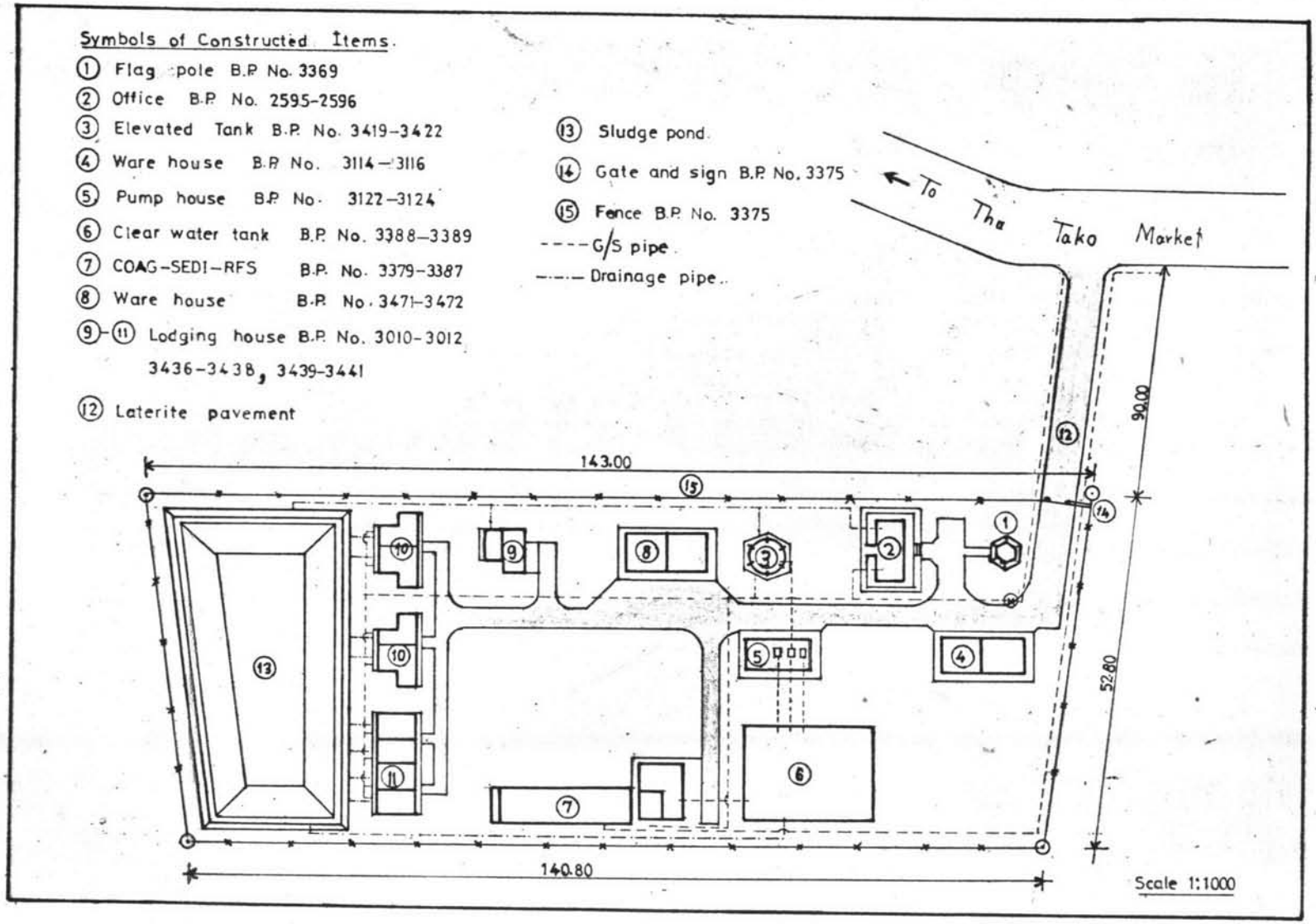

FIGURE 4 Treatment plants and headquater

2. Construction at Tha Tako Canal Intake Pumping Station

- Digging of receiving lagoon 600 m^3 @ 15 ฿	9,000 ฿
- 1 unit - Pump house B.P. No. 3583 - 3586	128,000 ฿
- Approach bridge B.P. No. 3583 - 3586	289,000 ฿
- Barbed wire fence 228 m. B.P. No. 3375	18,240 ฿
- Gate and sign board B.P. No. 3375	6,200 ฿
- Pump and equipment installation :	
2 sets - electric motor driven for a design flow of 220 m^3/hr and static head of 25 m @ 136,900 ฿	273,800 ฿
1 set diesel engine driven for a design flow of 110 m^3/hr and static head of 25 m. @ 134,000 ฿	134,000 ฿

3. Preparation for Expansion of Tha Tako Canal Intake Pumping Station

- Barbed wire fence 166 m. B.P. No. 3340	13,280 ฿
- Sign board B.P. No. 1981	7,000 ฿
- Site fill 1350 m^3	40,500 ฿
- Laterite 4 m. wide pavement 1650 m^2	57,750 ฿

4. Construction at Phibun Songkram Reservoir Intake Pumping Station

- Embankment and improvement of dyke crest B.P. No. 3592 - 3594	1,320,000 ฿
- Pump house B.P. No. 3582 - 3586	80,000 ฿

- Approach bridge B.P. No. 3582 - 3586 209,000 ฿
- Gate B.P. No. 3340 7,400 ฿
- Pump and equipment installation :

  2 sets - electric motor driven for a design flow of 110 m^3/hr and static head of 25 m. @ 84,100 ฿ 168,200 ฿

  2 sets (one as stand by) diesel engine driven for a design flow of 110 m^3/hr and static head of 25 m. @ 134,000 ฿ 268,000 ฿

5. Construction at Treatment plant and headquater.

- Flag pole B.P. No. 3369 7,900 ฿
- Office B.P. No. 2595 - 2596 75,000 ฿
- Elevated tank 120 m^3, with top height of 25 m. B.P. No. 3419 - 3422 433,000 ฿
- Warehouse for pipe and accessories B.P. No. 3114 - 3116 97,000 ฿
- Pump house B.P. No. 3122 - 3124 89,000 ฿
- Underground clear water tank 1000 m^3 B.P. No. 3388 - 3387 700,000 ฿
- COAG - SEDI - RSF 100 m^3/hr B.P. No. 3379 - 3387 1,040,000 ฿
- Warehouse for chemicals storage B.P. No. 3471 - 3472 159,000 ฿

- Two storey lodging houses :	
1 - blag., 1 - family house	77,000 ฿
2 - bldgs., 2 - family house	226,000 ฿
1 - bldg., 1 - family house	179,000 ฿
- Excavation of sludge pond 1300 m^3	19,500 ฿
- Sign board B.P. No. 3375	6,200 ฿
- Barbed wire fence 406 m. B.P. No. 3375	32,480 ฿
- Site fill 4550 m^3	136,500 ฿
- Laterite 4 m. wide pavement 1208 m^2	42,280 ฿
- 1 set Master meter ø 10"	14,400 ฿
- Pipe arrangement inside treatment plant	58,000 ฿
- Valves	18,000 ฿
- A/C Drainage pipe 120 m.	1,950 ฿
- R.C. Drainage pipe with manholes 40 m. B.P. No. 1729	16,000 ฿
- Power electric pole and wire :	
80 m. @ 280 ฿	22,400 ฿
70 m. @ 240 ฿	16,800 ฿
25 m. @ 180 ฿	4,500 ฿
- Lighting electric pole and wire 255 m. @ 80 ฿	20,400 ฿
- High lift pumps and equipment installation : 2 sets - electric motor driven for a design flow of 150 m^3/hr. and static head of 30 m. @ 123,900 ฿	247,800 ฿

1 set diesel engine driven for a design flow of 150 m^3/hr. and static head of 30 m.	190,800 ฿
3 sets chemicals injector	60,000 ฿
3 sets agitating device	30,000 ฿
- Connecting pipe tools and kits	23,000 ฿
- Laboratory instruments	47,000 ฿
- Stationary :	
Office Furniture, Chairs, Tablesets.	80,000 ฿
Steel carriage	5,000 ฿
"Pick up" car	79,000 ฿

6. Laying of Raw Water Transmission Pipe Lines

- Class 20 asbestos cement pipes :	
Ø 250 mm; 1500 m @ 115 ฿	172,500 ฿
Ø 200 mm; 1900 m @ 87 ฿	165,300 ฿
- Class medium gulvanizing steel pipes :	
Ø 10" ; 100 m. @ 730 ฿	73,000 ฿
Ø 8" ; 40 m. @ 580 ฿	23,200 ฿
- Fittings and accessories	19,000 ฿
- Gate valves :	
2 sets - underground type; Ø 250 mm.	9,200 ฿
4 sets - underground type; Ø 200 mm.	12,000 ฿
- Steel protecting aqueducts :	
G/S Ø 12" ; 13 m. @ 1300 ฿	16,900 ฿
G/S Ø 10" ; 36 m. @ 1100 ฿	39,600 ฿

- Surface pavement repair :	
Laterite 1497 m^2 @ 30 ฿	44,900 ฿
Asphaltic 6 m^2 @ 90 ฿	540 ฿
Concrete 95.8 m^2 @120 ฿	11,500 ฿
- Cost of labour for digging and installing pipes of approximate 3,450 m. in length	133,300 ฿

7. Laying of Distribution Pipe Lines

- Class 20 asbestos cement pipes :	
Ø 250 mm ; 550 m. @ 115 ฿	63,250 ฿
Ø 200 mm ; 770 m. @ 87 ฿	66,990 ฿
Ø 150 mm ;2160 m. @ 56 ฿	120,960 ฿
Ø 100 mm ;2520 m. @ 36 ฿	90,720 ฿
- Fittings and accessories	51,000 ฿
- Gate valves :	
2 sets- underground type; Ø 200 mm.	6,000 ฿
8 sets- underground type; Ø 150 mm.	13,760 ฿
19 sets- underground type; Ø 100 mm.	22,800 ฿
- 21 sets Fire hydrants Ø 100 mm.	48,300 ฿
- Steel protecting aqueducts :	
G/S Ø 12" ; 13 m. @ 1300 ฿	16,900 ฿
G/S Ø 10" ; 45 m. @ 1100 ฿	49,500 ฿
G/S Ø 8" ;128 m. @ 800 ฿	102,400 ฿
G/S Ø 6" ; 31 m. @ 300 ฿	9,300 ฿

- Surface pavement repair :	
Laterite 2,860 m^2 @ 30 ฿	85,800 ฿
Concrete 252 m^2 @120 ฿	30,200 ฿
- Cost of labour for digging and installing pipes of approximate 6,217 m. in length	108,580 ฿
Subtotal	8,891,680 ฿

8. Administrative Expenditures

- Transportation of approximate 1200 Ton of construction materials	40,000 ฿
- Office expenditure approximately 3%	266,750 ฿
- Tax approximately 4%	356,000 ฿
- Contingency approximately 5%	445,000 ฿
- Profits	240,570 ฿
Grand total	10,240,000 ฿

Note B.P. No. is abbreviated from 'PWSD Blue - Print Number'

Calculation for breakdown of various parts in Table 3 - 5

1. Intake special structure

Receiving lagoon + dyke crest + approach bridges

= 9,000 + 1,320,000 + 289,000 + 209,000 = 1,827,000 ฿

2. Process parts total 3,976,700 ฿

Pump houses = 128,000 + 80,000 + 89,000 = 297,000 ฿

$$= \frac{297}{3,976.7} \times 100 = 7.5\% \text{ of the total}$$

Pumps and equipments :

Low lift = 273,800 + 134,000 + 168,200 + 268,000

= 844,000 ฿

$= \frac{844}{3,976.7} \times 100 = 21.2$ % of the total

High lift= 247,800 + 190,800 = 438,600 ฿

$= \frac{438.6}{3,976.7} \times 100 = 11.0\%$ of the total

Chemical feeding apparatus

= 60,000 + 30,000 = 90,000 ฿

$= \frac{90}{3.976.7} \times 100 = 2.3$ % of the total

COAG - SEDI - RSF. unit = 1,040,000 ฿

$= \frac{1,040}{3,976.7} \times 100 = 26.1$ % of the total

Clear water tank = 700,000 ฿

$= \frac{700}{3,976.7} \times 100 = 17.6$ % of the total

Elevated tank = 433,000 ฿

$= \frac{433}{3,976.7} \times 100 = 10.9$ % of the total

Pipe arrangement inside the plants :

Pipe, fittings and accessories = 58,000 ฿

$= \frac{58}{3,976.7} \times 100 = 1.5$ % of the total

Valves = 18,000 ฿

$= \frac{18}{3,976.7} \times 100 = 0.5$ % of the total

Master meter = 14,400 ฿

$$= \frac{14.4}{3,976.7} \times 100 = 0.3\ \%\ \text{of the total}$$

Electric power equipment and installtion

$$= 22,400 + 16,800 + 4,500 = 43,700\ ฿$$

$$= \frac{43.7}{3,976.7} \times 100 = 1.1\ \%\ \text{of the total}$$

3. Non - process parts total 1,480,550 ฿

Office = 75,000 ฿

$$= \frac{75}{1480.55} \times 100 = 5.0\ \%\ \text{of the toatl}$$

Warehouses = 97,000 + 159,000 = 256,000 ฿

$$= \frac{256}{1480.55} \times 100 = 17.3\ \%\ \text{of the total}$$

Lodging houses= 77,000 + 226,000 + 179,000 = 482,000 ฿

$$= \frac{482}{1480.55} \times 100 = 32.6\ \%\ \text{of the total}$$

Yard improvement :

Fence, gate, flag, sign etc.

$$= 18,240 + 6,200 + 13,280 + 7,000 + 7,400 +$$
$$7,900 + 6,200 + 32,480 = 98,700\ ฿$$

$$= \frac{98.7}{1480.55} \times 100 = 6.7\ \%\ \text{of the total}$$

Earth embankment = 40,500 + 136,500 = 177,000 ฿

$$= \frac{177}{1480.55} \times 100 = 12\ \%\ \text{of the total}$$

Roads = 57,750 + 42,280 = 100,030 ฿

$$= \frac{100.03}{1480.55} \times 100 = 6.8\ \%\ \text{of the total}$$

Drainage systems = 19,500 + 1,950 + 16,000 = 37,450 ₿

$$= \frac{37.45}{1480.55} \times 100 = 2.5\ \%\ \text{of the total}$$

Illumination equipments = 20,400 ₿

$$= \frac{20.4}{1480.55} \times 100 = 1.4\ \%\ \text{of the total}$$

Connecting pipe tools = 23,000 ₿

$$= \frac{23}{1480.55} \times 100 = 1.5\ \%\ \text{of the total}$$

Laboratory instruments = 47,000 ₿

$$= \frac{47}{1480.55} \times 100 = 3.1\ \%\ \text{of the total}$$

Stationary = 5,000 + 80,000 + 79,000 = 164,000 ₿

$$= \frac{164}{1480.55} \times 100 = 11.1\ \%\ \text{of the total}$$

APPENDIX C

OMR COSTS

Table 1 Chemicals Usage and Expense

WW No.	Alum		Lime		Chlorine			Cost of Chemicals				
	PPm.	Kg.	PPm.	Kg.	PPm.	Powder (Kg.)	Liquid	Alum, ₱	Lime, ₱	Chlorine, ₱	Total, ₱	Unit, ₱/M^3
1	27.1	2746.6	–	–	7.0	705.9	–	4119.9	–	4588.4	8708.3	0.09
2	113.2	5238.1	0.3	15.8	5.8	268.7	–	7857.2	95.0	1746.6	9613.3	0.21
3	48.6	7401.0	–	–	2.3	349.5	–	11101.5	–	2271.8	13373.3	0.09
4	75.0	4704.4	–	–	4.8	301.4	–	7056.6	–	1959.1	9317.1	0.15
5	86.4	2255.	7.1	184.2	7.1	184.1	–	3382.5	110.5	1196.7	4689.7	0.18
10	54.7	1293.2	15.7	371.9	17.4	410.5	–	1939.8	223.1	2668.3	4831.2	0.20
11	57.3	3332.6	–	–	8.3	480.4	–	4998.9	–	3122.6	8601.9	0.15
12	90.2	8794.8	10.6	1030.3	8.2	798.6	–	13192.2	618.2	5190.9	19001.3	0.19
13	80.7	10147.4	1.0	130	9.4	1177.5	–	15221.1	78.0	7653.8	22952.9	0.18
14	47.7	1048.3	9.8	215.1	12.8	281.6	–	1572.5	129.1	1830.4	3532.0	0.16
15	86.8	10216.7	–	–	23.1	2723.5	–	15325.1	–	17702.8	35751.4	0.30
16	163.0	34141	0.5	100	4.3	903.0	–	51211.5	60.0	5869.5	57141.0	0.27
17	39.8	3515.7	–	–	4.9	432.7	–	5273.6	–	2812.6	8518.9	0.10
18	150.9	19525	3.4	435	4.9	634	–	29287.5	261.0	4121.0	33669.5	0.26

Table 1 (Contnued)

WW No.	Alum		Lime		Chlorine			Cost of Chemicals				
	PPm.	Kg.	PPm.	Kg.	PPm.	Powder (Kg.)	Liquid	Alum, ₱	Lime, ₱	Chlorine, ₱	Total, ₱	Unit, ₱/M^3
19	94.2	4512.9	–	–	7.1	341.5	–	6769.4	–	2219.8	8989.2	0.19
20	105.4	5274	50.1	2505	21.9	1096.8	–	7911.0	1503.0	7129.2	16543.2	0.33
21	108.4	35171	–	–	6.3	2033	–	52756.5	–	13214.5	65971.0	0.20
22	106.6	42079.1	0.2	90	4.6	1802.2	–	63118.7	54.0	11714.3	74887.0	0.19
23	124.2	37788.2	3.9	1200	3.4	1035.2	–	56682.3	720.0	6728.8	64131.1	0.21
24	70.9	49017.4	–	–	1.0	–	7tubes	73526.1	–	9240.0	82766.1	0.12
27	57.7	10050	13.3	2322	4.0	700	–	15075.0	1393.2	4550.0	21018.2	0.12
28	46.9	26537.8	0.6	333.3	4.6	2600	–	39806.7	200.0	16900.0	56906.7	0.10
29	5.4	2720.0	0.5	260	6.4	3260.0	–	4080.0	156.0	21190.0	25426	0.05
30	45.9	53983.3	0.8	893.8	3.7	4388.9	–	80975.0	536.3	28527.9	110039.2	0.09
31	74.3	48609.1	0.3	185	1.9	1243.3	–	72913.7	111.0	8081.5	81106.2	0.12
32	130.6	128780.3	4.2	4120	3.1	3094.6	–	193170.5	2472.0	20114.9	215757.4	0.22
33	79.0	28906.8	4.9	1806.7	8.1	2975.8	–	43360.2	1084.0	19342.7	63786.9	0.17
34	85.5	65657.2	–	–	5.3	4091.3	–	98485.8	–	26593.5	125079.3	0.16

