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REPUBLIC OF INDONESIA
MINISTRY OF PUBLIC WORKS
DIRECTORATE GENERAL OF HOUSING BUILDING
PLANNING AND URBAN DEVELOPMENT (CIPTA KARYA)

MEDAN URBAN DEVELOPMENT, HOUSING, WATER SUPPLY AND SANITATION PROJECT

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TECHNICAL MEMORANDUM NO. 28

RECOMMENDED WATER SUPPLY MANAGEMENT SYSTEM

This is a draft of Section 10 of the Master Plan Report
for Water Supply and Sanitation

NOVEMBER 1979

ENGINEERING - SCIENCE, INC. • SINOTECH ENGINEERING CONSULTANTS, INC
A JOINT VENTURE
in association with
PADCO and P.T. DACREA

MEDAN URBAN DEVELOPMENT, HOUSING, WATER SUPPLY AND SANITATION PROJECT

Jln. Singamangaraja 1-3, P. O. Box 26, Phone 20716, Medan-Sumatra, Indonesia

Our ref.: 79/1197/MUDS/313 7 November 1979

Director General Cipta Karya
Ministry of Public Works
Jalan Pattimura 20
Kebayoran Baru
Jakarta Selatan

Subject: Technical Memorandum No. 28, Recommended Water Supply Management System

Dear Sir:

Attached are 20 copies of the subject Technical Memorandum for your information and review. The material contained in this memorandum constitutes submission of Section 10 of the draft Master Plan for Water Supply and Sanitation Report.

Yours faithfully,

ENGINEERING SCIENCE INC. MEDAN URBAN PROJECT INDONESIA

John M. McGill
Project Representative

C.C.: Ir. Ruslan Diwiryo, Director of City & Regional Planning
Ir. Susanto Mertodiningrat, Director of Sanitary Engineering
Ir. Sunaryo, Head Sub-Directorate Town Planning
Ir. K. Pohan, Project Manager, MUDS
AID - Jakarta, attn.: P. Thorn, Project Officer
ES - Arcadia
SINOTECH - Taipei
DACREA - Jakarta

JM/1

SECTION 10

RECOMMENDED WATER SUPPLY MANAGEMENT SYSTEM

10.1 DESCRIPTION OF RECOMMENDED SYSTEM

10.1.1 Water Supply Improvement

10.1.1.1 Spring Supply

Supply: In this recommended plan, the present production of 46,000 m^3/d from the springs at Sibolangit would not be changed during the study period. Evaluation of the known springs in the Sibolangit area indicates that about 40 percent is not collected. During the next 20 years, additional negotiations with existing water users may allow larger production from the springs. If such additional flow is collected, larger capacity collection and transmission systems would be required.

Improvements: Several pipelines within the spring collection system are more than 50 years old, and eventual replacement of some old pipelines with larger diameter pipe would increase flows and pressure at the junction of the local pipelines and the transmission system to Medan.

Local collector and transmission pipelines at Sibolangit are near or at maximum flows. Pipeline breaks can disrupt and stop production from any of the four groups of springs. Therefore, all pipelines for the Rumah Sumbul and Lau Bengklewang springs should be examined and evaluated for replacement during the 1980-2000 period. Replacements should provide for at least 25 percent emergency capacity for each group of springs.

Low pH and high CO_2 content of the spring water have required aeration and lime treatment in order to reduce the water's corrosion potential. Apparent excessive lime treatments have caused calcium carbonate deposition on some pipeline walls. More frequent analyses of CO_2, pH, temperature, bicarbonate, sulphate, and dissolved solids should be conducted. Comparisons of analyses from the aerators, junction chambers, and air relief valves would allow accurate adjustments of the bicarbonate and pH levels in order to both reduce incrustation and control corrosion.

Costs: No additional cost is projected for the maintenance of existing facilities at the Sibolangit springs. Replacement of pipelines cannot be projected at this time.

10.1.1.2 Surface Water Supplies

Sunggal Plant: The existing raw water diversion and pre-settling facilities are sufficient for an extraction of 900 l/s. Additions and improvements will however he needed when the second stage of augmentation is undertaken to increase the output from 900 to 1500 l/s.

Though 600 l/s are obtained from the plant at present, the following improvements are necessary. The original clarifier and filter, built according to conventional principles and design, function well. The second clarifier is comparatively satisfactory, but the second set of filters is not. The performance of the raw water pumps has also deteriorated and, as a result of these two problems, all the pumps in the raw water pumping station have to be operated at one time to provide the required flow. The addition of at least one more pumping set as stand-by is necessary, so that at least one pump can be taken out of service. The situation in the filtered water pump house is similar and the addition of a stand-by set is needed.

The improvements necessary to ensure more efficient performance of the second set of filters are as follows:

1. There are no effluent rate of flow controllers at present, and provision of these at this stage is not feasible. Instead it is recommended that once the third set of filters is commissioned, the second set be structurally altered to make the filters operate on a variable head basis (See Section 5.2.1.3). The main structural alteration to enable this is the provision of a channel of suitable dimensions capable of carrying more water from the second clarifier to these filters. The wash-water troughs have to be demolished and new troughs installed sized and spaced according to orthodox design requirements.

2. The filter media in all filters should be regraded to obtain an effective size of at least 0.5 mm and a minimum uniformity coefficient of 1.5. The effective size, coefficient of uniformity and depth of media are directly related to the rate of filtration and back wash rate and these values should be determined from pilot plant tests.

3. The back-wash rate should be increased, the exact rate depanding on the success of the air scour.

4. It is also recommended that a modified method of transporting the filter effluent to the clear-water tank be provided, ensuring that no negative head or 'air binding' will occur. A simple arrangement is to provide a weir set a few centimeters above the level of the filter media, over which the filter effluent has to flow before reaching the channel leading to the clear water tank. This will ensure a positive head in the filter media at all times.

5. The addition of soda ash before coagulation and flocculation should be studied critically. Far tests should be run with varying dosages of soda ash (including none added) and alum to determine the optimun dosages. This should be done regularly to take care of changes in raw water quality. If, as seems likely, best coagulation occurs with no addition of soda ash, pH adjustment can be done on the finished water.