Table 1 (Continued)

WW No.	Alum		Lime		Chlorine			Cost of Chemicals				
	PPm.	Kg.	PPm.	Kg.	PPm.	Powder (Kg.)	Liquid	Alum, ₱	Lime, ₱	Chlorine, ₱	Total, ₱	Unit, ₱/M^3
35	41.9	30917.6	1.2	922.5	1.5	1107.0	–	46376.4	553.5	7195.5	54125.4	0.07
36	41.3	55930	2.8	3809	5.5	7440.0	–	83895.0	2285.4	48360.0	134540.4	0.10
37	34.5	13215	–	–	5.6	2140.0	–	19822.5	–	13910.0	33732.5	0.09
38	77.5	81486.3	8.0	8422	2.2	2333	–	122229.5	5053.2	15164.5	142447.2	0.14
39	154.1	44419.4	–	–	5.3	1536.8	–	66629.1	–	9989.2	76618.3	0.27
40	77.5	34812.0	4.0	1791.2	5.0	2266.3	–	52218.0	1074.7	14731.0	68023.7	0.15
41	131.2	180221.9	3.7	5053.3	4.3	5858.8	–	270332.9	3032.0	38082.2	311447.1	0.23
42	67.8	36067.3	1.4	768.2	6.2	3313.6	–	54101.0	460.9	21538.4	76100.3	0.14
43	10.4	8815.1	–	–	3.0	2546.7	–	13222.7	–	16553.6	29776.3	0.04
44	95.4	104825	–	–	4.3	4713.5	–	157237.5	–	30637.8	187875.3	0.17
45	74.2	158442.6	–	–	2.2	–	47 tubes	237663.9	–	62040.0	299703.9	0.14
46	30.8	65929	8.6	1871.4	2.3	2648.1	22 tubes	98893.5	11082.8	46252.7	156229.0	0.07
47	80.6	423927.3	5.4	28444	1.8	1100.0	83 tubes	635891.0	1706.4	116710.0	769667.4	0.15

Table 1 (Contnued)

WW	ALum		Lime		Chlorine			Cost of Chemicals				
No.	PPm.	Kg.	PPm.	Kg.	PPm.	Powder (Kg.)	Liquid	Alum,₿	Lime,₿	Chlorine,₿	Total,₿	Unit,₿/M^3
48	57.1	303376.5	1.8	9414	2.1	11278.7		455064.8	5648.4	73311.6	534024.8	0.10
49	31.0	137353.2	0.8	3761.1	2.7	1243.5	106tubes	206029.8	2256.7	356289.3	356289.3	0.08
50	46.8	197101.2	–	–	1.2	–	4924.4*	295651.8	–	360653.9	360653.9	0.09

* in Kg., 1 tube contains 100 Kg. of liquid chlorine

Table 2 Power Expense in Production Part

WW No.	Power Electric (Unit)	Diesel Gasoline (Litre)	Material Expense			Unit Cost
			Power Electric ¥	Diesel Gasoline ¥	Total ¥	¥/M^3
1	-	19726	-	54049.2	54049.2	0.53
2	-	8627	-	31661.0	31661.0	0.68
3	149174.2	3319	104421.9	7998.8	112420.7	0.74
4	-	26235	-	65062.8	65062.8	1.04
5	141.0	7848	98.7	19620.0	19718.7	0.76
10	-	3592	-	8836.3	8836.3	0.37
11	-	2319	-	5890.0	5890.0	0.10
12	-	7497	-	23742.8	23742.8	0.24
13	19108.0	1350	13375.6	3982.5	17358.1	0.14
14	-	2984	-	7460.7	7460.7	0.34
15	-	15561	-	4030.2	40302.0	0.34
16	19752.1	28034	13826.5	69804.7	83631.2	0.40
17	25079	791	17795.6	1899.4	19695.0	0.22
18	7254.6	-	5079.2	-	5079.2	0.04
19	20997.7	2922	14698.4	7509.5	22207.9	0.46
20	15328.8	690	10730.2	1746.0	12476.2	0.25
21	75131	40395	52591.7	98967.0	151558.7	0.47
22	131825.3	3009	92277.7	7250.5	99528.2	0.25
23	57510.7	7927	40257.5	21720.0	61977.5	0.20
24	532470.1	2925	372729.1	7049.3	379778.4	0.55
27	53460.7	7850	37422.5	20408.7	57831.2	0.33

Table 2 (Continued)

WW No.	Power Electric (Unit)	Diesel Gasoline (Litre)	Material Expense			Unit Cost
			Power Electric ₿	Diesel Gasoline ₿	Total ₿	₿/M^3
28	76865.1	84690	53805.6	211725.0	265530.6	0.47
29	327759	1116	229431.3	2790.0	232221.3	0.46
30	452720	3786	316904.1	9351.0	326255.1	0.28
31	169271	64132	118489.5	153915.8	272405.3	0.41
32	404411	7592	283087.7	19739.2	302826.9	0.31
33	97520	28266	68264.0	67273.1	135537.1	0.18
34	235960	22540	165172.0	54096	219268.0	0.29
35	372917	10460	261041.8	25940.8	286982.6	0.39
36	439993	5357	307995.4	13606.8	321601.2	0.24
37	62868	29215	44007.6	70116.2	114123.8	0.30
38	349445	4019	244611.5	9966.0	254577.5	0.24
39	194300	1116	136010.0	2678.4	138688.4	0.48
40	287965	13412	201575.8	35541.8	237117.6	0.53
41	271066	109656	189746.2	263174.4	452920.6	0.33
42	113021	2608	79114.8	3129.6	82244.4	0.15
43	528876	7396	370213.2	20708.8	390922.0	0.46
44	231553	2930	162087.0	5449.8	167536.8	0.15
45	480155	3786	336108.3	9351	345459.3	0.16
46	440786	103920	308550.2	245775.6	554325.8	0.26
47	1677600	8727	1174320.0	21555.0	1195875.0	0.23
48	1926404	55673	1348482.8	136954.6	1485437.4	0.28
49	1293076	8224	974453.2	20066.6	994519.8	0.22
50	844631	33480	591241.8	80352.0	671593.8	1.16

Table 3 Power Expense in Service Part

WW No.	Electric Lighting (Unit)	Electric Lighting ₱	Benzine Gasoline (₱)	Total Expense (₱)	Unit Cost ₱/M^3
1	7405	8886.3	19800.0	28686.3	0.28
2	2844	3412.1	5832.0	9244.1	0.20
3	7131	8557	7886.0	16443.0	0.11
4	8267	9919.8	3710.2	13630.0	0.22
5	4378	5253.7	1529.1	6782.7	0.26
10	3727	4471.9	3831.0	8302.9	0.35
11	8540	10248.0	1290.0	11538.0	0.20
12	5746	5746.4	2430.0	8176.4	0.08
13	6909	8290.8	10358.1	18648.9	1.15
14	2871	3445.3	-	3445.3	0.16
15	6628	7953.7	-	7953.7	0.08
16	6594	7912.8	6720.0	14632.8	0.07
17	1848	2217.6	2705.0	4922.6	0.06
18	3260	3912.0	2020.0	5932.0	0.05
19	2148	2577.6	10282.2	12859.8	0.27
20	2012	2514.4	-	2414.4	0.05
21	5903	7083.1	16123.5	23206.6	0.07
22	1358	1629.4	10779.4	12408.8	0.03
23	9471	11365.2	1340.0	12705.2	0.04
24	12293	14751.6	10825.5	25576.8	0.04
27	1716	2059.2	5048.4	7107.6	0.04
28	2044	2452.8	12159.8	14612.6	0.03

Table 3 (Continued)

WW No.	Electric Lighting (Unit)	Electric Lighting (฿)	Benzine Gasoline (฿)	Total Expense (฿)	Unit cost ฿/M^3
29	12583	15099.2	12761.1	27860.3	0.05
30	14308	17169.6	18156.6	25326.2	0.03
31	12409	14890.8	19120.2	34011.0	0.05
32	15730	18876.0	27459.7	46335.7	0.05
33	14046	16854.6	11740.1	28594.7	0.08
34	6440	7728.0	14271.2	21999.2	0.03
35	15228	18273.6	18500.6	36774.2	0.05
36	13446	16135.2	20968.1	37103.3	0.03
37	11215	13457.7	8562.0	22019.7	0.06
38	23507	28207.9	24297.1	52505.0	0.05
39	10397	12476.0	3087.5	15563.5	0.05
40	5013	6015.6	12286.1	18301.7	0.04
41	14568	17481.0	35834.5	53315.5	0.04
42	17020	20424.0	8976.5	29400.5	0.06
43	15740	18888.2	6290.3	25178.5	0.03
44	9698	11637.6	7400.0	19037.6	0.02
45	15526	18631.2	18156.6	36787.8	0.02
46	8157	9788.8	- *2	9788.8	0.02
47	42032	50438.3	41060.7	91499.0	0.02
48	49807	59768.4	22974.3	82742.9	0.04
49	42522	51026.6	33417.0	84443.4	0.02
50	25340	30408.0	12625.7	23033.7	0.01

*2 Surat Thani Water Works bore the charge of this gasoline.

Table 4 Maintenance Expense in Production Part

WW No.	Material Expense (¥)					Labour Cost (¥)		Total (¥)
	Tools	Structure	Pipe Apurte	Machine	Lubric	Structure	Machine	
1	520.0	46831.6	471.5	9391.0	6000.0	840.0	6690.0	63214.1
2	–	400.0	–	7487.0	5152.0	–	600.0	13639.0
3	130.0	703.2	62.0	35806.0	2002.0	966.0	10167.0	39669.2
4	358.5	17896.8	110.0	695.0	8580.8	–	7330.0	34971.1
5	42.0	1378.4	536.0	119.0	1859.0	–	440.0	4374.4
10	393.0	–	487.0	402.0	1512.0	–	75.0	2869.0
11	86.0	542.4	78.0	4348.5	793.0	3257.0	–	9104.9
12	165.0	3004.3	148.0	29665.0	2496.0	–	7325.0	42803.3
13	–	28.0	1813.0	258.0	490.0	558.0	125.0	3272.0
14	–	351.0	–	3190.0	931.0	–	40.0	4512.0
15	485.0	3409.6	91.0	6200.0	2886.1	–	7675.0	20746.7
16	–	1052.0	20.0	9574.0	1150.8	3360.0	14858.0	30014.8
17	382.0	135.0	–	374.0	330.0	–	–	1221.0
18	205.0	20.0	–	943.0	3066.0	–	290.0	4524.0

Table 4 (Continued)

WW No.	Material Expense (₿)					Labour Cost (₿)		Total (₿)
	Tools	Structure	Pipe Apurte	Machine	Lubric	Structure	Machine	
19	-	-	314.0	5633.0	1280.8	14000.0	1390.0	22617.8
20	33.0	73.0	70.0	539.0	1224.0	-	40.0	1979.0
21	1085.0	3960.0	591.0	8874.5	4520.0	-	730.0	19760.5
22	230.0	1249.6	181.0	686.0	1380.0	-	155.0	3881.6
23	24.0	6240.0	2577.0	11615.0	1708.8	-	1250.0	23414.8
24	2235.0	5098.4	4494.0	27529.0	2490.0	-	9418.0	51264.4
27	263.0	1417.6	15479.0	705.0	735.0	-	-	18599.6
28	288.0	12883.2	150.0	39910.0	20930.0	903.7	9600.0	84664.9
29	390.0	3310.4	158.5	6871.5	1800.0	-	1745.0	14275.4
30	263.0	896.4	538.5	1955.5	2100.0	466.0	615.0	6834.4
31	549.5	60.0	99.0	9971.5	17769.6	-	6630.0	35079.6
32	100.0	1014.4	1033.0	6630.0	2048.0	-	-	10825.4
33	72.0	7259.2	630.0	29141.0	14580.0	900.0	7180.0	59762.2
34	476.0	8117.2	4935.5	21492.0	4617.6	965.3	1630.0	42224.6
35	25.0	710.4	3137.0	9274.0	1755.0	218.0	12216.0	27335.4

Table 4 (Continued)

WW No.	Material Expense (₹)					Labour Cost (₹)		Total (₹)
	Tools	Structure	Pipe Apurte	Machine	Lubric	Structure	Machine	
36	–	745.2	200.0	1706.0	2031.3	127.5	8300.0	13110.0
37	192.0	170.0	83.0	4820.0	4992.0	–	148.0	10405.0
38	1366.0	279.0	725.0	1578.0	2048.0	800.0	3605.0	10401.0
39	–	4387.2	326.0	3665.0	1824.0	–	188.0	10390.2
40	536.8	5000.0	1218.0	921.0	3618.0	7000.0	730.0	19023.8
41	440.0	3861.6	2096.0	53364.0	36905.0	194.0	3741.0	100601.6
42	498.0	2095.8	3391.0	2243.0	2022.0	–	2400.0	12649.8
43	142.0	1404.0	726.5	3104.5	2192.0	–	9330.0	16899.0
44	606.0	348.0	–	12591.0	440.0	–	20.0	14005.0
45	32.0	994.0	911.0	13934.0	2100.0	24500.0	90.0	42561.0
46	48.0	1997.0	59.6	37201.5	17472.0	–	25460.0	82238.1
47	135.0	12740.0	75560.0	103896.5	3087.0	21367.5	48915.0	265701.0
48	131.0	3710.0	518.0	4629.0	11012.8	752.5	3560.0	24483.3
49	691.0	6740.0	2526.5	26219.0	1890.0	–	12750.0	50816.5
50	–	2432.0	40427.0	3004.0	9646.0	1054.0	5090.0	61653.0

Table 5 Maintenance Expense in Service Part

WW No	Material Expense (¥)			Labour Cost (¥)		Total (¥)
	Auto parts	Lubric	Stationary	Auto	Stationary	
1	3630.0	2201.0	11707.9	860.0	5290.0	23688.9
2	925.0	648.0	105.0	-	-	1678.0
3	11052.0	876.2	175.8	350.0	1794.0	14248.0
4	180.0	412.2	4474.2	105.0	800.0	5971.4
5	389.0	170.0	344.6	80.0	-	983.6
10	531.0	425.7	-	150.0	-	1106.7
11	927.0	765.0	135.6	1267.0	1956.0	5050.6
12	2986.0	633.2	751.0	-	-	4370.2
13	1378.0	1151.4	-	640.0	719.0	3888.4
14	482.0	-	-	-	-	482.0
15	1205.0	-	852.4	657.0	550.0	3264.4
16	17293.0	746.7	263.0	495.0	2020.0	20817.7
17	1457.0	300.6	-	-	-	1757.6
18	272.0	224.0	-	15.0	310.0	821.0
19	8115.0	1142.5	-	490.0	6000.0	15747.5
20	237.0	-	-	285.0	480.0	1002.0
21	4041.5	1791.5	990.0	90.0	530.0	7443.0
22	8613.0	1197.7	312.4	1910.0	500.0	12533.1
23	428.0	144.8	1560.0	965.0	2754.4	5852.2
24	6279.0	1202.7	1274.6	2705.0	900.0	12361.3
27	2564.0	560.9	354.4	3595.0	453.0	7527.3
28	2277.0	1351.1	3220.8	-	762.3	7611.2

Table 5 (Continued)

UW No	Material Expense (₱)			Labour Cost (₱)		Total (₱)
	Auto parts	Lubric	Stationary	Auto	Stationary	
29	4918.0	1417.9	827.6	2840.0	780.0	10783.5
30	5055.0	2017.4	224.1	327.0	805.0	8428.5
31	2133.0	1269.4	–	1195.0	401.0	4998.4
32	2430.0	3051.1	253.6	–	6824.0	12558.7
33	3620.0	1305.3	1814.8	1190.0	5630.0	13560.1
34	1792.0	1585.7	2029.3	195.0	3003.7	8605.7
35	3642.0	2055.6	117.6	7221.0	965.0	14001.2
36	7221.0	2329.8	186.3	735.0	650.0	11122.1
37	1768.0	951.3	–	435.0	2203.0	5357.3
38	5328.1	2699.7	–	5595.0	1434.0	15056.7
39	857.0	343.1	1096.8	460.0	–	2756.9
40	2026.0	1365.0	1249.0	1185.0	3880.0	9705.1
41	6485.5	3981.6	965.4	1225.0	1229.0	13886.5
42	3639.0	997.4	5240.0	2256.0	1815.0	9231.4
43	4813.0	698.9	350.0	270.0	2095.0	8226.9
44	229.0	822.2	–	918.0	663.0	2632.2
45	6847.0	2017.4	248.0	2920.0	10530.0	22562.0
46	4491.0	–	500.0	5000.0	9491.0	19482.0
47	6967.0	4562.3	3185.0	4414.5	11245.5	30374.3
48	2481.0	2552.7	927.0	8064.0	11905.0	25929.7
49	21229.0	3713.0	1685.0	11474.5	707.0	38808.5
50	1483.0	1402.9	608.0	9865.0	727.0	14085.9

Table 6 Number of Workers Classified According to Existing Works.