The first stage of augmentation, from 600 to 900 l/s, is due to commence shortly. However only construction of the third clarified has yet been definitely decided on. It must be stressed that the third set of filters is essential if an output of 900 l/s is to be obtained. From the experience Tirtanadi has had with the first set of filters, where all of the effluent rate of flow controllers failed, and with the second set where no controllers have been provided at all, it is strongly recommended that the third and future sets of filters be of the declining rate of flow type. These can be designed to function with the least amount of sophisticated imported equipment, but still provide an effluent of equal or better quality than the effluent flow control types. The emphasis will shift from automation to manual control based mainly on visual observations.

The clarifiers should in the new augmentation phases, be of the sludge upflow type which are functioning satisfactorily in the present plant. Uniformity in operation will be helpful but special attention should be focused on desludging during the hotter hours in the early afternoon at which time the performance of sludge blanket clarifiers tends to deteriorate.

The Percut diversion would have a weir across the Percut River similar to that on the Deli River. Sluice gates would regulate water levels across the weir and entering the pre-settling tank. Water would be withdrawn from the tank and pumped by four 180 to 200 HP pumps across the divide between the Percut and Deli River to the Deli Tua Water Plant. Total land requirements would be less than one hectare depending upon the inundation of the regulated pool behind the weir.

The pump station would be supplied with electrical power from the major distribution power lines along the old railroad right of way, 1.0 km to the west or by diesel generators on the site.

The layout of the Babura diversion would be similar to the Percut diversion except that Babura pumps and pipelines would be smaller than those at the Percut River. The pipeline would follow the edge of the year 2000 urban area for about 4.0 km in Medan Johor. At the study area boundary the pipeline would join the existing main pipeline right-of way from Sibolangit. After about 3.0 km, the pipeline would turn east for 1.0 km and cross the Deli River at the Deli River diversion. The Babura raw water would then be combined with that of the Deli and Percut.

A number of options for the best future developemnt of this system will have to be considered when more river discharge and other data are available. The final design of the Percut station pumps may also include facilities to boost spring water from the Marihan/Bantam springs to the railroad pipeline corridor. Further analyses may also indicate the desirability of pumping settled river water from the Belumai River, 4.0 km to the east, through the Percut Diversion to the Deli Tua Plant. Additional pump and pipeline capacity would be necessary to convey the combined raw water flows to the Deli Tua Plant.

The initial production of 120,000 m^3/d and the second phase increase of about 80,000 m^3/d would be sufficient to meet demands through 1997/98. By 1995, decisions would have been made to either use a low-flow control reservoir on the Deli River, use more water from the Deli River and Percut River low flows, or use raw water diverted from the Babura or the Belumai Rivers.

10.1.1.3 Transmission Pipelines

The existing transmission pipelines from the Sibolangit springs carry water to Johor and Deli Tua. These pipelines range in age from 70 years to 10 years, and some may be replaced during the next 20 years. New replacement pipes should be of larger diameters in order to reduce pressure losses and to allow for emergency re-routing of flows in the case of pipeline ruptures. If spring production can be expanded, new or replacement pipelines should be sized to provide for higher flows and emergency capacity.

New transmission pipelines and their costs are discussed as part of the Deli Tua Water Plant system. The Deli Tua pipeline system could also serve the expansion of Sibolangit and the Marihan springs. Only 21 km of new transmission pipeline would be required to join the Sibolangit Springs with the Deli Tua transmission pipelines. A 14 km spring water transmission pipeline from the Marihan springs could follow the Percut raw water diversion system and connect with the Deli Tua treated water pipeline. Any additional costs for the collection and transmission of spring waters would be balanced by reduction in costs of treating river water at the Deli Tua Plant.

The two existing 600 mm diameter transmission mains from Sunggal to the periphery of the present service area are adequate for a supply of 600 l/s. Between the point of entry at the periphery and the ground tanks and tower at Jalan Singamangaraja, the existing pipelines are inadequately sized and are more than 60 years old, resulting in little or no water from Sunggal reaching the latter site. Tirtanadi is however talking remedial measures by laying a 400 mm ductile iron transmission main which will make a radical improvement. Their intention is to use the existing lines as distribution mains, and the new main for transmission only.

It will cost nearly 182 million rupiahs and will be essential if the additional supply is to be utilized effectively. The exact length and route of the transmission main from Deli Tua Plant to the truck main network will depend on the location of the plant. Its estimated cost is 2280 million rupiahs.

10.1.1.4 Well Supplies

Wells, if feasible, will be the cheapest, most flexible source of municipal water supply for Medan. The well supply takes on even greater importance when considering total use of the estimated production from other local sources. If wells are not developed, about 100,000 m^3/d would have to be collected from more distant and more expensive regional sources. The 100,000 m^3/d groundwater availability figure must be recognized as being only an estimated based upon limited data. The results of the recommended groundwater exploration will dictate whether or not this figure should be increased or decreased. The substantially lower costs of groundwater calls for development of as much groundwater as possible, under any long on short range water resources management plan.

Well Exploration Program: A well exploration program has been recommended for initiation, in 1979. This program is described in Appendix D-2. The program would provide two wells for municipal water supply and is essential to development of the recommended first and second phase wells.

Facilities: The recommended plan would require construction of 100 deep wells which would produce a total of about 100,000 m^3/d. A standard production well design is recommended which will reduce the costs of facilities at each site.

Wells would have a large diameter bore, casing, and screens. Each well would be fitted with water-level switches for the subnersible pump, flow metres, pressure gages, and electric metres. Valves would allow on-site discharge for sampling of the flow to the distribution system. Each well would be provided with a dual electrical supply where possible.

The land area required for each well will be about 200 m^2. This area will permit construction of the well and periodic renovation. The building will be only 25 m^2 and would have wide doors and removable roof panels for renovation and pump removal.

The discharge pipeline of the pump would be connected to local street distribution pipelines of 100 to 200 mm diameter. A fire hydrant may also be located on the street side of the site and could be connected to the well discharge pipe or to the street distribution pipeline.

Locations: Most of the recommended 100 wells would be located on sites about 1,000 m from each other or at a density of about one per square kilometre. At this spacing, about 35 wells would be distributed across Medan east of the Deli River. Most remaining wells would be distributed in the Belawan corridor (15) and in the Sunggal-Medan Baru area (30). The final 20 wells would be located within the high demand areas of the northern urban area that may prove to have sufficient groundwater capacity to supply more than one well per square kilometre.

Schedule of Construction: The recommended schedule would require completion of 60 wells before 1984 with about 15 wells completed each year. After completion of the Sunggal Plant expansion, the remaining 40 wells would be completed between 1984 and 1989. This second phase of wells would be coordinated with the production from the Sunggal Plant and first increment of the Deli Tua Plant.

Costs: Costs and facilities for a typical recommended production well are described in Table 10.1. Capital and annual costs for the first phase (60 wells) and second phase (40 wells) are described in Table 10.2. No cost saving has been assumed for the 100 wells, although some could be expected with a 10 year drilling program. The total annual unit cost would be Rp.29.6/m^3 for each well.

10.1.2 Distribution System Improvments

10.1.2.1 Pipeline network

The existing supply is satisfactory in the North-East sector of Medan. The 400 mm main being laid by Tirtanadi, and the new mains recommended in the previous section on transmission mains will improve the existing situation. It is recommended that the highest priority be alotted to the laying of the new Stage I trunk distribution mains in this section of the city.

Table 10.3 summarizes the lengths of each size main recommended for Stage I and II of the project. (A detailed tabulation is given in Appendix E.2). The existing mains have been taken into account in computing the sizes of the new mains. The trunk mains recommended for Stage I will generally be adequate until 1990 by which time work on Stage II should be undertaken. The complete layout of the recommended distribution system is shown in Figure 6.10.

Additional clear water storage and a new clear water pump house will be needed as the capacity ot the existing facilities cannot be increased. Sufficient land space is available for both.

The total cost of upgrading the Sunggal Plant from its present capacity of 600 l/s is estimated at 4,280 million rupiahs. The first stage, which should also contain some of the facilities needed for the second stage, will cost approximately 200 million rupiahs and the latter, 2280 million rupiahs.

Deli Tua Plant: This plant would supply 250,000 m^3/d to the system by 2000. The initial construction, drawing water only from the Deli River, would have a capacity of 120,000 m^3/d available by 1987. Diversions from the Percut and Babura rivers and expansion of the Deli Tua Plant would provide the additional 130,000 m^3/d needed to meet the 2000 demand.

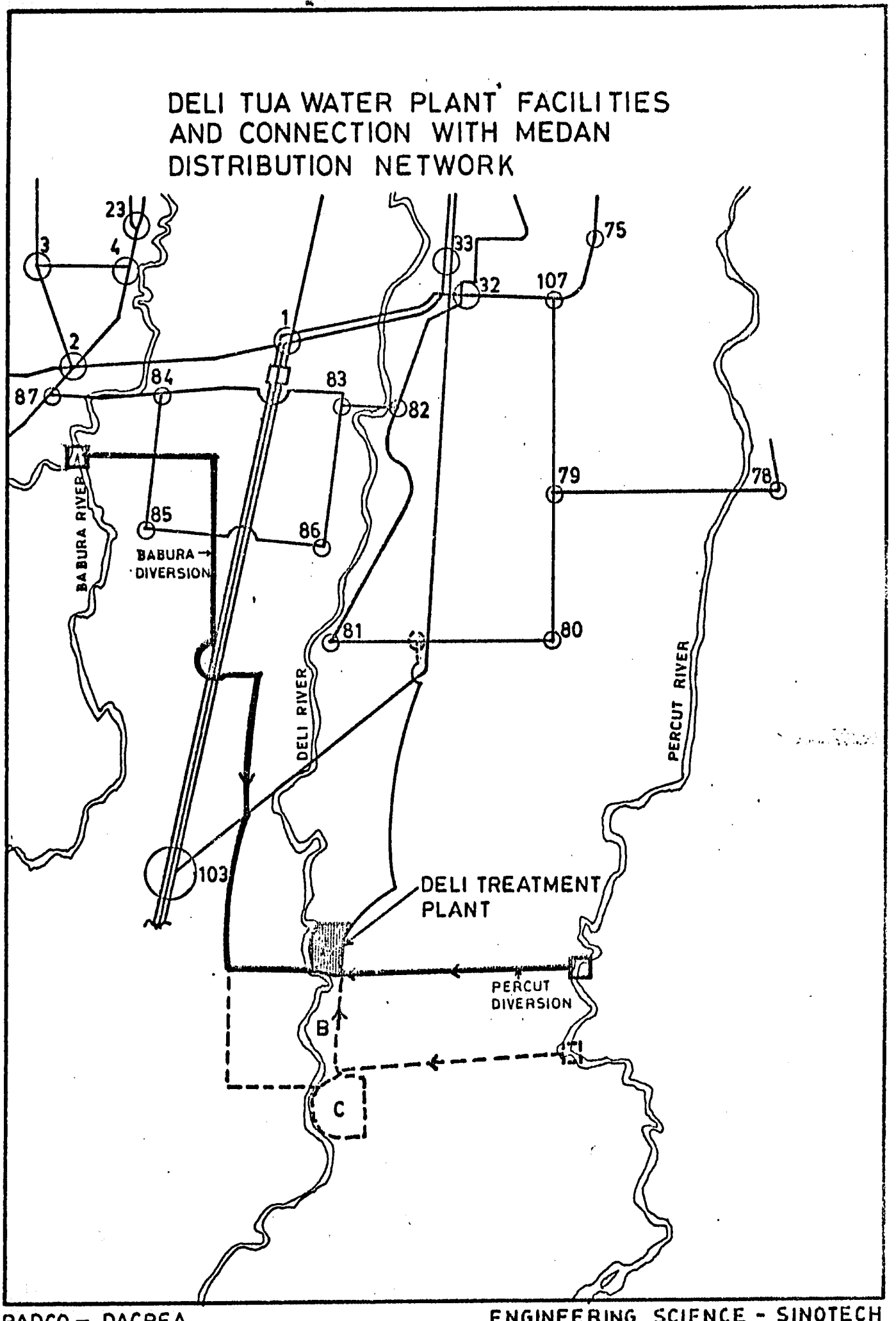
Figure 10.1 shows the locations and routes for the plant, diversions and pipelines.

Several alternative plant sites south of Deli Tua and along the east or west side of the river would have sufficient area (10 to 15 ha) for a plant of 250,000 m^3/d. Three candidate sites will be evaluated more fully. Sites A, B and C along the existing paved road from Deli Tua to the Deli River have at least 10 to 30 ha, and are upstream of Deli Tua and the small stream to the east which collect most urban runoff from Deli Tua.