WW	Executive		Production		Service				General					Total
No	A	B	C	D	E	F	G	H	J	K	L	M	N	
1	1	–	3	–	1	2	–	1	–	1	2	–	1	12
2	1	–	4	–	2	1	–	1	–	1	3	–	1	14
3	1	–	4	–	2	2	1	1	–	1	3	1	1	17
4	1	–	3	–	2	1	1	1	1	1	2	–	1	14
5	1	–	3	–	3	1	1	1	–	1	1	–	1	13
10	1	–	2	–	1	1	–	–	–	1	1	–	1	8
11	1	1	2	–	1	1	–	–	–	1	2	–	1	10
12	1	–	2	–	1	2	–	–	–	1	1	–	1	9
13	1	–	2	–	–	1	–	1	1	1	2	–	1	10
14	1	1	2	–	2	–	–	–	–	1	3	–	–	10
15	1	–	4	–	3	2	1	1	–	1	1	–	1	15
16	1	–	4	–	2	3	1	1	1	1	3	–	1	18
17	1	–	2	–	1	1	–	1	–	1	1	–	1	9
18	1	–	2	–	2	1	–	1	–	1	1	–	1	10
19	1	–	3	–	1	1	–	1	–	1	2	–	1	11
20	1	–	2	–	1	2	–	–	–	1	1	–	1	9
21	1	–	3	–	1	3	1	1	1	1	2	1	1	17
22	1	–	8	–	4	4	2	2	1	1	3	1	1	28
23	1	–	5	–	3	3	1	2	1	1	2	–	1	20
24	1	1	10	–	5	4	4	2	1	1	3	1	2	34
27	1	1	5	–	2	2	2	2	2	1	3	1	2	24

Table 6 (Continued)

WW No	Executive		Production		Service			General						Total
	A	B	C	D	E	F	G	H	J	K	L	M	N	
28	1	–	8	–	3	2	2	2	1	1	1	1	3	25
29	1	–	5	–	3	3	1	2	1	1	1	1	1	20
30	1	–	10	–	5	5	3	3	1	1	3	1	1	34
31	1	1	6	1	3	4	2	2	1	1	2	1	2	27
32	1	–	8	–	3	3	2	2	1	1	2	1	1	25
33	1	–	7	–	2	3	2	2	1	1	4	1	2	26
34	1	1	7	1	2	3	2	2	1	1	2	1	1	25
35	1	–	7	–	5	4	5	–	1	1	3	2	2	31
36	1	–	7	–	5	4	3	3	1	1	3	1	1	30
37	1	–	4	–	2	2	1	1	–	–	3	1	1	16
38	1	1	8	–	8	4	3	3	1	1	1	1	1	33
39	1	1	9	–	5	3	2	2	1	1	2	–	2	29
40	1	1	6	–	3	3	1	2	2	1	2	1	2	25
41	1	1	10	–	4	5	3	3	1	1	5	1	–	35
42	1	–	9	1	4	4	2	3	1	1	3	1	2	32
43	1	–	7	–	5	5	3	3	1	1	3	1	2	32
44	1	–	8	–	2	4	2	3	1	1	3	1	1	27
45	1	1	11	–	5	6	3	5	1	1	3	1	2	40
46	1	–	9	1	1	3	1	1	1	1	3	1	2	25
47	1	1	21	2	9	12	6	6	2	2	6	2	4	74
48	1	3	14	2	7	8	4	5	4	1	4	2	1	56
49	1	2	17	1	10	5	5	5	1	3	9	2	4	65
50	1	1	16	–	8	10	6	7	1	1	3	2	1	57

Abbreviation of Titles in Table 6

A	:	Superintendent
B	:	Assistant Superintendent
C	:	Pump operator
D	:	Laboratry boy
E	:	Civil technicians
F	:	Accountants
G	:	Meter recorders
H	:	Bill collectors
J	:	Clerical service
K	:	Store Keepers
L	:	Workers
M	:	Dvivers
N	:	Gaurds

Table 7 Salary and fringe benefits expense.

WW No	Salary (₿)					Fringe Benefit (₿)	Grand Total (₿)
	Executive	General	Production	Service	Total		
1	19740.0 (12.6)	43470.0 (27.8)	40320.0 (25.8)	52800.0 (33.8)	156330.0	9714.0	166044.0
2	16500.0 (10.3)	48540.0 (30.4)	48780.0 (30.6)	45780.0 (28.7)	159600.0	15740.0	175340.0
3	19740.0 (9.0)	70202.5 (32.1)	56100.0 (25.6)	72840.0 (33.3)	218882.5	28783.0	247665.5
4	19740.0 (10.1)	54480 (27.8)	51060.0 (26.1)	70500.0 (36.0)	195780.0	20050.0	215830.0
5	18600.0 (10.1)	40200 (21.9)	44160.0 (24.0)	80760.0 (44.0)	183720.0	19029.0	202749.0
10	16500.0 (19.8)	25012.3 (30.2)	18000.0 (21.6)	23640.0 (28.4)	83152.3	4345.0	87497.3
11	36240.0 (29.7)	37294.0 (30.6)	19200.0 (15.7)	29280.0 (24.0)	122014.0	39787.0	161801.0
12	19740.0 (16.9)	34380 (29.5)	29700.0 (25.4)	32940.0 (28.2)	116760.0	10731.0	127491.0
13	18600.0 (14.1)	51740 (39.1)	30660.0 (23.2)	31140.0 (23.6)	132140.0	17684.0	149824.0
14	34380.0 (25.2)	45840 (33.6)	23340.0 (17.1)	33060.0 (24.2)	136620.0	19847.0	156467.0
15	21000.0 (11.1)	33600 (17.9)	48900.0 (26.0)	84720.0 (45.0)	188220.0	24210.0	212430.0
16	22320.0 (9.7)	65753.6 (28.5)	65280.0 (28.4)	76848.0 (33.4)	230201.6	33495.0	263696.6

Table 7 (Continued)

WW No	Salary (฿)					Fringe Benefit (฿)	Grand Total (฿)
	Executive	General	Production	Service	Total		
17	19740.0 (16.9)	26977.2 (23.0)	23640.0 (20.2)	46680.0 (39.9)	117037.2	10224.0	127261.2
18	18600.0 (16.2)	27000 (23.4)	30000.0 (26.1)	39540.0 (34.3)	115140.0	14965.0	130105.0
19	19740.0 (13.7)	40200 (27.9)	40440.0 (28.0)	43920.0 (30.4)	144300.0	17738.0	162038.0
20	15540.0 (14.9)	30660 (29.4)	22260.0 (21.3)	35880.0 (34.4)	104340.0	11794.0	116134.0
21	22320.0 (10.0)	71930 (32.4)	51060.0 (23.0)	76680.0 (34.5)	221990.0	34528.0	256518.0
22	19740.0 (9.9)	86400 (24.8)	101940.0 (29.3)	139500.0 (36.0)	347580.0	5890.5	353470.5
23	22320.0 (8.0)	83425 (29.8)	86820.0 (31.0)	87360.0 (31.2)	279925.0	45089.0	325014.0
24	38520.0 (8.7)	44160.0 (10.0)	149460.0 (33.7)	211219.0 (47.6)	443359.0	72406.0	515765.0
27	38340.0 (11.8)	106549.0 (32.9)	77940.0 (24.1)	100956.0 (31.2)	323785.0	41756.0	365541.0
28	25200.0 (7.4)	87601.0 (25.6)	108240.0 (31.7)	120384.0 (35.3)	341425	84958.0	426383.0
29	22320.0 (8.0)	67673.1 (24.1)	75120.0 (26.8)	115140.0 (41.1)	280253.1	40722.0	320975.1
30	22320.0 (4.8)	110684.8 (23.9)	164400.0 (35.4)	166560.0 (35.9)	463964.8	39370.0	503334.8

Table 7 (Continued)

HW No	Salary (₿)					Fringe Bencfit (₿)	Grand Total (₿)
	Executive	General	Production	Service	Total		
31	55200.0 (14.5)	63735.0 (16.8)	97800.0 (25.7)	163500.0 (43.0)	380235.0	63034.0	443269.0
32	23700.0 (6.8)	100471.4 (28.7)	108960.0 (31.2)	116520.0 (33.3)	349651.4	35540.0	385191.4
33	18600.0 (5.2)	115710.0 (32.3)	98340.0 (27.5)	125100.0 (35.0)	357750.0	47429.5	405179.5
34	36960.0 (11.6)	93240.8 (29.2)	93720.0 (29.4)	94920.0 (29.8)	318840.8	49962.0	368802.8
35	26760.0 (6.0)	149290.0 (33.4)	119160.0 (26.6)	151920.0 (34.0)	447130.0	55741.0	502871.0
36	23700.0 (5.6)	77009.5 (17.8)	127140.0 (29.4)	204060.0 (47.2)	431909.5	52934.0	484843.5
37	21000.0 (10.4)	51572.9 (25.5)	53400.0 (26.4)	75960.0 (37.6)	201932.9	22927.4	224860.3
38	44940.0 (9.5)	47683.5 (10.1)	131400.0 (27.8)	248880.0 (52.6)	472903.5	41882.0	514785.5
39	39480.0 (10.2)	98220.0 (25.4)	111120.0 (28.7)	138060.0 (35.7)	386880.0	56916.0	443796.0
40	40920.0 (11.3)	100661.4 (27.7)	98316.0 (27.1)	123240.0 (33.9)	363137.4	67792.5	430929.9
41	45360.0 (9.8)	124843.7 (26.9)	122880.0 (26.4)	171660.0 (36.9)	464743.7	59733.5	524477.2
42	28440.0 (6.3)	121550.0 (26.8)	144420.0 (31.9)	158640.0 (35.0)	453050.0	50470.0	503525.0

Table 7 (Continued)

WW No	Salary (₿)					Fringe Bencfit (₿)	Grand Total (₿)
	Executive	General	Production	Service	Total		
43	28440.0 (6.2)	90630.0 (19.9)	102900.0 (22.6)	233880.0 (51.3)	455850.0	41512.0	497362.0
44	22320.0 (5.9)	71138.2 (18.8)	125400.0 (33.2)	159360.0 (42.1)	378218.2	34697.5	412915.7
45	48180.0 (8.1)	103745.0 (17.4)	162540.0 (27.3)	280320.0 (47.1)	594785.0	65413.0	660198.0
46	19740.0 (5.5)	99230.0 (27.5)	139920.0 (38.7)	102420.0 (48.3)	361310.0	51468.5	412778.5
47	28440.0 (2.6)	214544.0 (19.5)	369840.0 (33.6)	488520.0 (44.3)	1101344.0	102583.5	1203927.5
48	82320.0 (10.0)	154752.3 (18.7)	258240.0 (31.2)	331740.0 (40.1)	827052.3	83211.5	910263.8
49	65520.0 (7.6)	199055.0 (23.2)	259080.0 (30.2)	333900.0 (38.9)	857555.0	104168.0	961723.0
50	48840.0 (6.1)	103810.0 (12.9)	221280.0 (27.6)	427680.0 (53.4)	801610.0	90761.0	892371.0

Note Figures in brackets are expressed in percentage.

Table 8 Allocation of Salary and Fringe Benefits to Production and Service Part.

WW No	Production Part (₱)				Service Part (₱)			
	Direct Production	Partially Involved	Fringe Benefits	Total	Direct Service	Partially Involved	Fringe Benefits	Total
1	40320.0	25284.0	4853.0	70457.0	52800.0	37926.0	4861.0	95587.0
2	48780.0	26016.0	7379.0	82175.0	45780.0	39024.0	8361.0	93165.0
3	56100.0	35977.0	12100.4	104177.4	72840.0	53965.5	16682.6	143488.1
4	51060.0	29688.0	8272.6	89020.6	70500.0	44532.0	11777.4	126809.4
5	44160.0	23520.0	7002.7	74682.7	80760.0	35280.0	12026.3	128066.3
10	18000.0	16604.9	1807.5	36412.4	23640.0	24907.4	2537.5	51084.9
11	19200.0	29413.6	15843.2	64456.8	29280.0	44120.4	23943.8	97344.2
12	29700.0	21648.0	4717.3	56065.3	32940.0	32472.0	6013.7	71425.7
13	30660.0	28136.0	7865.8	66661.8	31140.0	42204.0	9818.2	83162.2
14	23340.0	32088.0	8061.9	63489.9	33060.0	48132.0	11785.1	92977.1
15	48900.0	21840.0	9103.0	79843.0	84720.0	32760.0	15107.0	132587.0
16	65280.0	35229.4	14630.6	115140.0	76848.0	52844.2	18864.4	148556.6
17	23640.0	18686.9	3697.0	46023.9	46680.0	28030.3	6527.0	81237.3
18	30000.0	18240.0	6276.3	54516.3	39540.0	27360.0	8688.7	75588.7

Table 8 (Continued)

WW No	Production Part (Ø)				Service Part (Ø)			
	Direct Production	Partially Involved	Fringe Benefits	Total	Direct Service	Partially Involved	Fringe Benefits	Total
19	40440.0	23976.0	7918.2	72334.2	43920.0	35964.0	9819.8	89703.8
20	22260.0	18480.0	4602.0	45342.0	35880.0	27720.0	7192.0	70792.0
21	51060.0	37700.0	13797.4	102557.4	76680.0	56550.0	20730.6	153960.6
22	101940.0	42456.0	2543.6	146939.6	139500.0	63684.0	3347.0	206531.0
23	86820.0	42298.0	20795.0	149913.0	87360.0	63447.0	24294.0	175101.0
24	149460.0	33072.0	29816.8	212348.8	211219.0	49608.0	42589.2	303416.2
27	77940.0	57955.6	17529.8	153424.8	100956.0	86933.4	24226.8	212116.2
28	108240	45120.4	38146.1	191506.5	120384.0	67680.6	46811.9	234876.5
29	75120.0	35997.2	16142.2	127259.4	115140.0	53995.9	24579.8	193715.7
30	164400.0	53201.9	18456.7	236058.6	166560.0	79802.9	20913.3	267276.2
31	97800.0	47574.0	24091.6	169465.6	163500.0	71361.0	38942.4	273803.4
32	108960.0	49668.6	16135.2	174763.8	116520.0	74502.8	19404.8	210427.6
33	98340.0	53724.0	20157.5	172221.5	125100.0	80586.0	27272.0	232958.0
34	93720.0	52080.3	22842.6	168642.9	94920.0	78120.5	27119.4	200159.9
35	119160.0	70420.0	23611.9	213191.9	151920.0	105630.0	32129.1	289679.1

Table 8 (Continued)

WW No	Production Part (₿)				Service Part (₿)			
	Direct Production	Partially Involved	Fringe Benefits	Total	Direct Service	Partially Involved	Fringe Benefits	Total
36	127140.0	40283.8	20517.2	187941.0	204060.0	60425.7	32416.8	296902.5
37	53400.0	29029.2	9345.2	91774.4	75960.0	43543.7	13582.2	133085.9
38	131400.0	37049.4	14926.7	183376.1	248880.0	55574.1	26955.3	331409.4
39	111120.0	55080.0	24439.7	190639.7	138060.0	82620.0	32476.3	253156.3
40	98316.0	56632.6	28947.4	183896.0	123240.0	84948.8	38845.1	247033.9
41	122880.0	68081.5	24538.5	215500.0	171660.0	102122.2	35195.0	308977.2
42	144420.0	59996.0	22784.4	227200.4	158640.0	89994.0	27690.6	276324.6
43	102900.0	47628.0	13715.6	164243.6	233880.0	71442.0	27796.4	333118.4
44	125400.0	37383.3	14947.7	177731.0	159360.0	56074.9	19749.8	235184.7
45	162540.0	60770.0	24529.9	247839.9	280320.0	91155.0	40883.1	412358.1
46	139920.0	47588.0	26712.2	214220.2	102420.0	71382.0	24756.3	198558.3
47	369840.0	97193.6	43536.4	510570.0	488520.0	145790.4	59047.1	693357.5
48	258240.0	94828.9	35514.7	388583.6	331740.0	142243.4	47696.8	521680.2
49	259080.0	105830.0	44292.2	409202.2	333900.0	158745.0	59875.8	552520.8
50	221280.0	61060.0	31947.9	314287.6	427680.0	91590.0	58813.1	578083.1

Table 9 Miscellaneous Expense.

WW No.	Production Part (Ø)	Service Part (Ø)			
	Transporting of Chemicels	Office Stationary Package	Message Deliverying Telephone	Renting Travelling	Total
1	8644.5	830.5	619.0	-	1499.5
2	5263.3	356.0	-	-	356.0
3	2875.5	403.0	-	1847.0	2250.0
4	5331.8	126.0	-	-	126.0
5	1516.3	180.0	189.0	-	369.0
10	10853.0	146.0	190.0	-	336.0
11	4181.5	442.0	47.0	-	489.0
12	3754.5	96.0	455.0	-	551.0
13	21872.2	259.5	-	1215.0	1474.5
14	1647.0	45.0	9.0	-	54.0
15	7303.8	429.6	1558.0	-	1987.6
16	6276.3	197.0	-	1005.0	1202.0
17	1283.0	263.0	60.0	-	323.0
18	7957.5	-	-	586.0	586.0
19	5942.0	737.0	10.0	-	747.0
20	5232.5	1030.0	314.0	-	1344.0
21	9935.5	1492.0	133.0	-	1625.0
22	1325.8	713.0	55.5	-	1268.0
23	14082.5	1149.0	92.0	-	1241.0

Table 9 (Continued)

WW No.	Production Part (₿)	Service Part (₿)			
	Transporting of Chemicals	Office Stationary, Package	Message Deliverying, Telephone	Renting, Travelling	Total
24	12267.3	2654.0	134.0	4209.0	6997.0
27	11287.3	791.5	6.5	-	798.0
28	6419.3	9551.0	208.5	-	9759.5
29	6778.5	765.5	821.5	-	1587.0
30	12731.8	535.5	150.0	590.0	1275.5
31	11620.3	1560.0	253.5	1500.0	3313.5
32	25391.0	1523.0	78.0	200.0	1801.0
33	1085.0	595.0	68.0	1000.0	1663.0
34	22427.0	562.5	33.0	420.0	1015.5
35	14239.3	6413.0	216.0	2844.0	9473.0
36	29210.6	405.0	48.5	515.0	968.5
37	11836.3	489.5	10.0	-	499.5
38	18726.5	2266.0	110.5	-	2376.5
39	14791.0	1416.0	-	-	1416.0
40	40939.0	467.0	12.0	-	479.0
41	6599.5	2279.0	38.0	-	2317.0
42	17926.5	1378.5	87.0	520.0	1985.5
43	570.8	409.0	-	2757.0	3166.0
44	11237.5	682.0	68.0	-	750.0

Table 9 (Continued)

WW. No.	Production Part (Ø)		Service Part (Ø)		
	Transporting of Chemicals	Office Stationary, Package	Message Deliverying Telephone	Renting, Travelling	Total
45	39357.1	1418.0	-	511.5	1929.5
46	57597.3	-	344.5	851.8	1196.3
47	117832.8	8301.5	129.5	4777.0	13208.0
48	89138.7	4184.0	452.8	3000.0	7636.8
49	32628.8	3336.0	372.8	2454.0	6162.8
50	31094.0	9097.0	332.0	600.0	10029.0

Table 10 Breakdown of OMR Cost in Production Part in Baht

WW No.	Chemicals	Power	Maintenance	Salary	Miscellaneous	Total
1	8708.3 (4.2)	54092.2 (26.4)	63214.1 (30.8)	70457.0 (34.4)	8644.5 (4.2)	205073.1
2	9613.3 (6.8)	31661.0 (22.2)	13639.0 (9.6)	82175.0 (57.7)	5263.3 (3.7)	142351.6
3	13373.3 (4.9)	112420.7 (41.3)	39669.2 (14.6)	104177.4 (38.2)	2875.5 (1.1)	272516.1
4	9317.1 (4.6)	65062.8 (31.9)	34971.1 (17.2)	89020.6 (43.7)	5331.8 (2.6)	203703.4
5	4689.7 (4.5)	19718.7 (18.8)	4374.4 (4.2)	74682.7 (71.1)	1516.3 (1.4)	104981.8
10	4831.2 (7.6)	8836.3 (13.8)	2869.0 (4.5)	36412.4 (57.1)	10853.0 (17.0)	63801.9
11	8601.9 (9.3)	5890.0 (6.4)	9104.9 (9.9)	64456.8 (69.9)	4181.5 (4.5)	92235.1
12	19001.3 (13.1)	23742.8 (16.3)	42803.3 (29.4)	56065.3 (38.6)	3754.5 (2.6)	145367.2
13	22952.9 (17.4)	17358.1 (13.1)	3272.0 (2.5)	66661.8 (50.5)	21872.2 (16.6)	132117.0
14	3532.0 (4.4)	7460.7 (9.3)	4512.0 (5.6)	63489.9 (78.7)	1647.0 (2.0)	80641.6
15	35751.4 (19.4)	40302.0 (21.9)	20746.7 (11.3)	79843.0 (43.4)	7303.8 (3.4)	183946.9
16	57141.0 (19.6)	83631.2 (28.6)	30014.8 (10.3)	115140.0 (39.4)	6276.3 (2.1)	292203.3

Table 10 (Continued)

WW No	Chemicals	Power	Maintenance	Salary	Misullaneous	Total
17	8518.9 (11.1)	19695.0 (25.7)	1221.0 (1.6)	46023.9 (60.0)	1283.0 (1.7)	76741.8
18	33669.5 (31.8)	5079.2 (4.8)	4524.0 (4.3)	54516.3 (51.6)	7957.5 (7.5)	105746.5
19	8989.2 (6.8)	22207.9 (16.8)	22617.8 (17.1)	72334.2 (54.8)	5942.0 (4.5)	132091.1
20	16543.2 (20.3)	12476.2 (15.3)	1979.0 (2.4)	45342.0 (55.6)	5232.5 (6.4)	81572.9
21	65971.0 (18.7)	151558.7 (43.3)	19760.5 (5.6)	102557.4 (29.3)	9935.5 (2.8)	349783.1
22	74887.0 (22.9)	99528.2 (30.5)	3881.6 (1.2)	146939.6 (45.0)	1325.8 (0.4)	326562.2
23	64131.1 (20.6)	61977.5 (19.8)	23414.8 (7.5)	149913.0 (47.8)	14082.5 (4.5)	315518.9
24	82766.1 (11.2)	379778.4 (51.4)	51264.4 (6.9)	212348.8 (28.8)	12267.3 (1.7)	738425.0
27	21018.2 (8.0)	57831.2 (22.1)	18599.6 (7.1)	153424.8 (58.5)	11287.2 (4.3)	262161.0
28	56906.7 (9.4)	265530.6 (43.9)	84664.9 (14.0)	191506.5 (31.7)	6419.3 (1.1)	605028.0
29	25426.0 (6.3)	232221.3 (57.2)	14275.4 (3.5)	127259.4 (31.3)	6778.5 (1.7)	405960.6
30	110039.2 (15.9)	326255.1 (47.2)	6834.4 (1.0)	236058.6 (34.1)	12731.8 (1.8)	691919.1

Table 10 (Continued)

WW No.	Chemicals	Power	Maintenance	Salary	Misullaneous	Total
31	81106.2 (14.2)	272405.3 (47.8)	35079.6 (6.2)	169465.6 (29.7)	11620.3 (2.0)	569677.0
32	215757.4 (29.6)	302826.9 (41.5)	10825.4 (1.5)	174763.8 (24.0)	25391.0 (3.5)	729564.5
33	63786.9 (14.8)	135537.1 (31.3)	59762.2 (13.8)	172221.5 (39.8)	1085.0 (0.3)	432392.7
34	125079.3 (21.7)	219268.0 (38.0)	42224.6 (7.3)	168642.9 (29.2)	22427.0 (3.9)	577641.8
35	54125.4 (9.1)	286982.6 (48.2)	27335.4 (4.6)	213191.9 (35.8)	14239.3 (2.4)	595874.6
36	134540.4 (19.6)	321602.2 (46.9)	13110.0 (1.9)	187941.0 (27.4)	29210.6 (4.3)	686404.2
37	33732.5 (12.9)	114123.8 (43.6)	10405.0 (4.0)	91774.4 (35.0)	11836.3 (4.5)	261872.0
38	142447.2 (23.4)	254577.5 (41.8)	10401.0 (1.7)	183376.1 (30.1)	18726.5 (3.1)	609528.3
39	76618.3 (17.8)	138668.4 (32.2)	10390.2 (2.4)	190639.7 (44.2)	14791.0 (3.4)	431127.6
40	68023.7 (12.4)	237117.6 (43.2)	19023.8 (3.5)	183896.0 (33.5)	40939.0 (7.5)	549000.1
41	311447.1 (28.7)	452920.6 (41.7)	100601.6 (9.2)	215500.0 (19.8)	6599.5 (0.6)	1087068.8
42	76100.3 (18.3)	82244.4 (19.8)	12649.8 (3.0)	227200.4 (54.6)	17926.5 (4.3)	416121.4

Table 10 (Continued)

WI No.	Chemicals	Power	Maintenance	Salary	Misullaneous	Total
43	29776.3 (4.9)	390922.0 (64.9)	16899.0 (2.8)	164243.6 (27.3)	570.8 (0.1)	602411.7
44	187875.3 (33.6)	167536.8 (30.0)	14005.0 (2.5)	177731.0 (31.8)	11237.5 (2.0)	558385.6
45	299703.9 (30.7)	345459.3 (35.4)	42561.0 (4.4)	247839.9 (25.4)	39357.1 (4.0)	974921.2
46	156229.0 (14.7)	554325.8 (52.1)	82238.1 (7.7)	214220.2 (20.1)	57597.3 (5.4)	1064610.4
47	769667.4 (26.9)	1195875.0 (41.8)	265701.0 (9.3)	510570.0 (17.9)	117832.8 (4.1)	2859646.2
48	534024.8 (22.0)	1485437.4 (61.1)	24483.3 (1.0)	388583.6 (16.0)	89138.7 (3.7)	2432529.1
49	356289.3 (19.3)	994519.8 (53.9)	50816.5 (2.8)	409202.2 (22.2)	32628.8 (1.8)	1843456.6
50	360653.9 (25.1)	671593.8 (46.7)	61653.0 (4.3)	314287.9 (21.8)	31094.0 (2.2)	1439282.6

Note Figures in brackets are expressed in percentage.

Table 11 Breakdown of OMR Cost in Service Part in Baht.

WW No	Power	Maintenauce	Salary	Miscellaneaus	Total
1	28686.3 (19.2)	23688.9 (15.8)	95587.0 (64.0)	1499.5 (1.0)	149461.7
2	9244.1 (8.9)	1678.0 (1.6)	93165.0 (89.2)	356.0 (0.3)	104443.1
3	16443.0 (9.3)	14248.0 (8.1)	143488.1 (81.3)	2250.0 (1.3)	176429.1
4	13630.0 (9.3)	5971.4 (4.1)	126809.4 (86.5)	124.0 (0.1)	146536.8
5	6782.7 (5.0)	983.6 (0.7)	128066.3 (94.0)	369.0 (0.3)	136201.6
10	8302.9 (13.6)	1106.7 (1.8)	51084.9 (84.0)	336.0 (0.6)	60830.5
11	11538.0 (10.1)	5050.6 (4.4)	97344.2 (85.1)	489.0 (0.4)	114421.8
12	8176.4 (9.7)	4370.2 (5.2)	71425.7 (84.5)	551.0 (0.7)	84523.3
13	18648.9 (17.4)	3888.4 (3.6)	83162.2 (77.6)	1474.5 (1.4)	107174.0
14	3445.3 (3.6)	482.0 (0.5)	92977.1 (95.9)	54.0 (0.1)	96958.4
15	7953.7 (5.5)	3264.4 (2.4)	132587.0 (90.9)	1987.6 (1.4)	145792.7
16	14632.8 (7.9)	20817.7 (11.2)	148556.6 (80.2)	1202.0 (0.6)	185209.1

Table 11 (Continued)

WW No	Power	Maintenauce	Salary	Miscellaneaus	Total
17	4922.6 (5.6)	1757.6 (2.0)	81237.3 (92.1)	323.0 (0.4)	88240.5
18	5932.0 (7.2)	821.0 (1.0)	75588.7 (91.2)	586.0 (0.7)	82927.7
19	12859.8 (10.8)	15747.5 (13.2)	89703.8 (75.3)	747.0 (0.6)	119058.1
20	2414.4 (3.2)	1002.0 (1.3)	70792.0 (93.7)	1344.0 (1.8)	75552.4
21	23206.6 (12.5)	7443.0 (4.0)	153960.6 (82.7)	1625.0 (0.9)	186235.2
22	12408.8 (5.3)	12533.1 (5.4)	206531.0 (88.7)	1268.0 (0.5)	232740.9
23	12705.2 (6.5)	5852.2 (3.0)	175101.0 (89.8)	1241.0 (0.6)	194899.4
24	25576.8 (7.3)	12361.3 (3.5)	303416.2 (87.1)	6997.0 (2.0)	348351.3
27	7107.6 (3.1)	7527.3 (3.3)	212116.2 (93.2)	798.0 (0.4)	227548.9
28	14612.6 (5.5)	7611.2 (2.9)	234876.5 (88.0)	9759.5 (3.7)	266859.8
29	27860.3 (11.9)	10783.5 (4.6)	193715.7 (82.8)	1587.0 (0.7)	233946.5
30	35326.2 (11.3)	8428.5 (2.7)	267276.2 (85.6)	1275.5 (0.4)	312306.4

Table 11 (Continued)

WW No	Power	Maintenauce	Salary	Miscellaneaus	Total
31	34011.0 (10.8)	4998.4 (1.6)	273803.4 (86.6)	3313.5 (1.0)	316126.3
32	46335.7 (17.1)	12558.7 (4.6)	210427.6 (77.6)	1801.0 (0.7)	271123.0
33	28594.7 (10.3)	13560.1 (4.9)	232958.0 (84.2)	1663.0 (0.6)	276775.8
34	21999.2 (9.5)	8605.7 (3.7)	200159.9 (86.4)	1015.5 (0.4)	231780.3
35	36774.2 (10.5)	14001.2 (4.0)	289679.1 (82.8)	9473.0 (2.7)	349927.5
36	37103.3 (10.7)	11122.1 (3.2)	296902.5 (85.8)	968.5 (0.3)	346096.4
37	22019.7 (13.7)	5357.3 (3.3)	133085.9 (82.7)	499.5 (0.3)	160962.4
38	52505.0 (13.1)	15056.7 (3.8)	331409.4 (82.6)	2376.5 (0.6)	401347.6
39	15563.5 (5.7)	2756.9 (1.0)	253156.3 (92.8)	1416.0 (0.5)	272892.7
40	18301.7 (6.6)	9705.1 (3.5)	247033.9 (89.7)	479.0 (0.2)	275519.7
41	53315.5 (14.1)	13886.5 (3.7)	308977.2 (81.6)	2317.0 (0.6)	378496.2
42	29400.5 (9.3)	9231.4 (2.9)	276324.6 (87.2)	1985.5 (0.6)	316942.0

Table 11 (Continued)

WW No	Power	Maintenauce	Salary	Miscellaneaus	Total
43	25178.5 (6.8)	8226.9 (2.2)	333118.4 (90.1)	3166.0 (0.9)	369689.8
44	19037.6 (7.3)	2632.2 (1.0)	235184.7 (91.3)	750.0 (0.3)	257604.5
45	36787.8 (7.8)	22562.0 (4.8)	412358.1 (87.1)	1929.5 (0.4)	473637.4
46	9788.8 (4.3)	19482.0 (8.5)	198558.3 (86.7)	1196.3 (0.5)	229025.4
47	91499.0 (11.0)	30374.3 (3.7)	693357.5 (83.7)	13208.0 (1.6)	828438.8
48	82742.7 (13.0)	25929.7 (4.1)	521680.2 (81.8)	7636.8 (1.2)	637989.4
49	84443.6 (12.4)	38808.5 (5.7)	552520.8 (81.0)	6162.8 (0.9)	681935.7
50	43033.7 (6.7)	14085.9 (2.2)	578083.1 (89.6)	10029.0 (1.6)	645231.7

Note Figures in brackets are expressed in percentage.

APPENDIX D

COMPUTER PROGRAMS AND RESULTS

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DOS FORTRAN IV 360N-FO-479 3-8        MAINPGM        DATE  09/10/78    TIME  15.31.08    PAGE 0001

      C 67550 MR. THANADE DAWASUWAN
0001        DIMENSION C(350),Q(350),X(350),Y(350),A(350),B(350),YF(350),
           1  CNEW(350),SUBYYF(350),SUBYYB(350)
0002        DO 200 J=1,8
0003        READ (1,10) N,(C(L),L=1,N)
0004     10 FORMAT(I3,/,(8F10.4))
0005        READ (1,20) (Q(L),L=1,N)
0006     20 FORMAT(10F8.1)
0007        SUMXY = 0
0008        SUMX = 0
0009        SUMY = 0
0010        SUMX2 = 0
0011        SUMYYF = 0
0012        SUMYYB = 0
0013        DO 30 I=1,N
0014        X(I) = ALOG(Q(I))
0015        Y(I) = ALOG(C(I))
0016        A(I) = X(I)**2
0017        SUMX = SUMX+X(I)
0018        SUMY = SUMY+Y(I)
0019        SUMX2 = SUMX2+A(I)
0020        B(I) = X(I)*Y(I)
0021        SUMXY = SUMXY+B(I)
0022     30 CONTINUE
0023        AN = N
0024        ALPHA = (AN*SUMXY-SUMX*SUMY)/(AN*SUMX2-SUMX**2)
0025        BEE = (SUMX2*SUMY-SUMX*SUMXY)/(AN*SUMX2-SUMX**2)
0026        CAYK = EXP(BEE)
0027        DO 40 K=1,N
0028        CNEW(K) = CAYK*Q(K)**ALPHA
0029        YF(K) = ALOG(CNEW(K))
0030        YBAR = SUMY/AN
0031        SUBYYF(K) = (Y(K)-YF(K))**2
0032        SUMYYF = SUMYYF+SUBYYF(K)
0033        SUBYYB(K) = (Y(K)-YBAR)**2
0034        SUMYYB = SUMYYB+SUBYYB(K)
0035     40 CONTINUE
0036        STATUS = ABS(1.-SUMYYF/SUMYYB)
0037        R = SQRT(STATUS)
0038        GO TO (60,70,80,90,100,110,120,130),J
0039     60 WRITE (3,65)
0040     65 FORMAT(////,10X,91HFIND THE ECONOMY OF SCALE FACTOR AND CONSTANT O
           1F PROCESS PART IN INVESTMENT COST FUNCTION.,//)
0041        GO TO 140
0042     70 WRITE (3,75)
0043     75 FORMAT(////,10X,66HFIND THE ECONOMY OF SCALE FACTOR AND CONSTANT O
           1F NON-PROCESS PART.,//)
0044        GO TO 140
0045     80 WRITE (3,85)
0046     85 FORMAT(////,10X,94HFIND THE ECONOMY OF SCALE FACTOR AND CONSTANT O
           1F THE TREATMENT PLANT INVESTMENT COST FUNCTION.,//)
0047        GO TO 140
0048     90 WRITE (3,95)
0049     95 FORMAT(////,10X,84HFIND THE ECONOMY OF SCALE FACTOR AND CONSTANT O
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DOS FORTRAN IV 360N-FO-479 3-8        MAINPGM        DATE 09/10/78    TIME 15.31.08        PAGE 0002