The Deli Tua Plant would contain the same elements as described for the Sunggal Water Plant: weir and sluice gate, presedimentation basin, raw water pumps and chemical feed facilities, clarifiers, filters, filtered water reservoirs, and a treated water pump station. Major electrical power lines lie within 2 km and both an electrical substation and diesel back up generators would be required.

The treated water would be transmitted first to Deli Tua, 600 m to the northeast of the plant. From Deli Tua, the transmmision pipeline route would follow the existing spring water pipeline right of away for about 4.0 km along the old railroad right-of way. The new pipeline would connect with the future distribution.network between Nodes 80 and 81 in Titi Kuning. Water supply service could be provided throughout this south-central, Medan-Deli Tua development corridor.

FIGURE 10.1



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The total length of new mains will be 291 km of which 198 km will be needed in Stage I and 93 km in Stage II. (See Table 10.3 and Appendix E-2). Gate valves have been provided in the estimates on the basis of one valve between two junctions, enabling a repair on any line to be carried out by closing the line affected and one more. According to statistic obtained from the Fire Department, nearly 3,700 fire hydrants have been installed in the existing service area of which, however, very few are in working order due to lack of sufficient pressure. Provision has been made for 1500 new hydrants, mainly in the new service area. Flow metres should be installed on each separate transmission main leaving the treatment plants and on each outlet distribution main from the booster pumping stations. Metres have been installed on the transmission mains from the springs but some are defective and should be repaired.

The total cost of the distribution system improvements is 10,472 million rupiahs, Stage I improvements costing 6,670 million rupiahs and Stage II 4,072 million rupiahs. This includes the cost of gate valves and hydrants but not feeder mains of diameters less than 200 mm.

It is estimated that about 870 km of feeder mains of average diameter 80 mm will be needed to provide 80 percent of the projected 2000 population with reasonable access to the municipal system. The cost of supplying and laying these mains, (including valves) is estimated at 3,470 million rupiahs. It will be done progressively, the Stage I cost being estimated at 1000 million rupiahs and the Stage II cost at 2,470 million rupiahs.

10.1.2.2 Storage and Booster Stations

The available storage is quite inadequate, but the insufficiency is not felt directly due to the demand far outstripping the supply, and the limited amount reaching the Jalan Singamangaraja reservoirs and tower. The situation will change radically when the new transmission mains are provided and additional storage will have to be given priority. Land space is not likely be available at or near the Singamangaraja site, and it is therefore recommended that of the four new reservoirs provided in the new system in Stage II, the one at East Medan be constructed first together with a booster station of the recommended capacity.

Three more reservoirs, each of capacity 1,200 m^3 have to be completed during Stage I if the supply of 1500 l/s from Sunggal and the additional

amount from the well program are to be utilized effectively. The booster stations should each have a peak pumping capacity, during Stage I, of 850 m^3/hour, the pressures being boosted in each case by 40 metres. Three pumps are to be provided, two working together having the peak capacity and the third being a stand-by. The periods of peak-hour pumping will be determined by pressure readings transmitted electrically to a recorder at the booster station either from a small capacity tower or a pressure gauge located at a critical point in the area served by each reservoir. The pumps will operate at constant speed and will be controlled manually.

In the second stage, the capacity of the four reservoirs constructed in Stage I will be doubled and an additional pumping set of the same capacity will be added. The new peak pumping rate will be 1285 m^3/hour. Two new additional reservoirs, each of 6000 m^3 capacity, will be provided, one in the southwestern sector of the service area and the other close to the industrial estate in the north. Boosting to Belawan will be done mainly by the booster stations at the northern reservoir site. The peak pumping capacities of the booster stations at the two additional reservoirs will be the same as those at the other four. The existing booster station at Sei Agul and Jalan Singamangaraja will continue to function, but at the same peak capacities as the other stations. The recommended storage and booster pumping capacities are given in Table 10.4.

TABLE 10.4

RECOMMENDED STORAGE AND BOOSTER PUMPING

Reservoir Location (Reference Figure 9)	Reservoir Capacity m^3	Booster Station Peak Pumping rate m^3/h	Reservoir Capacity m^3	Booster Station Peak Pumping rate m^3/h
"A"	12,000	850	24,000	1285
"B"	12,000	850	24,000	1285
"C"	12,000	850	24,000	1285
"D"	12,000	850	24,000	1285
"E"	-	-	6,000	1285
"F"	-	-	6,000	1285
Sei Agul (existing)	1,400	540 (estimated)	no change	1285
Jl. S.M. Raja (Ground tanks)	3,900	540	No change	1285
Jl. S.M.Raja (Elevated Tank)	1,200	Present	no change	present rate

The locations of the reservoir and booster pumping stations are shown in Figure . Pumping to the existing tower at S.M.Raja is done only for a few hours each day due to the insufficient supply, but in the new scheme pumping will be done whenever the level indicates the necessity for it.

The cost of reservoirs in Stage I will be 960 million rupiah and in Stage II 1,200 million rupiah. The corresponding figures for the booster pumping stations are 510 million rupiahs and 240 million rupiahs, respectively.

10.1.3 Public Standpipes and Water Services

10.1.3.1 Standpipes

Public standpipes have been provided in the system on the basis of one per 300 residents in selected low income areas. The 1985 projected population in the service area is 1,150,000. Since the increase in the number of house connections is likely to be slow at the start, sufficient standpipes should be provided to serve 20 percent of the above population. The total required in Stage I is assessed at 700 and the cost estimates allow for 250 in 1980/89 and 150 each year through 1983/84. As access to the municipal system through metreed connections increases, the annual rate of provision of standpipes is expected to decrease.

The total number of standpipes needed by 2000 is estimated at 1000, costing approximately. 84 million rupiahs in Stage I and 36 million 100 rupiahs in Stage II. There are less than standpipes in the city at present, about half of which are not in working condition, due mainly to damage or insufficient pressure.

10.1.3.2 Water Service Connections

In 1978, there were approximately 33,000 service connections. In 2000, 125,000 individual and multiple service connections are estimated to be required to achieved the targets set for domestic and non-domestic service from the municipal system. The total cost is estimated at 4,900 million rupiahs, 1,500 million rupiahs being for Stage I and 3,400 for Stage II.