     1F THE TOTAL INVESTMENT COST FUNCTION.,//)
0050       GO TO 140
0051   100 WRITE (3,105)
0052   105 FORMAT(////,10X,91HFIND THE ECONOMY OF SCALE FACTOR AND CONSTANT O
     1F THE PRODUCTION PART IN OMR COST FUNCTION.,//)
0053       GO TO 140
0054   110 WRITE (3,115)
0055   115 FORMAT(////,10X,88HFIND THE ECONOMY OF SCALE FACTOR AND CONSTANT O
     1F THE SERVICE PART IN OMR COST FUNCTION.,//)
0056       GO TO 140
0057   120 WRITE (3,125)
0058   125 FORMAT(////,10X45HFIND THE UNIT COST OF PRODUCTION AND SERVICE.,//
     1)
0059       GO TO 140
0060   130 WRITE (3,135)
0061   135 FORMAT(////,10X,49HFIND THE WATER DEMAND RELATED TO POPULATION SIZ
     1E.,//)
0062   140 WRITE (3,150) ALPHA,CAYK,R
0063   150 FORMAT(5X,8HALPHA =,F8.2,5X,8H K =,F7.2,5X,
     132H COEFFICIENT OF CORRELATION =,F7.3,//)
          IF (J.EQ.8) GO TO 500
0064       WRITE (3,160)
0065   160 FORMAT(30X,5X,7H CD.,8X,1H1,10X,1HQ,9X,1H1,5X,11H CF.)
0066       WRITE(3,183)
0067   183 FORMAT(26X,24H IN 1000 BAHT.,1H1,6X,10HCUBE/DAY ,4X,
     11H1,2X,24H IN 1000 BAHT. )
0068       WRITE (3,165)
0069   165 FORMAT(50X,1H1,20X,1H1,/,30X,20(1H-),1H1,20(1H-),1H1,
     120(1H-),/,50X,1H1,20X,1H1)
0070   400 DO 180 M=1,N
0071       WRITE (3,170) C(M),Q(M),CNEW(M)
0072   170 FORMAT(29X,F12.2,9X,1H1,F13.1,7X,1H1,F15.2,/)
0073   180 CONTINUE
0074   200 CONTINUE
0075       STOP
0076   500 WRITE (3,550)
0077   550 FORMAT(30X,5X,7H DD.,8X,1H1,10X,1HP,9X,1H1,5X,7H OF.)
0078       WRITE(3,551)
0079   551 FORMAT(35X,7H LPCD ,8X,1H1,6X,6HPERSON,8X,1H1,5X,7H LPCD )
0080       WRITE(3,552)
0081   552 FORMAT(50X,1H1,20X,1H1,/,30X,20(1H-),1H1,20(1H-),1H1,20(1H-),/,
0082     150X,1H1,20X,1H1)
0083       GO TO 400
0084       END
```

FIND THE ECONOMY OF SCALE FACTOR AND CONSTANT OF PROCESS PART IN INVESTMENT COST FUNCTION.

ALPHA = 0.67 K = 22.03 COEFFICIENT OF CORRELATION = 0.967

CD. IN 1000 BAHT.	Q CUBE/DAY	CF. IN 1000 BAHT.
1444.90	400.0	1230.07
1201.30	400.0	1230.07
2573.20	800.0	1958.98
1963.80	800.0	1958.98
1716.10	800.0	1958.98
1744.00	800.0	1958.98
1931.00	800.0	1958.98
2129.10	800.0	1958.98
2497.80	800.0	1958.98
1763.70	800.0	1958.98
2161.50	800.0	1958.98
3166.30	1600.0	3119.82
2573.70	1600.0	3119.82
2608.70	1600.0	3119.82
2319.90	1600.0	3119.82
1761.80	800.0	1958.98
3976.70	2000.0	3624.02
3229.30	2000.0	3624.02
3172.40	1600.0	3119.82
7471.60	5000.0	6704.27
6721.00	4000.0	5771.52
2764.10	2000.0	3624.02
3682.30	2000.0	3624.02
6132.90	3200.0	4968.54
5540.90	4000.0	5771.52
3439.10	1600.0	3119.82
4996.60	3200.0	4968.54
5511.10	4000.0	5771.52
7114.50	5000.0	6704.27
10727.80	10000.0	10677.04

FIND THE ECONOMY OF SCALE FACTOR AND CONSTANT OF NON-PROCESS PART.

ALPHA = 0.21 K = 255.34 COEFFICIENT OF CORRELATION = 0.367

CD. IN 1000 BAHT.	Q CUBE/DAY	CF. IN 1000 BAHT.
1109.80	400.0	879.91
770.60	400.0	879.91
1096.00	800.0	1015.31
694.40	800.0	1015.31
470.20	800.0	1015.31
1316.20	800.0	1015.31
1533.50	800.0	1015.31
1210.80	800.0	1015.31
920.60	800.0	1015.31
1079.80	800.0	1015.31
618.80	800.0	1015.31
1736.20	1600.0	1171.55
2307.70	1600.0	1171.55
951.60	1600.0	1171.55
1117.60	1600.0	1171.55
1642.80	800.0	1015.31
1480.60	2000.0	1226.80
1467.90	2000.0	1226.80
1060.90	1600.0	1171.55
2190.70	5000.0	1482.34
2176.50	4000.0	1415.59
318.10	2000.0	1226.80
1702.50	2000.0	1226.80
1802.40	3200.0	1351.84
1006.90	4000.0	1415.59
1159.70	1600.0	1171.55
1355.10	3200.0	1351.84
900.80	4000.0	1415.59
1224.80	5000.0	1482.34
1706.70	10000.0	1710.45

FIND THE ECONOMY OF SCALE FACTOR AND CONSTANT OF THE TREATMENT INVESTMENT COST FUNCTION.

ALPHA = 0.62 K = 89.53 COEFFICIENT OF CORRELATION = 0.923

CD. IN 1000 BAHT.	Q CUBE/DAY	CF. IN 1000 BAHT.
5899.70	400.0	3755.07
3153.90	400.0	3755.07
6421.00	800.0	5785.48
7089.10	800.0	5785.48
5073.50	800.0	5785.48
5036.50	800.0	5785.48
6578.90	800.0	5785.48
5147.60	800.0	5785.48
6368.30	800.0	5785.48
6404.30	800.0	5785.48
4868.60	800.0	5785.48
8754.80	1600.0	8913.75
10574.90	1600.0	8913.75
7609.00	1600.0	8913.75
6256.80	1600.0	8913.75
5072.20	800.0	5785.48
10240.00	2000.0	10244.57
11020.60	2000.0	10244.57
9779.70	1600.0	8913.75
27500.00	5000.0	18140.45
17024.30	4000.0	15783.93
7570.10	2000.0	10244.57
12060.00	2000.0	10244.57
18431.00	3200.0	13733.54
13362.00	4000.0	15783.93
7877.70	1600.0	8913.75
11854.10	3200.0	13733.54
10663.90	4000.0	15783.93
19944.70	5000.0	18140.45
29807.60	10000.0	27949.19

FIND THE ECONOMY OF SCALE FACTOR AND CONSTANT OF THE TOTAL INVESTMENT COST FUNCTION.

ALPHA = 0.55 K = 78.46 COEFFICIENT OF CORRELATION = 0.934

CD. IN 1000 BAHT.	Q CUBE/DAY	CF. IN 1000 BAHT.
2554.70	400.0	2069.15
1971.90	400.0	2069.15
3669.20	800.0	3021.37
2658.20	800.0	3021.37
2186.30	800.0	3021.37
3060.20	800.0	3021.37
3464.50	800.0	3021.37
3359.90	800.0	3021.37
3418.40	800.0	3021.37
2843.50	800.0	3021.37
2780.30	800.0	3021.37
4902.50	1600.0	4411.80
4881.40	1600.0	4411.80
3560.30	1600.0	4411.80
3437.50	1600.0	4411.80
3404.60	800.0	3021.37
5457.30	2000.0	4983.61
4697.20	2000.0	4983.61
4233.30	1600.0	4411.80
9662.30	5000.0	8220.25
8897.50	4000.0	7277.06
3082.20	2000.0	4983.61
5384.80	2000.0	4983.61
7935.30	3200.0	6442.10
6547.80	4000.0	7277.06
4598.80	1600.0	4411.80
6351.70	3200.0	6442.10
6411.90	4000.0	7277.06
8339.30	5000.0	8220.25
12434.50	10000.0	12003.18

FIND THE ECONOMY OF SCALE FACTOR AND CONSTANT OF THE PRODUCTION PART IN OMR COST FUNCTION.

ALPHA = 0.59 K = 6.36 COEFFICIENT OF CORRELATION = 0.945

CD. IN 1000 BAHT.	Q CUBE/DAY	CF. IN 1000 BAHT.
205.10	277.6	179.52
142.30	126.8	112.73
272.50	416.8	228.52
203.70	171.9	135.06
105.00	71.5	80.22
63.80	64.8	75.67
92.20	159.3	129.09
145.40	267.2	175.50
132.10	344.7	204.15
80.60	60.2	72.43
183.90	323.2	196.49
292.20	573.9	276.32
76.70	241.8	165.39
105.70	354.4	207.54
132.10	131.2	115.04
81.60	137.1	118.08
349.90	889.1	358.34
326.60	108.1	102.54
313.50	833.6	344.89
738.40	1894.6	561.57
262.20	477.0	247.58
605.00	1550.9	498.63
406.00	1393.6	467.95
691.90	3219.8	769.41
569.70	1793.6	543.59
729.60	2702.1	693.35
432.40	1002.3	384.77
577.60	2104.5	597.72
595.90	2022.4	583.76
686.40	3709.7	836.92
261.90	1048.5	395.21
609.50	2381.6	720.34
431.10	789.5	333.93
549.00	1230.3	434.57

1097.10	1	3763.2	1	844.06
416.10	1	1457.1	1	480.50
602.40	1	2329.2	1	634.83
558.40	1	3010.1	1	739.25
974.90	1	5849.8	1	1096.82
1064.60	1	5865.2	1	1098.53
2859.60	1	14412.1	1	1873.51
2432.50	1	14568.0	1	1885.52
1843.50	1	12136.5	1	1691.76
1439.30	1	11531.6	1	1641.17

FIND THE ECONOMY OF SCALE FACTOR AND CONSTANT OF THE SERVICE PART IN OMR COST FUNCTION.

ALPHA = 0.35 K = 19.49 COEFFICIENT OF CORRELATION = 0.821

CO. IN 1000 BAHT.	Q CUBE/DAY	CF. IN 1000 BAHT.
149.50	277.6	139.22
104.40	126.8	105.87
176.40	416.8	160.47
146.50	171.9	117.75
136.20	71.5	86.66
60.80	64.8	83.73
114.40	159.3	114.66
84.50	267.2	137.38
107.20	344.7	150.17
97.00	60.2	81.60
145.80	323.2	146.82
185.20	573.9	179.45
88.20	241.8	132.66
82.90	354.4	151.63
119.10	131.2	107.14
75.60	137.1	108.80
186.20	889.1	209.12
232.70	108.1	100.13
194.90	833.6	204.46
348.40	1894.6	272.41
227.50	477.0	168.22
266.90	1550.9	254.01
233.90	1393.6	244.69
71.80	3219.8	327.89
316.10	1793.6	267.25
271.10	2702.1	308.40
276.80	1002.3	218.06
231.80	2104.5	282.60
349.90	2022.4	278.70
346.10	3709.7	344.52
161.00	1048.5	221.53
401.30	2881.6	315.41
272.90	789.5	200.61

275.50	1	1230.3	1	234.26
378.50	1	3763.2	1	346.25
316.90	1	1457.1	1	248.53
369.70	1	2329.2	1	292.80
257.60	1	3010.1	1	320.26
473.60	1	5849.8	1	403.97
229.00	1	5865.2	1	404.34
828.40	1	14412.1	1	553.62
638.00	1	14568.0	1	555.71
681.90	1	12136.5	1	521.35
645.20	1	11531.6	1	512.11

FIND THE UNIT COST OF PRODUCTION AND SERVICE.

ALPHA = =0.42 K = 30.93 COEFFICIENT OF CORRELATION = 0.900

CD. IN 1,000 BAHT.	Q CUBE/DAY	CF. IN 1,000 BAHT.
3.50	277.6	2.84
5.33	126.8	3.97
2.95	416.8	2.39
5.58	171.9	3.48
9.24	71.5	5.06
5.27	64.8	5.27
3.55	159.3	3.60
2.36	267.2	2.89
1.90	344.7	2.59
8.08	60.2	5.44
2.90	323.2	2.67
2.28	573.9	2.09
1.87	241.8	3.02
1.46	354.4	2.56
5.25	131.2	3.91
3.14	137.1	3.84
1.65	889.1	1.74
1.42	108.1	4.24
1.67	833.6	1.78
1.57	1894.6	1.26
2.81	477.0	2.26
1.54	1550.9	1.37
1.26	1393.6	1.43
0.65	3219.8	1.01
1.35	1793.6	1.29
1.01	2702.1	1.08
1.94	1002.3	1.65
1.05	2104.5	1.20
1.28	2022.4	1.22
0.76	3709.7	0.95
1.10	1048.5	1.62
0.96	2881.6	1.05
2.44	789.5	1.83

1.84	1	1230.3	1	1.51
1.07	1	3763.2	1	0.94
1.38	1	1457.1	1	1.41
1.14	1	2329.2	1	1.15
0.74	1	3010.1	1	1.03
0.68	1	5849.8	1	0.78
1.21	1	5865.2	1	0.78
0.70	1	14412.1	1	0.53
0.76	1	14568.0	1	0.53
0.57	1	12136.5	1	0.57
0.50	1	11531.6	1	0.59

FIND THE WATER DEMAND RELATED TO POPULATION SIZE.

ALPHA = 0.16 K = 28.23 COEFFICIENT OF CORRELATION = 0.330

DD. LPCD	P PERSON	DF. LPCD
74.00	4360.0	109.94
84.00	4430.0	110.23
105.70	4122.0	108.95
92.30	3570.0	106.43
98.20	3664.0	106.88
103.40	4397.0	110.09
134.60	3114.0	104.10
100.60	4520.0	110.59
117.70	3812.0	107.57
118.40	3998.0	108.41
125.80	4381.0	110.03
94.80	4885.0	111.99
111.80	4980.0	112.34
136.40	4180.0	109.19
145.20	4133.0	108.99
150.20	4200.0	109.28
172.10	4265.0	109.55
106.00	4513.0	110.56
63.00	5328.0	113.58
85.50	5359.0	113.68
108.20	1893.0	96.03
122.00	2045.0	97.24
75.90	2105.0	97.69
86.10	2247.0	98.73
77.00	2250.0	98.76
60.20	2398.0	99.78
66.00	2527.0	100.63
68.80	2557.0	100.83
94.10	6818.0	118.21
60.20	6542.0	117.42
47.10	7090.0	118.97
84.70	3876.0	107.86
74.00	4535.0	110.65

90.70	1	4620.0	1	110.98
79.00	1	4737.0	1	111.43
99.00	1	4392.0	1	110.07
190.60	1	4469.0	1	110.38
294.70	1	4524.0	1	110.60
288.30	1	4689.0	1	111.25
254.40	1	4720.0	1	111.37
111.20	1	5487.0	1	114.12
117.50	1	5640.0	1	114.63
90.80	1	5613.0	1	114.54
104.30	1	6584.0	1	117.55
85.90	1	6420.0	1	117.07
66.30	1	8003.0	1	121.33
131.80	1	7743.0	1	120.68
65.00	1	9152.0	1	124.00
65.90	1	9480.0	1	124.71
77.00	1	8613.0	1	122.78
87.60	1	8620.0	1	122.80
299.00	1	4681.0	1	111.22
256.10	1	4712.0	1	111.34
257.30	1	4789.0	1	111.63
222.00	1	4804.0	1	111.69
220.00	1	4913.0	1	112.09
214.70	1	5038.0	1	112.55
221.50	1	5017.0	1	112.47
62.10	1	9760.0	1	125.30
74.80	1	7143.0	1	119.11
45.80	1	11959.0	1	129.49
43.10	1	12631.0	1	130.65
39.00	1	12200.0	1	129.91
67.00	1	11800.0	1	129.21
67.40	1	9847.0	1	125.48
50.80	1	10085.0	1	125.96
35.10	1	16917.0	1	136.99
146.30	1	24158.0	1	145.14
131.70	1	28156.0	1	148.79
130.80	1	26671.0	1	147.49
120.00	1	29035.0	1	149.53
119.90	1	5700.0	1	114.83

149.50	1	5979.0	1	115.72
135.80	1	6169.0	1	116.31
127.40	1	11574.0	1	128.81
119.00	1	11933.0	1	129.45
96.00	1	12400.0	1	130.26
71.20	1	12467.0	1	130.37
129.90	1	12515.0	1	130.45
80.90	1	12837.0	1	130.99
77.00	1	14500.0	1	133.61
62.20	1	10806.0	1	127.38
61.30	1	11195.0	1	128.12
69.00	1	11112.0	1	127.96
71.80	1	11268.0	1	128.25
70.90	1	11278.0	1	128.27
63.50	1	11327.0	1	128.36
76.60	1	10624.0	1	127.03
72.30	1	11277.0	1	128.27
72.60	1	11151.0	1	128.03
115.90	1	11209.0	1	128.14
119.70	1	16316.0	1	136.19
115.30	1	18434.0	1	138.91
126.90	1	18734.0	1	139.28
116.90	1	19148.0	1	139.77
110.80	1	19515.0	1	140.20
106.60	1	19744.0	1	140.47
101.80	1	20128.0	1	140.91
109.30	1	20505.0	1	141.33
107.30	1	20882.0	1	141.75
109.70	1	21600.0	1	142.53
112.10	1	4226.0	1	109.39
116.30	1	4243.0	1	109.46
123.20	1	4249.0	1	109.48
134.80	1	4240.0	1	109.45
116.70	1	4258.0	1	109.52
116.30	1	4390.0	1	110.07
115.10	1	4462.0	1	110.36
256.80	1	8900.0	1	123.44
185.10	1	6356.0	1	116.88
129.10	1	6803.0	1	118.17

127.30	1	7111.0	1	119.02
150.50	1	7296.0	1	119.52
173.70	1	7566.0	1	120.23
199.80	1	7873.0	1	121.00
184.70	1	8353.0	1	122.17
186.50	1	8854.0	1	123.33
185.30	1	9912.0	1	125.61
191.70	1	10020.0	1	125.83
122.90	1	8036.0	1	121.41
108.40	1	8605.0	1	122.76
119.10	1	8937.0	1	123.52
147.50	1	9277.0	1	124.27
134.50	1	9551.0	1	124.86
128.50	1	9977.0	1	125.74
134.50	1	10574.0	1	126.93
130.90	1	10800.0	1	127.37
130.20	1	11621.0	1	128.89
110.80	1	11500.0	1	128.68
161.50	1	15309.0	1	134.79
160.10	1	16362.0	1	136.25
180.40	1	16362.0	1	136.25
181.30	1	18313.0	1	138.76
183.10	1	19148.0	1	139.77
181.00	1	20024.0	1	140.79
204.80	1	20798.0	1	141.66
215.70	1	21777.0	1	142.72
212.00	1	22952.0	1	143.84
206.50	1	24300.0	1	145.28
209.30	1	13180.0	1	131.55
158.10	1	13480.0	1	132.03
155.40	1	13558.0	1	132.16
171.10	1	13899.0	1	132.69
183.10	1	14001.0	1	132.85
173.60	1	13260.0	1	131.68
177.60	1	13449.0	1	131.98
188.80	1	13579.0	1	132.19
165.80	1	14065.0	1	132.95
172.40	1	15100.0	1	134.49
96.20	1	16148.0	1	135.96

118.40	1	16718.0	1	136.73
178.10	1	17061.0	1	137.18
135.70	1	17562.0	1	137.82
130.70	1	18176.0	1	138.59
138.80	1	18760.0	1	139.31
184.10	1	19728.0	1	140.45
203.40	1	20584.0	1	141.42
214.00	1	21942.0	1	142.89
159.20	1	22562.0	1	143.54
101.60	1	8317.0	1	122.09
125.90	1	8418.0	1	122.33
141.90	1	8628.0	1	122.82
148.60	1	8832.0	1	123.28
145.10	1	9072.0	1	123.82
147.10	1	9373.0	1	124.48
106.80	1	9357.0	1	124.44
161.50	1	9445.0	1	124.63
124.20	1	9874.0	1	125.53
156.00	1	9296.0	1	124.31
112.10	1	10938.0	1	127.63
104.10	1	11146.0	1	128.02
129.20	1	11529.0	1	128.73
124.10	1	11736.0	1	129.10
131.60	1	12189.0	1	129.90
150.80	1	12400.0	1	130.26
114.20	1	15748.0	1	135.41
118.50	1	16211.0	1	136.05
141.20	1	16467.0	1	136.39
138.60	1	16909.0	1	136.98
114.80	1	15734.0	1	135.39
168.00	1	16247.0	1	136.09
205.20	1	16839.0	1	136.89
195.60	1	17514.0	1	137.76
170.40	1	18099.0	1	138.50
214.90	1	17139.0	1	137.28
168.20	1	17684.0	1	137.98
151.60	1	20000.0	1	140.76
147.60	1	18685.0	1	139.22
141.70	1	21300.0	1	142.21

195.40	1	13809.0	1	132.55
212.20	1	13809.0	1	132.55
244.30	1	14705.0	1	133.91
213.10	1	14735.0	1	133.95
196.80	1	15104.0	1	134.49
184.40	1	15500.0	1	135.06
200.90	1	15720.0	1	135.37
225.40	1	15857.0	1	135.56
245.10	1	17029.0	1	137.14
250.80	1	17200.0	1	137.36
73.10	1	18081.0	1	138.48
126.20	1	19500.0	1	140.18
154.80	1	17029.0	1	137.14
130.60	1	17316.0	1	137.51
121.40	1	17626.0	1	137.90
130.90	1	18121.0	1	138.53
152.30	1	18412.0	1	138.88
173.40	1	23733.0	1	144.72
153.00	1	27995.0	1	148.65
161.20	1	28709.0	1	149.26
157.20	1	29642.0	1	150.04
162.10	1	30292.0	1	150.57
77.10	1	14510.0	1	133.62
86.80	1	14759.0	1	133.99
88.10	1	15430.0	1	134.96
87.20	1	15674.0	1	135.30
77.70	1	15923.0	1	135.65
80.50	1	15949.0	1	135.69
82.50	1	16039.0	1	135.81
74.20	1	16038.0	1	135.81
69.70	1	15977.0	1	135.72
69.20	1	15823.0	1	135.51
121.20	1	14198.0	1	133.15
137.00	1	14358.0	1	133.39
176.50	1	14564.0	1	133.70
181.00	1	14656.0	1	133.84
118.30	1	14871.0	1	134.15
187.50	1	15284.0	1	134.75
205.80	1	15341.0	1	134.83

232.20	1	15530.0	1	135.10
236.00	1	15161.0	1	134.58
202.10	1	16000.0	1	135.76
100.10	1	21577.0	1	142.50
95.20	1	22517.0	1	143.49
193.00	1	22935.0	1	143.92
201.50	1	23227.0	1	144.22
171.30	1	23470.0	1	144.46
184.90	1	23769.0	1	144.76
145.50	1	27072.0	1	147.85
137.40	1	27367.0	1	148.11
151.20	1	32416.0	1	152.23
176.90	1	32900.0	1	152.60
91.00	1	11747.0	1	129.12
94.60	1	11958.0	1	129.49
109.90	1	12322.0	1	130.12
108.20	1	12649.0	1	130.68
126.40	1	14304.0	1	133.31
138.50	1	14732.0	1	133.95
137.00	1	16228.0	1	136.07
148.60	1	16447.0	1	136.36
129.70	1	16914.0	1	136.99
143.40	1	17200.0	1	137.36
72.20	1	19363.0	1	140.02
80.40	1	20408.0	1	141.22
108.20	1	20643.0	1	141.48
126.60	1	20934.0	1	141.81
155.00	1	21458.0	1	142.38
165.00	1	21822.0	1	142.77
113.70	1	22036.0	1	142.99
105.30	1	22216.0	1	143.18
102.20	1	23535.0	1	144.53
100.20	1	24100.0	1	145.08
149.80	1	15101.0	1	134.49
177.60	1	15877.0	1	135.59
227.60	1	16226.0	1	136.07
247.50	1	16478.0	1	136.41
202.70	1	16963.0	1	137.05
132.40	1	17508.0	1	137.75

136.10	1	17994.0	1	138.37
151.10	1	18385.0	1	138.85
158.50	1	23426.0	1	144.42
154.50	1	23900.0	1	144.89
193.30	1	40270.0	1	157.68
207.10	1	40515.0	1	157.84
203.40	1	40533.0	1	157.85
203.10	1	41084.0	1	158.20
196.20	1	40943.0	1	158.11
217.90	1	41748.0	1	158.61
194.30	1	42146.0	1	158.85
217.80	1	42589.0	1	159.12
220.00	1	43097.0	1	159.43
220.80	1	43900.0	1	159.91
138.20	1	6937.0	1	118.55
113.70	1	7121.0	1	119.05
154.70	1	9338.0	1	124.40
246.50	1	9666.0	1	125.10
169.50	1	10200.0	1	126.20
97.90	1	12124.0	1	129.78
97.70	1	12126.0	1	129.79
166.80	1	12600.0	1	130.60
103.70	1	14884.0	1	134.17
128.50	1	14900.0	1	134.20
114.50	1	79694.0	1	176.15
120.20	1	81579.0	1	176.82
119.50	1	84105.0	1	177.69
186.20	1	86638.0	1	178.55
185.40	1	89272.0	1	179.42
194.60	1	91264.0	1	180.06
195.20	1	93351.0	1	180.72
202.70	1	96196.0	1	181.61
219.60	1	98319.0	1	182.25
336.20	1	104000.0	1	183.92
134.80	1	32652.0	1	152.41
130.00	1	34619.0	1	153.86
169.40	1	35224.0	1	154.30
203.80	1	37005.0	1	155.54
176.20	1	38744.0	1	156.70

169.40	1	40710.0	1	157.96
181.10	1	50755.0	1	163.72
175.80	1	52690.0	1	164.71
176.30	1	52713.0	1	164.72
169.80	1	52281.0	1	164.50
210.10	1	26050.0	1	146.93
210.50	1	28437.0	1	149.03
182.80	1	29267.0	1	149.73
193.70	1	30247.0	1	150.53
192.50	1	31403.0	1	151.45
168.10	1	32269.0	1	152.12
158.50	1	60508.0	1	168.45
206.30	1	64124.0	1	170.04
224.40	1	67616.0	1	171.51
269.60	1	71200.0	1	172.96
115.70	1	43440.0	1	159.63
165.00	1	46686.0	1	161.51
145.30	1	49217.0	1	162.90
193.60	1	52300.0	1	164.51
140.50	1	54808.0	1	165.77
123.20	1	58707.0	1	167.63
110.80	1	70110.0	1	172.52
108.80	1	70552.0	1	172.70
118.00	1	72281.0	1	173.38
135.20	1	74658.0	1	174.29

```
C 67550 MR. THANADE  DAWASUWAN
0001          DIMENSION K(14),D(21),Z(12),G(12),C(50)
0002          READ(1,10) Y1,Y2,A1,A2,R,G
0003       10 FORMAT(4F4.2,/,14F3.3,/,12F3.3)
0004          READ(1,11) D
0005       11 FORMAT(16F5.0)
0006          WRITE(3,12)
0007       12 FORMAT(1H1,10X,49H50.0 = THE YEAR IS GREATER THAN OR EQUAL 50 YEAR
             *S,/,10X,40H-50.0 = R IS < OR = ALPHA1*G OR ALPHA2*G,//)
0008          DO 110 L=1,21
0009          DO 20 I=1,12
0010          G(I)=G(I)*100.0
0011       20 CONTINUE
0012          J=D(L)
0013          WRITE(3,25) J
0014       25 FORMAT(15X,6HD  =  ,I6,//,2X,90(1H-),/,8HI * G %I,12(6X,1HI))
0015          WRITE(3,27) G
0016       27 FORMAT(1H ,8HIR % * I,12(F5.1,2H I),/,2H I,90(1H-),1HI,/,
             *9H I       I,12(7H      I))
0017          DO 30 I=1,12
0018          G(I)=G(I)/100.0
0019       30 CONTINUE
0020          DO 100 N=1,14
0021          DO 90 J=1,12
0022          A1G=A1*G(J)
0023          A2G=A2*G(J)
0024          IF(R(N).LE.A1G.OR.R(N).LE.A2G) GO TO 80
0025          DO 40 K=1,49
0026          X=K
0027          IF(K.EQ.1)C(K)=(Y1*(D(L)*(EXP(X*G(J))-1.0))**A1/(1.0-EXP(-X*(R(N)-
             *A1*G(J)))))+(Y2*(D(L)*(EXP(X*G(J))-1.0))**A2/(1.0-EXP(-X*(R(N)-A2*
             *G(J)))))
0028          X=X+1.0
0029          C(K+1)=(Y1*(D(L)*(EXP(X*G(J))-1.0))**A1/(1.0-EXP(-X*(R(N)-A1*G(J)
             *))))+(Y2*(D(L)*(EXP(X*G(J))-1.0))**A2/(1.0-EXP(-X*(R(N)-A2*G(J))))
             *)
0030          IF(C(K+1).GT.C(K)) GO TO 50
0031       40 CONTINUE
0032          Z(J)=50.0
0033          GO TO 90
0034       50 IF(K.NE.1) X=X-1.0
0035          X=X-1.0
0036          DO 60 M=1,19
0037          IF(M.EQ.1)C(M)=(Y1*(D(L)*(EXP(X*G(J))-1.0))**A1/(1.0-EXP(-X*(R(N)-
             *A1*G(J)))))+(Y2*(D(L)*(EXP(X*G(J))-1.0))**A2/(1.0-EXP(-X*(R(N)-A2*
             *G(J)))))
0038          X=X+0.1
0039          C(M+1)=(Y1*(D(L)*(EXP(X*G(J))-1.0))**A1/(1.0-EXP(-X*(R(N)-A1*G(J)
             *))))+(Y2*(D(L)*(EXP(X*G(J))-1.0))**A2/(1.0-EXP(-X*(R(N)-A2*G(J))))
             *)
0040          IF(C(M+1).GT.C(M)) GO TO 70
0041       60 CONTINUE
0042       70 Z(J)=X-0.1
0043          GO TO 90
```

** UNIT OF D IS M /D/YR

R IS % (PERCENT)

* D * \ R	1.0	2.0	3.0	4.0	5.0	6.0	7.0	8.0	9.0	10.0	12.5	15.0	17.5	20.0
1	50.0	39.6	26.4	19.8	15.9	13.2	11.4	9.9	8.8	8.0	6.4	5.3	4.6	4.0
2	50.0	39.5	26.4	19.8	15.8	13.2	11.3	9.9	8.8	7.9	6.4	5.3	4.5	4.0
3	50.0	39.5	26.4	19.8	15.8	13.2	11.3	9.9	8.8	7.9	6.3	5.3	4.5	4.0
4	50.0	39.4	26.3	19.8	15.8	13.2	11.3	9.9	8.8	7.9	6.3	5.3	4.5	4.0
5	50.0	39.4	26.3	19.7	15.8	13.2	11.3	9.9	8.8	7.9	6.3	5.3	4.5	4.0
6	50.0	39.4	26.2	19.7	15.8	13.2	11.3	9.9	8.8	7.9	6.3	5.3	4.5	4.0
7	50.0	39.4	26.2	19.7	15.8	13.2	11.3	9.9	8.8	7.9	6.3	5.3	4.5	4.0
8	50.0	39.4	26.3	19.7	15.8	13.2	11.3	9.9	8.8	7.9	6.3	5.3	4.5	4.0
9	50.0	39.4	26.2	19.7	15.8	13.2	11.3	9.9	8.8	7.9	6.3	5.3	4.5	4.0
10	50.0	39.4	26.2	19.7	15.8	13.1	11.3	9.9	8.8	7.9	6.3	5.3	4.5	4.0
20	50.0	39.3	26.2	19.7	15.7	13.1	11.3	9.9	8.8	7.9	6.3	5.3	4.5	4.0
30	50.0	39.2	26.2	19.6	15.7	13.1	11.2	9.8	8.7	7.9	6.3	5.3	4.5	3.9
40	50.0	39.2	26.2	19.6	15.7	13.1	11.2	9.8	8.7	7.9	6.3	5.3	4.5	3.9
50	50.0	39.2	26.1	19.6	15.7	13.1	11.2	9.8	8.7	7.9	6.3	5.2	4.5	3.9
60	50.0	39.1	26.1	19.6	15.7	13.1	11.2	9.8	8.7	7.9	6.3	5.2	4.5	3.9
70	50.0	39.1	26.1	19.6	15.7	13.1	11.2	9.8	8.7	7.9	6.3	5.2	4.5	3.9
80	50.0	39.1	26.1	19.6	15.7	13.1	11.2	9.8	8.7	7.9	6.3	5.2	4.5	3.9
90	50.0	39.1	26.1	19.6	15.7	13.1	11.2	9.8	8.7	7.8	6.3	5.2	4.5	3.9
100	50.0	39.1	26.1	19.6	15.7	13.1	11.2	9.8	8.7	7.8	6.3	5.2	4.5	3.9
150	50.0	39.1	26.0	19.6	15.6	13.1	11.2	9.8	8.7	7.8	6.3	5.2	4.5	3.9
200	50.0	39.0	26.0	19.5	15.6	13.0	11.2	9.8	8.7	7.8	6.3	5.2	4.5	3.9
250	50.0	39.0	26.0	19.5	15.6	13.0	11.2	9.8	8.7	7.8	6.3	5.2	4.5	3.9
300	50.0	39.0	26.0	19.5	15.6	13.0	11.2	9.8	8.7	7.8	6.3	5.2	4.5	3.9

50.0 = THE YEAR IS GREATER THAN OR EQUAL 50 YEARS

```
DOS FORTRAN IV 360N-FO-479 3-8          MAINPGM          DATE   30/10/78      TIME     11.17.30

      C 67550 MR. THANADE  DAWASUWAN
0001        DIMENSION R(14), D(23), Z(14), C(50)
0002        READ(1,10)Y1,Y2,A1,A2,R,D
0003     10 FORMAT(4F4.2,/,14F3.3,/,23F3.0)
0004        WRITE(3,15)
0005     15 FORMAT(1H1,31X,1H3,/,13X,25H** UNIT OF D IS   M /D/YR,//,24X,
           *18HR IS   % (PERCENT),/,2X,104(1H-))
0006        DO 16 J=1,14
0007        R(J)=R(J)*100.0
0008     16 CONTINUE
0009        WRITE(3,17) R
0010     17 FORMAT(1H ,8HI *  R I,14(6X,1HI),/,1H ,8HI D  * I,14(F5.1,2H I),/,
           *2H I,15(7H------I),/,9H I       I,14(7H       I))
0011        DO 18 J=1,14
0012        R(J)=R(J)/100.0
0013     18 CONTINUE
0014        DO 80 L=1,23
0015        DO 60 N=1,14
0016        DO 20 K=1,49
0017        X=K
0018        IF(K.EQ.1)C(K)=(Y1*D(L)**A1+Y2*D(L)**A2)/(1.0-EXP(-R(N)))
0019        X=X+1.0
0020        C(K+1)=(Y1*(X*D(L))**A1+Y2*(X*D(L))**A2)/(1.0-EXP(-R(N)*X))
0021        IF(C(K+1).GT.C(K)) GO TO 30
0022     20 CONTINUE
0023        Z(N)=50.0
0024        GO TO 60
0025     30 IF(K.NE.1) X=X-1.0
0026        X=X-1.0
0027        DO 40 M=1,19
0028        IF(M.EQ.1)C(M)=(Y1*(X*D(L))**A1+Y2*(X*D(L))**A2)/(1.0-EXP(-R(N)*X)
           *)
0029        X=X+0.1
0030        C(M+1)=(Y1*(X*D(L))**A1+Y2*(X*D(L))**A2)/(1.0-EXP(-R(N)*X))
0031        IF(C(M+1).GT.C(M)) GO TO 50
0032     40 CONTINUE
0033     50 Z(N)=X-0.1
0034     60 CONTINUE
0035        I=D(L)
0036        WRITE(3,70) I,Z
0037     70 FORMAT(2H I,14,3H  I,14(F5.1,2H I),/,9H I       I,14(7H       I))
0038     80 CONTINUE
0039        WRITE(3,90)
0040     90 FORMAT(2X,104(1H-),///,10X,49H50.0 = THE YEAR IS GREATER THAN OR E
           *QUAL 50 YEARS)
0041        STOP
0042        END
```

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DOS FORTRAN IV 360N-FO-479 3-8          MAINPGM          DATE   30/10/78      TIME     11.19.07

0044     80 Z(J)=-50.0
0045     90 CONTINUE
0046        R(N)=R(N)*100.0
0047        WRITE(3,95) R(N),Z
0048     95 FORMAT(2H I,F5.1,2H I,12(F5.1,2H I),/,9H I       I,12(7H       I))
0049        R(N)=R(N)/100.0
0050    100 CONTINUE
0051        WRITE(3,105)
0052    105 FORMAT(2X,90(1H-),//)
0053    110 CONTINUE
0054        STOP
0055        END
```