10.1.4 Shallow Well Improvement Program

Approximately 850,000 persons presently obtain their water requirements from non-municipal sources. Of these about 700,000 belong to the middle income, medium density group and the remaining 150,000 to the low income, high density group. Almost all of them obtain their water needs from shallow wells which are mostly polluted, or from surface sources which are invariably polluted.

Assuming that about 100,000 of those in the low income, high density areas obtain water from public standpipes and surface sources, the estimated number of persons using shallow wells is about 750,000. Of the middle income group, a major part, particularly those living outside the

busier sections of the presently built up area, have individual wells. Probably there are about 500,000 in this category. The balance of 200,000 have wells shared, perhaps, by two families. The number of wells, on this basis, used by the middle income group is about 75,000.

In the case of the 50,000 people in the low income, high density group using wells, each well is probably used, on an average, by about five families. The total number of wells used by this group is therefore estimated at 50,000/8 x 5 or 1250 wells.

The present program strategy is to increase the access to safe water from 25 percent of the population in 1980 to 60 percent in 1985 and 80 percent in the year 2000. Even if 80 percent coverage is achieved, therefore, an appreciable fraction of the population will still continue to use shallow wells for many more years. A simple and inexpensive, but effective and continuing program to improve such wells to aesthetically acceptable and safe sanitary standards is needed.

A few of the multiple dwelling wells in the congested areas are not capable of being meaningfully improved because it will be a practical impossibility to eliminate the sources of underground and surface pollution. Assuming that about 40 percent of the wells will continue to be used for a reasonable period, a shallow well improvement program will have to cover about 30,000 wells on a phased schedule. To derive the fullest benefit from such a program, there should also be a parallel and continuing maintenance program.

The present government Shallow Well Program is handled by a unit of the Health Department and it seems both appropriate and economical to entrust the improvement and maintenance programs to the same unit. An educational program is also likely to be extremely beneficial.

The initial cost of improvements, if done under the supervision and advice of a trained officer, should be around Rp.5000 per well. A phased program of well improvement expenditures is given below.

Year	Number of Wells Improved	Initial Cost (Millions of Rp.)
1980/81	2000	10
1981/82	4000	20
1982/83	4000	20
1983/84	2000	10
1984/89	8000	40
1989/2000	10000	50
Total	30000	150

Once the improvements are carried out the organization in charge of the program should have a regular schedule of inspections to ensure that the initial expenditure is not wasted. If subsequent repairs become necessary after a few years, some residents are likely to get the repairs done at their own expense and on their own initiative. Others who may not be able to afford to make these repairs will need assistance. It is estimated that on an average a satisfactory repair can be carried out at a cost of 2500 rupiahs each. On this basis, the maintenance program given below is recommended for implementation with the well improvement program. Each household could be restricted to one grant for a specific period of time, say 3 or 5 years.

10.1.5 Summary of Capital Costs and Implementation Schedule

A summary of costs of the recommended water system, phased annually, is given in Table 10.5. An implementation schedule based on these figures is given in Figure 10.2., which takes into account appropriate provision for negotiations, design, tenders, and construction.

TABLE 10.5

ESTIMATED CAPITAL COSTS - WATER SUPPLY MANAGEMENT SYSTEM Rp.(millions)
CONSTANT 1979 PRICES

Item	REPELITA III							Total
	1979/80	1980/81	1981/82	1982/83	1983/84	1984/89	1989/2000	1979/2000
Sunggal Treatment Plant								
Stage I	(200)	(900)	900	-	-	-	-	900 (1,100)
Stage II	-	-	700	700	880	-	-	2,280
Deli Treatment Plant	-	-	-	-	-	8,437	13,093	21,530
Well Program	(150)	(350)	500	500	450	430	870	2,750 (500)
Transmission pipelines	-	(100)	82	-	-	2,462	-	2,544 (100)
Service Reservoirs	-	(240)	400	320	-	-	1,200	1,920 (240)
Booster Pumping Stations	-	(126)	134	250	-	-	240	624 (126)
Major distribution mains	-	(210)	1,650	2,100	1,455	-	3,445	8,650 (210)
Minor distribution mains	-	-	300	300	400	1,000	1,470	3,470
Service connections	-	(300)	400	400	400	2,000	1,400	4,600 (300)
Public standpipes	-	(20)	10	10	20	30	30	100 (20)
Shallow well improvements	-	(10)	20	20	10	40	50	140 (10)
Base Totals	(350)	(2,256)	5,096	4,600	3,615	14,399	21,798	49,508 (2,606)
Engineering	(35)	(226)	509	460	362	1,440	2,180	4,951 (261)
Land	(200)	(100)	200	-	-	-	-	200 (300)
Physical contingency	(88)	(387)	871	759	597	2,375	3,596	8,198 (475)
Totals	(673)	(2,969)	6,676	5,819	4,574	18,214	27,574	62,857 (3,642)

Note: ( ) indicates immediate action program expenditures.

WATER SUPPLY PHASED IMPLEMENTATION PROGRAM

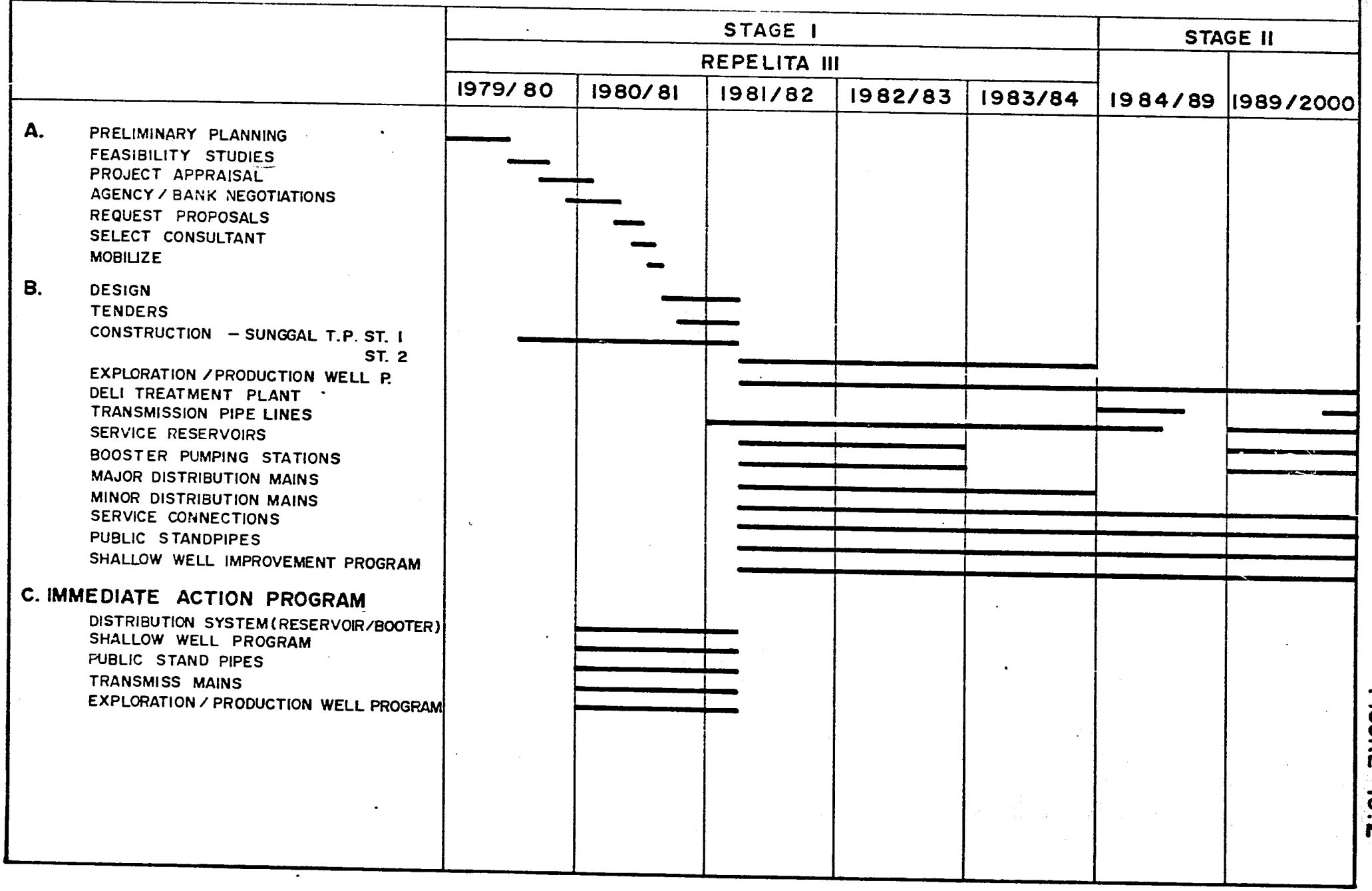

FIGURE 10.2

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Year	Number of Wells Repaired	Repair Cost (Millions of Rp.)
1980/81	-	-
1981/82	-	-
1982/83	2,600	6.5
1983/84	2,600	6.5
1984/89	13,000	32.5
1989/2000	26,000	65.0
Totals	44,200	110.5

The Shallow Well Improvement Program, together with the auxilliary Maintenance Programme, if successfully implemented, could have a marked impact on the health and living standards of that part of the population which does not have access to, or cannot afford water from the municipal system.

10.1.6 Discussion

The basic difference between the two alternative water supply management systems lies in the degree of reliance placed on the deep well ground water supply. Of the estimated requirement, of 435,000 m^3/day in the year 2000, Alternative No.1 would involve the production of 150,000 m^3/day from the Deli Tua Water Treatment Plant and the extraction of approximately 193,000 m^3/day from deep wells. In Alternative No.2, the corresponding figures are 245,000 m^3/day and approximately 98,000 m^3/day,respectively.

In Alternative No.1, deep wells will be located in many parts of the service area,the concentration being higher in the East and North West areas of the city and the needs of these areas will be served in large measure by these wells. In Alternative No.2, a larger portion of the total water supplied will have to be brought from the Deli Tua Plant, nearly 7 km away, resulting in larger pipes and higher costs. The Deli Tua Plant supply is fed into the network at node 81. In Alternative No.1, the pipe sizes needed in the year 2000 between nodes 81 and 80 and 81 and 82 are 750 mm and 700 mm,respectively. In Alternative No.2 the two corresponding sizes are 850 and 900 mm. The cost of the distribution

networks in Alternatives No.1 and 2 are approximately 8,900 million and 10,750 million rupiahs, for supplying and laying of pipes only, the difference being mainly due to the above reason.

The difference in capital construction costs of the sources themselves is also appreciable. The costs of the Deli Tua Plant and the wells in Alternative No.1 add up to approximately 20,860 million rupiah whereas in Alternative No.2 the total is 24,780 rupiahs.

From the information available, the deep well water is unlikely to need any elaborate treatment, chlorination alone being likely to suffice. Surface water, on the other hand, needs full treatment and the recurrent production costs are appreciable higher. However, in the two alternatives under consideration, the relatively conservative production per well assumed for forecasting the safe yields increased the unit cost of well production and consequently the total annual operation and maintenance costs are almost the same in the two alternatives.

10.2 OPERATION AND MAINTENANCE

10.2.1 Operations

The operations division of the future water supply system will have five units:

1. Spring Supply
2. Surface Water Plants
3. Well Supply
4. Transmission Systems
5. Distribution System

Although the first three operating units will be independent, the transmission unit will be closely linked to the spring supply and surface water plant units by transmission facilities for the Sibolangit Springs, the Sunggal Plant and the Deli Tua Plant and its diversions. The transmission systems unit will also interact with the distribution system unit and may assume operating responsibility for some of the larger diameter pipelines within the distribution system (e.g. 600 mm pipelines from the Sunggal and Deli Tua Plants and the pipeline connecting Medan and Belawan.

10.2.1.1 Springs

The isolated location of the Sibolangit Springs requires separate operating units for the spring collectors, treatment facilities, and both local collector and transmission pipelines. At the junction of the local transmission pipelines downstream of Sembahe, the transmission system unit would be given operational responsibility. Spring operations would include:

- Daily inspection of each spring collector, recording of flow level and overflow.
- Daily inspection of all local collector and transmission pipelines and junction chambers, and immediate, temporary patching of leaks.
- Daily record of water levels of incoming water at each treatment facility and discharge to local transmission pipelines.
- Daily recording of water temperature, dissolved solids, and alkalinity and calculation or graph determination of required dosage of lime for pH balancing. Hourly adjustments of lime and chlorination treatments to flow and chemical characteristics of the spring flows.
- Daily inspection of all roads and buildings for repairs and daily cleaning of grounds and building. Weekly trimming and clearing of vegetation from general area of all collectors, pipelines, roads and building areas.
- Display of daily flows, water quality, and materials usage at each treatment works, daily communication of daily discharge to transmission system.
- Immediate communication to Medan of any disruption of flow lasting more than 30 minutes and affecting more than 50 percent of the discharge from the treatment works,

10.2.1.2 Surface Water Plants

Extraction, treatment and pumping of surface water will be done at two points in the scheme - the existing plant at Sunggal and the proposed plant at Deli Tua.