50.0 = THE YEAR IS GREATER THAN OR EQUAL 50 YEARS
-50.0 = R IS < OR = ALPHA1*G OR ALPHA2*G

D = 100

* G %I / R % *	1.0	1.5	2.0	2.5	3.0	3.5	4.0	4.5	5.0	6.0	7.0	8.0
1.0	50.0	-50.0	-50.0	-50.0	-50.0	-50.0	-50.0	-50.0	-50.0	-50.0	-50.0	-50.0
2.0	35.6	33.8	32.3	30.8	-50.0	-50.0	-50.0	-50.0	-50.0	-50.0	-50.0	-50.0
3.0	24.6	23.7	22.9	22.2	21.5	20.9	20.2	-50.0	-50.0	-50.0	-50.0	-50.0
4.0	18.8	18.3	17.8	17.3	16.9	16.5	16.1	15.8	15.4	-50.0	-50.0	-50.0
5.0	15.2	14.8	14.5	14.2	13.9	13.7	13.4	13.1	12.9	12.4	11.9	-50.0
6.0	12.8	12.5	12.3	12.1	11.9	11.7	11.5	11.3	11.1	10.8	10.4	10.1
7.0	11.0	10.8	10.6	10.5	10.3	10.2	10.0	9.9	9.7	9.5	9.2	9.0
8.0	9.7	9.5	9.4	9.2	9.1	9.0	8.9	8.8	8.7	8.5	8.3	8.1
9.0	8.6	8.5	8.4	8.3	8.2	8.1	8.0	7.9	7.8	7.6	7.5	7.3
10.0	7.8	7.7	7.6	7.5	7.4	7.3	7.3	7.2	7.1	7.0	6.8	6.7
12.5	6.3	6.2	6.1	6.1	6.0	6.0	5.9	5.9	5.8	5.7	5.6	5.5
15.0	5.2	5.2	5.1	5.1	5.1	5.0	5.0	4.9	4.9	4.8	4.8	4.7
17.5	4.5	4.5	4.4	4.4	4.4	4.3	4.3	4.3	4.3	4.2	4.2	4.1
20.0	3.9	3.9	3.9	3.9	3.8	3.8	3.8	3.8	3.8	3.7	3.7	3.6

D = 200

* G %I / R % *	1.0	1.5	2.0	2.5	3.0	3.5	4.0	4.5	5.0	6.0	7.0	8.0
1.0	50.0	-50.0	-50.0	-50.0	-50.0	-50.0	-50.0	-50.0	-50.0	-50.0	-50.0	-50.0
2.0	35.5	33.8	32.2	30.7	-50.0	-50.0	-50.0	-50.0	-50.0	-50.0	-50.0	-50.0
3.0	24.5	23.7	22.9	22.2	21.5	20.8	20.1	-50.0	-50.0	-50.0	-50.0	-50.0
4.0	18.8	18.2	17.8	17.3	16.9	16.5	16.1	15.7	15.4	-50.0	-50.0	-50.0
5.0	15.1	14.8	14.5	14.2	13.9	13.6	13.4	13.1	12.9	12.4	11.9	-50.0
6.0	12.7	12.5	12.2	12.0	11.8	11.6	11.4	11.3	11.1	10.7	10.4	10.1
7.0	11.0	10.8	10.6	10.5	10.3	10.1	10.0	9.9	9.7	9.5	9.2	9.0
8.0	9.6	9.5	9.4	9.2	9.1	9.0	8.9	8.8	8.7	8.4	8.2	8.1
9.0	8.6	8.5	8.4	8.3	8.2	8.1	8.0	7.9	7.8	7.6	7.5	7.3
10.0	7.8	7.7	7.6	7.5	7.4	7.3	7.2	7.2	7.1	7.0	6.8	6.7
12.5	6.2	6.2	6.1	6.1	6.0	6.0	5.9	5.9	5.8	5.7	5.6	5.5
15.0	5.2	5.2	5.1	5.1	5.1	5.0	5.0	4.9	4.9	4.8	4.8	4.7
17.5	4.5	4.5	4.4	4.4	4.4	4.3	4.3	4.3	4.2	4.2	4.1	4.1
20.0	3.9	3.9	3.9	3.9	3.8	3.8	3.8	3.8	3.7	3.7	3.7	3.6

D = 300

* G %I / IR % *	1.0	1.5	2.0	2.5	3.0	3.5	4.0	4.5	5.0	6.0	7.0	8.0
1.0	50.0	-50.0	-50.0	-50.0	-50.0	-50.0	-50.0	-50.0	-50.0	-50.0	-50.0	-50.0
2.0	35.5	33.8	32.2	30.7	-50.0	-50.0	-50.0	-50.0	-50.0	-50.0	-50.0	-50.0
3.0	24.5	23.6	22.9	22.2	21.5	20.8	20.1	-50.0	-50.0	-50.0	-50.0	-50.0
4.0	18.7	18.2	17.7	17.3	16.9	16.5	16.1	15.7	15.4	-50.0	-50.0	-50.0
5.0	15.1	14.8	14.5	14.2	13.9	13.6	13.4	13.1	12.9	12.4	11.9	-50.0
6.0	12.7	12.5	12.2	12.0	11.8	11.6	11.4	11.2	11.1	10.7	10.4	10.1
7.0	11.0	10.8	10.6	10.4	10.3	10.1	10.0	9.8	9.7	9.4	9.2	9.0
8.0	9.6	9.5	9.4	9.2	9.1	9.0	8.9	8.8	8.6	8.4	8.2	8.0
9.0	8.6	8.5	8.4	8.3	8.2	8.1	8.0	7.9	7.8	7.6	7.5	7.3
10.0	7.8	7.6	7.6	7.5	7.4	7.3	7.2	7.2	7.1	7.0	6.8	6.7
12.5	6.2	6.2	6.1	6.1	6.0	5.9	5.9	5.8	5.8	5.7	5.6	5.5
15.0	5.2	5.2	5.1	5.1	5.0	5.0	5.0	4.9	4.9	4.8	4.8	4.7
17.5	4.5	4.4	4.4	4.4	4.4	4.3	4.3	4.3	4.2	4.2	4.1	4.1
20.0	3.9	3.9	3.9	3.9	3.8	3.8	3.8	3.8	3.7	3.7	3.7	3.6

D = 400

* G %I / IR % *	1.0	1.5	2.0	2.5	3.0	3.5	4.0	4.5	5.0	6.0	7.0	8.0
1.0	50.0	-50.0	-50.0	-50.0	-50.0	-50.0	-50.0	-50.0	-50.0	-50.0	-50.0	-50.0
2.0	35.4	33.7	32.2	30.7	-50.0	-50.0	-50.0	-50.0	-50.0	-50.0	-50.0	-50.0
3.0	24.5	23.6	22.8	22.1	21.5	20.8	20.1	-50.0	-50.0	-50.0	-50.0	-50.0
4.0	18.7	18.2	17.7	17.3	16.9	16.5	16.1	15.7	15.3	-50.0	-50.0	-50.0
5.0	15.1	14.8	14.5	14.2	13.9	13.6	13.4	13.1	12.9	12.4	11.9	-50.0
6.0	12.7	12.5	12.2	12.0	11.8	11.6	11.4	11.2	11.1	10.7	10.4	10.1
7.0	10.9	10.8	10.6	10.4	10.3	10.1	10.0	9.8	9.7	9.4	9.2	9.0
8.0	9.6	9.5	9.3	9.2	9.1	9.0	8.9	8.7	8.6	8.4	8.2	8.0
9.0	8.6	8.5	8.4	8.3	8.2	8.1	8.0	7.9	7.8	7.6	7.5	7.3
10.0	7.7	7.7	7.6	7.5	7.4	7.3	7.2	7.2	7.1	6.9	6.8	6.7
12.5	6.2	6.2	6.1	6.1	6.0	5.9	5.9	5.8	5.8	5.7	5.6	5.5
15.0	5.2	5.2	5.1	5.1	5.0	5.0	5.0	4.9	4.9	4.8	4.8	4.7
17.5	4.5	4.4	4.4	4.4	4.3	4.3	4.3	4.3	4.2	4.2	4.1	4.1
20.0	3.9	3.9	3.9	3.8	3.8	3.8	3.8	3.8	3.7	3.7	3.7	3.6

D = 500

* G %I / IR % *	1.0	1.5	2.0	2.5	3.0	3.5	4.0	4.5	5.0	6.0	7.0	8.0
1.0	50.0	-50.0	-50.0	-50.0	-50.0	-50.0	-50.0	-50.0	-50.0	-50.0	-50.0	-50.0
2.0	35.5	33.7	32.2	30.7	-50.0	-50.0	-50.0	-50.0	-50.0	-50.0	-50.0	-50.0
3.0	24.4	23.6	22.8	22.1	21.4	20.8	20.1	-50.0	-50.0	-50.0	-50.0	-50.0
4.0	18.7	18.2	17.7	17.3	16.9	16.5	16.1	15.7	15.3	-50.0	-50.0	-50.0
5.0	15.1	14.8	14.5	14.2	13.9	13.6	13.4	13.1	12.9	12.4	11.9	-50.0
6.0	12.7	12.4	12.2	12.0	11.8	11.6	11.4	11.2	11.1	10.7	10.4	10.1
7.0	10.9	10.8	10.6	10.4	10.3	10.1	10.0	9.8	9.7	9.4	9.2	8.9
8.0	9.6	9.5	9.3	9.2	9.1	9.0	8.9	8.7	8.6	8.4	8.2	8.0
9.0	8.6	8.5	8.4	8.3	8.1	8.1	8.0	7.9	7.8	7.6	7.5	7.3
10.0	7.7	7.6	7.6	7.5	7.4	7.3	7.2	7.2	7.1	6.9	6.8	6.7
12.5	6.2	6.2	6.1	6.0	6.0	5.9	5.9	5.8	5.8	5.7	5.6	5.5
15.0	5.2	5.2	5.1	5.1	5.0	5.0	5.0	4.9	4.9	4.8	4.8	4.7
17.5	4.5	4.4	4.4	4.4	4.3	4.3	4.3	4.3	4.2	4.2	4.1	4.1
20.0	3.9	3.9	3.9	3.8	3.8	3.8	3.8	3.8	3.7	3.7	3.7	3.6

D = 600

* G %I / IR % *	1.0	1.5	2.0	2.5	3.0	3.5	4.0	4.5	5.0	6.0	7.0	8.0
1.0	50.0	-50.0	-50.0	-50.0	-50.0	-50.0	-50.0	-50.0	-50.0	-50.0	-50.0	-50.0
2.0	35.4	33.8	32.2	30.7	-50.0	-50.0	-50.0	-50.0	-50.0	-50.0	-50.0	-50.0
3.0	24.4	23.6	22.8	22.1	21.4	20.8	20.1	-50.0	-50.0	-50.0	-50.0	-50.0
4.0	18.6	18.2	17.7	17.3	16.9	16.5	16.1	15.7	15.3	-50.0	-50.0	-50.0
5.0	15.1	14.8	14.4	14.2	13.9	13.6	13.4	13.1	12.9	12.4	11.9	-50.0
6.0	12.7	12.4	12.2	12.0	11.8	11.6	11.4	11.2	11.1	10.7	10.4	10.0
7.0	10.9	10.8	10.6	10.4	10.3	10.1	10.0	9.8	9.7	9.4	9.2	8.9
8.0	9.6	9.5	9.3	9.2	9.1	9.0	8.9	8.7	8.6	8.4	8.2	8.0
9.0	8.6	8.4	8.3	8.2	8.1	8.0	8.0	7.9	7.8	7.6	7.4	7.3
10.0	7.7	7.6	7.6	7.5	7.4	7.3	7.2	7.2	7.1	6.9	6.8	6.7
12.5	6.2	6.2	6.1	6.0	6.0	5.9	5.9	5.8	5.8	5.7	5.6	5.5
15.0	5.2	5.2	5.1	5.1	5.0	5.0	5.0	4.9	4.9	4.8	4.8	4.7
17.5	4.5	4.4	4.4	4.4	4.3	4.3	4.3	4.3	4.2	4.2	4.1	4.1
20.0	3.9	3.9	3.9	3.8	3.8	3.8	3.8	3.8	3.7	3.7	3.7	3.6

APPENDIX E

ESCALATION FACTOR

Method of Escalation

There are various methods for comparable measures of time streams of money which exist at distinct time. Present worth factors are used to translate future monetary values to the present ones while cost indices are used to relate past values to the present ones.

In Thailand, there are so few cost indices available to engineers or contractors. The well known indices which are recorded by Ministry of Commerce are Consumer Price Index and Wholesale Price Index. These indices are too general to be applicable to engineering or construction works. In 1974, the Government introduced escalation clauses, which were submitted by a Committee which Professor Aroon Sorathesn was chairman, for adjusting monetary value in the construction contracts as the results of world economic crisis has been so persistent that the cost of construction materials has been in an unstable stage. This method which is accepted by the Government is also selected to relate past values to the present values in this study.

The general formular for escalating the past values is

$$P = Po \cdot K$$

where P = cost at time of payment or at recent time

Po = cost at time which price is related to.

K = Constant factors used to adjust monetary values depending upon types of construction.

Value of Various Escalation Factor K

Section I Earthworks of Canals, Open Channel

1.1 Excavation works and concrete lining of canals

$$K = 0.45 + 0.34 \frac{C_t}{C_o} + 0.13 \frac{I_t}{I_o} + 0.08 \frac{F_t}{F_o}$$

1.2 Embankment of canal ridge

$$K = 0.30 + 0.45 \frac{I_t}{I_o} + 0.25 \frac{F_t}{F_o}$$

Section II Irrigation Structure and Drainage Works

2.1 Irrigation Structure without reinforcement including reinforced concrete pipe, culvert and manhole for other construction

$$K = 0.48 + 0.18 \frac{C_t}{C_o} + 0.34 \frac{S_t}{S_o}$$

2.2 Irrigation Structure with reinforcement

$$K = 0.45 + 0.16 \frac{C_t}{C_o} + 0.39 \frac{S_t}{S_o}$$

Section III Rock Explosive Works

$$K = 0.50 + 0.32 \frac{I_t}{I_o} + 0.18 \frac{F_t}{F_o}$$

Section IV Drilling and Mortar Grouting

4.1 Drilling

$$K = 0.40 + 0.47 \frac{I_t}{I_o} + 0.13 \frac{F_t}{F_o}$$

4.2 Mortar Grouting

K depends on price level of cement which is announced by Ministry of Commerce

Section V Earthworks including excavation, fill, hauling, compaction, stock piling, rock rip-rap, trenching backfill.

$$K = 0.30 + 0.45 \frac{I_t}{I_o} + 0.25 \frac{F_t}{F_o}$$

Section VI Buildings Construction including general purpose buildings, pumping stations, garages, workshops, warehouse, family quarters and fencing.

$$K = 0.40 + 0.30 \frac{I_t}{I_o} + 0.30 \frac{M_t}{M_o}$$

where K = Escalation factor for each type of works as indicated in above sections.

I = Consumer Price Index

M = Index of construction items

C = Price of cement

S = Price of steel reinforcement

F = Price of diesel oil

Note 1. Subscrip 'o' and 't' denotes time at bidding and making the term payment respectively.

2. Values of I, M, C, S, and F are valid after the announcement of Ministry of Commerce.

Available Price Indices

Consumer Price Index (C.P.I.) represents the general price level in the measurement of inflation. The C.P.I. is computed for a market basket of goods and services purchased by typical wage earners. This market basket is established during the base period and consists of all important raw foods and all commodities whose prices are subject to significant variation through fiscal action.

Wholesale Price Index (W.P.I.) measures price level of 256 important goods bought in large quantities in transaction between firms.

In Thailand values of C.P.I. and W.P.I. are recorded by Department of Business Economics, Ministry of Commerce. Some price indices are included in Table 1. If it is not specifically stated, the year 1968 is set as the base year.

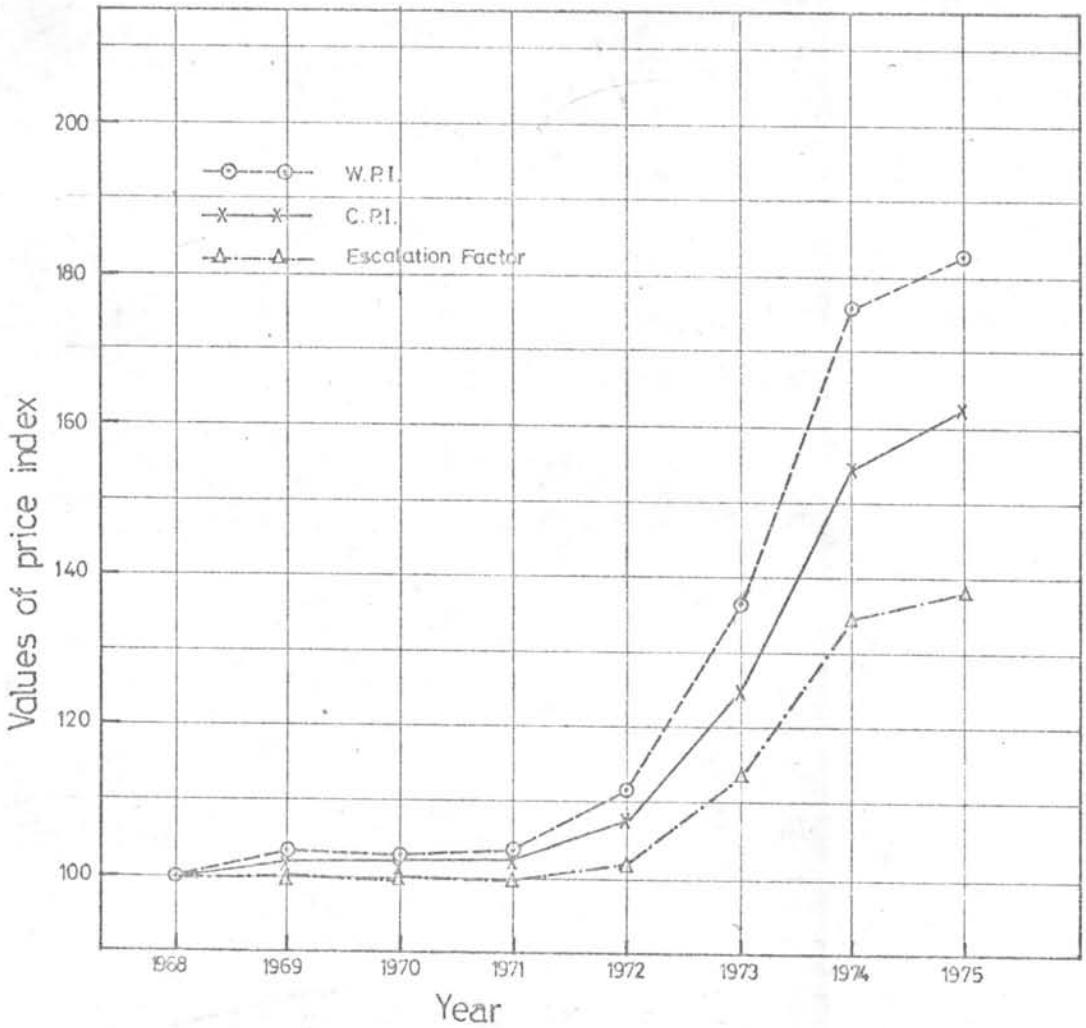

FIGURE 1. Comparision of monetary level adjusted by C.P.I., W.P.I., and escalation factor

Price Levels of Some Construction Materials and Wages

Price of some construction materials are scatteringly recorded by so many concerned authorities. They are occasionally presented in various journals and magazines. The information in Table 1 is collected from Department of Business Economics and Department of Labour.

Table 1 Some figures of price indices, materials and wages.

Description	1968	1969	1970	1971	1972	1973	1974	1975
Price Indices								
C.P.I. *1 (Whole country)	110.9	113.6	113.5	114.0	119.5	138.1	171.7	180.8
W.P.I. (Whole country)	100.0	103.3	102.8	103.3	111.3	136.6	176.0	182.6
C.P.I. (Only in Bangkok) *2	114.4	116.8	117.7	120.2	124.9	139.5	172.0	179.0
General Construction Materials	100	100.3	99.5	96.6	99.4	117.8	160.7	167.1
Domestic Construction Materials	100	98.2	96.8	97.5	97.8	107.0	148.7	152.7
Foreign Construction Materials	100	109.9	121.2	119.7	127.3	206.9	285.6	282.1
Petroleum products	100	99.8	99.1	103.7	104.9	116.7	214.4	219.4
Chemical products	100	101.4	105.3	107.2	108.6	138.2	234.4	214.6

Table 1 (Continued)

Description	1968	1969	1970	1971	1972	1973	1974	1975
Mechinery and equipment	100	100.3	108.9	120	132.2	155.9	189.7	209.2
Value of Escalation Factor "K" in this study	1.390	1.377	1.382	1.395	1.358	1.218	1.028	1.000
Materials								
"Tiger" brand cement, ฿/ton	411.60	405.22	420.5	417	430	445.67	501.42	516
Coarse Sand, ฿/M^3	43.94	41.83	40.0	40.0	40.0	46.94	64.17	70.0
Crushed stone No.2 ฿/M^3 *3	82.6	82.37	82.7	83.69	82.5	85	100	100
Reinforced Steel, ฿/ton	2430	2580	3020	3100	3100	5280	6410	6100
Hard wood "Daeng", ฿/ft^3	68.40	65.72	66.44	68.11	68.14	90.08	124.03	115.62
Soft wood "Yang" ฿/ft^3	30.22	30.39	27.81	27.37	30.05	38.08	48.19	53.87
NaOH with 50% concentration, ฿/ton	1004.17	986.67	1006.25	1304.17	1500	1765	2725	2933.33
Engine Lubricant, ฿/litre	8.04	8.04	8.04	7.48	7.02	7.62	9.71	9.91
Diesel Gasoline, ฿/litre	0.885	0.885	0.875	0.89	0.88	1.01	2.21	2.27
Benzine Gasoline, ฿/litre	1.78	1.78	1.78	1.78	1.75	1.95	3.26	3.31

Table 1 (Continued)

Descriptions	1968	1969	1970	1971	1972	1973	1974	1975
Wages								
Mason ฿/day	45	50	50	55	60	65	75	80
Bricklayer ฿/day	30	30	30	35	40	45	50	50
Carpenter ฿/day	45	50	50	50	60	70	85	85
Steel fabricator ฿/day	40	40	45	45	50	55	55	55
Male labourer ฿/day	20	22	22	25	25	30	35	30
Female labourer ฿/day	15	18	18	20	20	25	30	30

Note

*1 Setting Year 1965 as base year

*2 Setting Year 1962 as base year

*3 Size of coarse aggregates, which is locally named, lies between 2 to 3 centimetres.

APPENDIX F

APPLICATION FEES AND WATER RATES

APPLICATION FEES

In first applying for the use of potable water supplied by the water works under the Control of Provincial Water Works Division, the applicants have to pay the following fees:

1. Inspection expense

1.1 Residential customers. The expense accounts 15 Baht per dwelling or connection.

1.2 Other customer. The expense accounts 15 Baht per one lavatory room

2. Labour expense

The expense is 60 Baht per day

3. Materials expense

The expense depends on costs of pipe accessories and meters connected. It also includes the expense of reparing the damaged pavement.

Cost of materials often used for connection is shown below:

Size	Meter (฿/piece)	Globe value (฿/piece)	G/S pipe (฿/m.)
ø1/2"	275	40	13.50
ø3/4"	450	80	18.80
ø 1"	750	128	26.30
ø 1 1/2"	5,150	190	41.75
ø 2"	8,000	280	52.40
ø 3"	15,000	645	88.50
ø 4"	25,000	1395	128.60

The applicants may find these materials themselves but these materials must be checked by the water works.

4. Travelling expense

Such expense will be charged if the water works do not possess any vehicle carrying the materials to applicants' dwellings.

5. Guarantee fund

This fund will return to applicants when they stop using the supplied water. It depends on size of meters connected as shown below :

Meter size	Guarantee fund
ø 1/2"	100 ฿
ø 3/4"	200 ฿
ø 1"	300 ฿
ø 1 1/2"	600 ฿
ø 2"	1200 ฿
ø 2 1/2"	2400 ฿
ø 3"	4800 ฿
ø 4"	9600 ฿
ø 6"	20000 ฿

The average application fees not including guarantee fund in the observed water works are shown in Table 1. The annual increasing applicants range from 10 to 490 per water works. The average application fees range from 400 ฿ to 1800 ฿ per connection.

Table 1 Average application fees per connection

WW No.	Number of Appli.	Inspection expense (₿)	Labour expense (₿)	Materials expense (₿)	Travel expense (₿)	Total (₿)	Average per connection (₿/con)
1	32	1020.0	1620.0	11236.0	-	13876.0	433.6
2	35	570.0	2340.0	38480.0	-	41390.0	1182.6
3	65	1230.0	4590.0	25395.0	-	31215.0	480.2
4	10	195.0	940.0	16545.0	-	17680.0	1768.0
5	12	180.0	720.0	12401.0	-	13301.0	1108.4
10	61	930.0	3720.0	44975.0	-	49625.0	813.5
11	95	1335.0	5670.0	58032.0	120.0	65157.0	685.9
12	38	1645.0	2880.0	39239.0	-	43764.0	1151.7
13	70	1925.0	5550.0	51620.0	-	59095.0	844.2
14	14	210.0	840.0	8111.0	-	9161.0	654.4
15	54	1280.0	3540.0	40214.0	-	45034.0	834.0
16	26	1095.0	1680.0	12152.0	-	14927.0	574.1
17	173	3485.0	11190.0	60491.5	-	75166.5	434.5
18	117	1800.0	7980.0	41470.0	-	51250.0	438.0
19	176	3760.0	10560.0	95025.0	-	109345.0	621.3
20	56	975.0	3360.0	25683.0	-	30018.0	536.0
21	122	2050.0	7260.0	62849.0	-	72164.0	591.5
22	81	3870.0	10680.0	41688.0	-	56238.0	694.3
23	49	1050.0	4450.0	23636.0	-	29136.0	594.6
24	196	8205	20940.0	87635.0	-	116780.0	595.8
27	33	1955	2340.0	16177.0	-	20472.0	620.4
28	131	12435	13170.0	63037.0	-	88642.0	676.7

Table 1 (Continued)

WW	Number of Appli.	Inspection expense (฿)	Labour expense (฿)	Materials expense (฿)	Travel expense (฿)	Total (฿)	Average per connection (฿/con)
29	124	8835.0	9180.0	53792.0	-	71807.0	579.1
30	109	15740.0	11850.0	59495.0	-	87085.0	798.9
31	112	3030.0	7230.0	50816.0	-	61076.0	545.3
32	249	6035.0	15240.0	97625.8	-	118900.8	477.5
33	70	3415.0	6300.0	25491.5	-	35206.5	503.0
34	120	4745.0	7860.0	67392.0	-	79997.0	666.6
35	81	1735.0	5100.0	44046.0	-	50881.0	628.2
36	192	16260.0	14490.0	113249.0	-	143999.0	750.0
37	241	5855.0	24210.0	120405.0	-	150470.0	624.4
38	166	6405.0	9910.0	70493.0	30.0	86838.0	523.1
39	92	1300.0	5160.0	31528.0	-	37988.0	412.9
40	41	1390.0	5100.0	21874.0	-	28364.0	691.8
41	151	12890.0	16440.0	55809.0	-	85139.0	563.8
42	159	13225.0	18545.0	103116.0	-	134886.0	848.3
43	216	5175.0	14640.0	79335.0	-	99150.0	459.0
44	233	11585.0	28470.0	100265.0	-	140320.0	602.2
45	318	9915.0	113560.0	136146.0	-	259621.0	816.4
46	17	2370.0	4710.0	15860.0	-	22940.0	1349.4
47	461	34215.0	44390.0	342515.0	6000.0	427120.0	926.5
48	233	9135.0	14160.0	107615.0	230.0	131140.0	562.8
49	346	17455.0	45420.0	292899.0	-	355774.0	1028.3
50	462	43065.0	37980.0	407633.0	100.0	488778.0	1058.0

WATER RATES

Two types of rates are suggested i.e. uniform or constant and incremental block type. They are constructed as shown in following paragraphs.

Uniform rate

Total numbers of water works which average production rate less than 2000 m^3/day shown in Table 4 in Chapter 4 are 96 undertakers.

Equation $C = 30.93\ Q^{-0.42}$ is used to find the unit cost for those water works which are unobserved. Average daily production of those unobserved are assumed to be the average value of the observed ones.

Average Q for 400 m^3/d design capacity is 212.9 m^3/d
Average Q for 800 m^3/d design capacity is 256.2 m^3/d
Average Q for 1200 m^3/d design capacity is 480.0 m^3/d
Average Q for 1600 m^3/d design capacity is 573.6 m^3/d
Average Q for 2000 m^3/d design capacity is 1140.0 m^3/d

Equation $C = \frac{\Sigma NC}{\Sigma N}$ is used to give the average value for these water works. For observed water works, unit costs are shown in Appendix D. The calculated figures of (ΣNxc) for each design capacity are tabulated as follows :

Plant size (m^3/d)	$\sum N \times c$
400	1 (3.50 + 5.33 + 2.95 + 5.58 + 9.24) + 4 x 3.25
800	1 (5.27 + 3.55 + 2.36 + 1.90 + 8.08 + 2.80 + 2.28) + 34 x 3.01
1200	6 x 2.31
1600	1 (1.87 + 1.46 + 5.25 + 3.14 + 1.65 + 1.42 + 1.67 + 1.57) + 16 x 2.14
2000	1 (2.81 + 1.54 + 1.26) + 13 x 1.61

$$C = \frac{\sum Nxc}{\sum N} = \frac{260.85}{96} = 2.72 \quad ฿/m^3$$

In Table 8 Appendix A, average losses due to operation is about 24.8 per cent. To cover the losses, rate should be raised. Thus

$$C = 1.248 \times 2.72 = 3.39 \quad ฿/m^3$$

Rounded up uniform rate ranges from 2.75 - 3.50 $฿/m^3$

Incremental block rate

Data used in the design of water rate is obtained from direct observation and interview with the superintendent of Chieng Rai Water works. The development of water rate involves the following major areas of study :

1. Determination of revenue requirements

Base for the determination of revenue requirements is the utility basis. Total revenue includes OMR expense, depreciation and a return on the rate base.

1.1 OMR Expense

In Appendix C, the OMR expense is divided into two parts according to the function of the water works i.e. production and service part. For Chieng Rai Water Works, total annual OMR expense in the year 1975 was 1,032,500.6 ฿ or 0.76 ฿/m^3 of produced water.

1.2 Depreciation

In the year 1975, the investment cost for expansion and improvement of Chieng Rai Water Works was 12,060,000 ฿ from national fiscal budget. Depreciation allowances are based on fixed annual per centage of the items of plant investment which is regulated by Department of Comptroller (1962). The calculation for depreciation allowances is shown in Table 2.

Table 2 Depreciation allowance for Chieng Rai Water Works

Construction Items	Invested costs (in 1000 ฿)	Fixed rate (%)	Depreciation (in 1000฿)
Structure type I Coag. - Sedi. - RFS., clear water tank, intake special structures, pipe arrangement inside the plant, etc.	2204.8	3	66.14

Table 2 (Continued)

Construction Items	Invested costs (in 1000 ₿)	Fixed rate (%)	Depre-ciation (in1000₿)
Structure type II			
Pump houses, lodging houses, warehouses, office, fence, gate etc.	1786.5	6	107.19
Equipments and instruments			
Pumps, chemical feeders, stationary, laboratory instrument	1808.7	10	180.87
Meters	57.6	6	3.46
Pipes			
A/C pipes and accessories	3624.135	5	181.21
Metal pipes	634.085	3	19.02
Administration expense	1944.18	10	194.42
Total	12060.0	-	752.31

1.3 Return on the rate base

There is much controversy on selection of return rate. So in this study, the return rate is set equal to interest rate of bank deposit. That is eight per centage per year. Thus, a return on the rate base in this case is

$$12,060,000 \times 0.08 = 964,800 \text{ ฿}$$

2. Customer characteristics and demand

2.1 Customer classes

There are three principal customer classes.

2.1.1 residential, amounting to approximately 60 %

2.1.2 commercial and small industrial, amounting to approximately 35 %

2.1.3 special, amounting to approximately 5 %.

Not much details of commercial and small industrial class and special class can be obtained, so they are grouped into one class as commercial and special class.

2.2 Meter sizes

There are totally 2,085 connections in the year 1975. The number of connections for each meter size is shown following :

Meter size	Number of connections
ø 1/2"	1827
ø 3/4"	147

Meter Size	Number of connections
ø 1"	79
ø 1 1/2"	10
ø 2"	14
ø 3"	7
ø 4"	1

2.3 Water demand

Since there is one master meter detecting the sale flows and there is no pattern of city planning, so the characteristics of water demand such as maximum hour demand, off-peak use etc. can not be obtainable.

Total sale in the year 1975 is 1,035,859 m^3

If domestic consumption rate is 200 lpcd and the average size of family is 5 person per family, the residential sale would be

$$0.2 \times 5 \times 0.6 \times 2085 \times 365 = 456,615 \ m^3$$

That is 44 % of total sale, and the sale for commercial and special class would be 56 % of the total sale.

3. Design of rate schedules

3.1 Allocation of costs to customer classes

The OMR costs and partial depreciation will be allocated to residential class while OMR costs, partial depreciation, and total return on a rate base will be allocated to

commercial and special classes.

Thus 44 % of 752,310 ฿ would be 331,016 ฿. This expense is burden on residential class. The amount of the residue 421,294 ฿ and a return of 964,800 ฿ will be paid by commercial and special class.

3.2 Construction of block rate

Three simple subsequent rate blocks are designed for residential class. The uniform rate is designed for commercial and special class due to unavailable of level of water use of each commercial and industrial establishments.

Average of domestic demand is about 30 m^3 per connection. The first block up to 10 m^3 covers only OMR expense. To compensate for the losses in Table 9 Appendix, the rate is raised to

$$1.248 \times 0.76 = 0.95 \text{ ฿}/m^3$$

The second block with consumed water from 10 to 30 m^3, the rate covering depreciation allowances will be

$$\frac{331016}{20 \times 0.6 \times 2085 \times 12} = 1.10 \text{ ฿}/m^3$$

The third block with consumed water over 30 m^3, the rate will generate profit to the water works. Thus suggested incremental block rate is shown as follows:

Water Use (m^3/month)	Calculated Rate (฿ / m^3)	Adjusted Rate (฿ / m^3)
0 - 10	0.95	1.0
10 - 30	2.05	2.0
Over 30	3.00	3.0

With the average use, customer will pay the charge of water approximately 1.67 ฿ / m^3.

The sum of depreciation allowances and return on rate base for commercial and special class is 1,386,094 ฿. Thus, the uniform rate is

$$0.95 + \frac{1386094}{0.56 \times 1035859} = 3.34 \text{ ฿ / } m^3.$$

The rounded up value will be 3.50 ฿ / m^3.

VITA

The author, Mr. Thanade Dawasuwan, was born in 1950. He completed his elementary and secondary study at Bangkok Christian College. He recieved a bachelor degree in Civil engineering from Chulalongkorn University in 1972. After graduation, he worked for Department of Public Works as a design engineer in Provincial Water Supply Division. In 1974, he took a leave for his postgraduate study in Sanitary Engineering Department at Graduate School, Chulalongkorn University. At present, he still works for the Provincial Water Supply Division, Department of Public Works.