The unit operations adopted at the Sunggal and Deli Tua Plants are extraction and pre-settlement, pre-chlorination and addition of soda ash, pumping of the pre-settled water to the clarifiers, clarification, filtration, post chlorination, pH correction and pumping of treated water to the city. The following routine procedures are recommended for efficient operation of the plant.

- Check the operation of sluice gate at the entrance of the diversion channel and the two sluice gates at entrances to the two halves of the pre-settling tank, daily, to ensure sufficient flow of raw water to the raw water pump house. Check the level of debris and silt in the pre-settling tank weekly. Check the quality of the effluent from this tank daily and if any deterioration is noted, particularly an increase in the amount of algae, inform the quality control officers for adjustment of the pre-chlorination dose. Examine the raw water channel between the pre-settling tank and raw water pump-house once a week for excessive silting and blockage.

- Check raw water tank under raw water pump house floor once a week for excessive silt which can clog the foot valve. Check raw water pumps for working load, record voltages and amperages each hour, as is now being done, check general condition of pumps and motors, shaft seals, discharge pressure and temperatures of motor bearings every hour.

- Check on flow of raw water to each clarifier hourly. Dissolve coagulant, and coagulant aid such as Kaolin clay if turbidily is low, (the dosages should be determined from daily jar tests), for each shift separately. If clay is added for stabilization of flow it should precede addition of alum. If a polymer is used, it should follow the addition of the coagulant. Keep a close watch on the quality of the water reaching the overflow weirs, particularly during the afternoon. Sludge circulation is necessary, but should be controlled during these hours. Check on the turbidity of clarifier effluent. Check on the functioning of the scraper and agitator. Turbidity of effluent should be kept under 10 units. Keep close contact with monitoring unit and operate dosing equipment accordingly.

- Operational procedures for the filters will depend on the design of the filters. The original set is of conventional design, but the rate of flow controllers are non-functional. After each wash, the flow should be controlled by throttling effluent gate valve to avoid an excessively rapid rate of filtration. Present practice of backwashing filters in the original set only once in 72 hours should be checked for economy. After the flow metres are repaired, conduct tests over a reasonable period varying the length of filter run and the total daily output. The turbidities of clarifier and filter effluents should be recorded for any meaningful interpretation of results. A graphical recording of results will indicate optimum length of filter run. The duration of the tests should be at least one month.

  If the second set of filters is converted to a constant flow rate (variable head) type without effluent rate controllers the operation is simpler. The same test should be carried out for optimum length of filter run. Backwashing should be done carefully with air-scour and surface wash.

  If, as recommended, the future sets of filters are of the declining rate of flow type, the operation is similar. Examine filter media for cracks and formation of mud-balls. Record time of each backwash.

- The Wallace and Tiernan - type chlorinators provide a chlorine solution from chlorine gas cylinders. The rate of application should be done in consultation with the monitoring staff for post-chlorination. Check safety equipment daily.

- Check level of water in clear water tanks every half hour. Check, at least once per shift, whether all valves are open. Make same checks recommended for raw water pumps. Record flow of water through each transmission main leaving treatment plant. Check accumulation of silt in clear water tank periodically and in any case clean the tank, one half at a time once every six months.

The operating staff should maintain complete records of performance of the unit processes. These should be a source of regular and reliable information to the Manager of the Plant from which he should not only be

able to ascertain what is already wrong with any section of the plant, but should be able to take action to correct developing problems which the records may indicate are likely to occur.

The operation of the Deli Tua plant should be carried out on a similar basis.

The Deli Tua Plant will eventually receive water from two diversions, one on the Babura and one on the Percut River. Since the weirs, settling tanks, pump stations and pipelines will serve the Deli Tua Plant, operations of the two diversion must be under the authority of the Deli Tua Plant engineer. Staff at each diversion will have direct contact with the control engineer of the Deli Tua Plant. Operations will include the following:

- Hourly inspection and adjustment of water levels in the settling tank and of the pumps,
- Hourly recording of water levels, pump discharges and power consumption. If diesel engines are used to power the pumps, periodic inspection and adjustment of engines and fuel supplies.
- Periodic inspection and removal of debris from intake screens.
- Daily inspection and maintenance of site appearance, sluice gates, and pipeline to the Deli Tua Plant,

10.2.1.3 Well Supply

Operation of 100 wells will require a mobile staff of 20 well operators and four supervisors who will operate as unit closely associated with the distribution system unit. Operations will include:

- Thrice daily inspection and adjustment of wells, pumps, valves, and chlorinators,
- Daily recording of well production,discharge pressure,power consumption. and water levels and any power outages (a simple electric clock would indicate the daily loss of power). Values should be placed on chart for visual inspection of well performance.
- Daily inspection of security locks, doors,fences and gates.

- Deliver weekly records of well operations and performance to well supervisor and include any repairs or replacements needed.

10.2.1.4 Transmission Systems

Operations of the transmission system largely involve the weekly inspection of the pipeline route for leaks, nearby construction activities, and air relief valves, the daily inspection and adjustment of flow regulating valves, and the monitoring and recording of flows and pressures at meters along the pipelines. The performance of the transmission system and especially any emergency or maintenance disruption of flow must be directly and quickly communicated to the staffs of the Sibolangit Springs and the Deli Tua Plant in order for them to adjust their discharges to the transmission system.

Each month and at the end of the operating year, the performance of the transmission pipelines should be evaluated to determine long-term changes in pressure losses and flow reduction. Any repairs or preventive maintenance which opens the pipeline should be coordinated with inspection of the pipe wall for corrosion and deposition. This data would be correlated with changing pipeline performance.

10.2.1.5 Distribution System

The major components of a distribution system are:

1. Pipelines and valves
2. Storage and booster pump station
3. Metering

Pipelines and Valves. The operation of this component, unlike most other componets of the system can usually be done on a one-shift basis, with stand-by gangs available on a 24-hour basis for emergencies.

Operational procedures generally consist of:

- Monitor valves to accomodate system demands for any unusual conditions that may arise
- Operate each system valve at least one in six months
- Check all pipeline appurtenances on a routine basis.

Storage and Booster Pumping Stations

The operational procedures necessary are:

- Check positions of inlet valve at beginning of each shift
- Check and record water levels every hour
- Check on pressure recorder for pressure transmitted from tower, and check pressure gauges
- Check pumps
- Check for overflowing or any unusual changes in level at beginning and end of each shift
- Check chlorine residual once per shift and maintain a record of same.

Meters

The following operational procedures are recommended:

- Daily and weekly recording of meters at outlet of each pumping station and any other meters in the system
- Replace automatic recorder charts. If these are non-functional, record readings manually and have recorders repaired
- Check the valves immediately before and after each meter
- Regularly calibrate the meters
- Report any unusual flow patterns to reservoir manager.

For operational and maintenance purposes, it is recommended that the system be divided into four zones with headquarters at the four major reservoir - booster station sites.

10.2.2 Maintenance and Repairs

Regular maintenance will be the responsibility of the operating units, while the maintenance group will be in charge of regular and preventive maintenance and the repair of facilities. Staff will be divided among the maintenance and workshop units.

10.2.2.1 Routine Maintenance and Minor Repairs

Regular maintenance and minor repairs of all pumping and other equipment in the system should generally be done by the operating staff.

It will be the responsibility of the officer-in-charge of the particular unit to ensure that all machinery and equipment in his division are kept in good running condition. In the event his staff is unable to carry out a repair, is should be made by the central workshop.

The maintenance of buildings should be done at regular intervals, and no efforts should be spared to keep the entire premises neat and attractive. It should always be kept in mind that water-works sites in general and treatment plants in particular are often visited by groups of students for educational purposes and by other officials and people. It is important that a good image of the water authority be projected during such visits and a feeling of confidence in the authority be created which may be needed on occasions when the authority encounters operational problems and has to curtail or suspend the supply for a short time.

Springs

- Clean debris and deposits from spring collector and collection basins
- Lubricate valves and paint or coat exposed metals
- Service chemical mixing equipment and dosing pumps
- Clean and renovate aerators
- Test and flush local collector and transmission pipeline and repair leaks

Treatment Plants

- Service all pumps, motors and other electrical equipment and clean panels, wiring, terminals etc., in accordance with manufactures instructions. Repair any leaks through valve gland packings.
- Service chemical mixing equipment and the dosing pumps according to makers' instructions. Service sludge scraper, agitator and motor of clarifier at specified intervals. Check, and if necessary, clean piping from chemical mixing room to clarifier.
- Check and service valves, replace piping as required
- Keep hand-railing, walkways clean

- Clean walls of filters, walk-ways, hand-railing clean. Check influent and effluent valves for proper functioning
- Maintain plant grounds and buildings. Make repairs and paint as required

Distribution System

- Repair leaks, install new pipes and appurtances on routine basis or when required
- Test and flush lines, and disinfect same, on a regular schedule
- Maintain accurate valve location records
- Maintain pumps, motors, and auxilliary equipment according to maker's instructions. Follow recommendations for Treatment Plant pump stations.
- Preventive maintenance unit should maintain all system meters, excluding service connection meters
- Maintain reservoir and booster station sites in clean and attractive condition.

Wells

Repairs and maintenance of wells is somewhat similar to that of any pumping station plus those features unique to the well. Thrice daily inspection of wells will indicate any immediate problems with equipment on the surface, chlorinator, valves, meters, and electric panels.

Unless a total failure occurs in the pump, the performance of the submersible pump can only be judged on the basis of its efficiency as determined from the ratio of water production to power consumption in relationship to well water levels and system pressures. Each well house should keep records of daily measurements of flow and energy consumption charted for indications of declining efficiency. The values can be compared quickly to water depth in the well and distribution pressure. If the efficiency drops rapidly, the pump may have to be pulled and inspected. If efficiency declines slowly, the pump may be undergoing normal wear or sediment has begun clogging the screens and reducing inflow. Individual well performance should be compared to that of surrounding wells, and if disproportionately poorer, the pump may have to be pulled.

Either as an ongoing maintenance program or based upon performance evaluation, the submersible pump and effluent pipe should be pulled from the well casing annually. In an annual maintenance program, a new or renovated pump would replace the previous pump and operations would continue on normal schedule. While the pump is removed, the level of the gravel pack between the well casing and the conductor pipe should be inspected and replenished if needed.

If the pump is removed for more than 24 hours and performance evaluation indicates that the screen may be clogged, the well should be cleaned by air lifting sediment from the well casing and by surging the well. Swabbing of the casing and screen may also be done, if equipment is available.

The above discussion of well and pump maintenance also implies a maintenance division within Tirtanadi which will be capable of repairing and inspecting well pumps. At present, submersible pumps of 20 to 45 HP are available and would provide required heads and capacities. Maintenance and repairs would be simpler if only one or two makes of pumps were used. At least seven makes are available locally or on three to six months orders.

Annual purchases of 20 pumps plus two stand-by replacements would allow sufficient time for importation. Dealers should provide a local training program for the repair and maintenance staff. With five years experience with 20 to 60 operating pumps, maintenance schedules and parts inventories could be developed for an orderly maintenance system through the year 2000. This theme is further discussed under preventive maintenance.

Well-cleaning requires mobile equipment which would be a part of the drilling division of Tirtanadi. High pressure air compressors would be required for development of newly drilled wells. A drilling schedule of one well every three weeks would allow the air compressor to be rotated between well screen cleaning after the total number of wells reaches 60 (1985). Similarly, a truck or trailer mounted hoist could be designed and operated for both well development and well cleaning. Such a hoist would allow better use of the drilling rig for drilling only. The hoist would be scheduled for three days well development every two weeks, and

during the remaining work days it could be used for cleaning wells on a regular well maintenance program. As with the air compressor for cleaning, such a hoist would become part of the maintenance and drilling divisions only after 1985, when the second phase of more than 60 wells may be implemented.

Transmission Systems

- Check and service valves, pressure gauges, flow metres and air relief systems.
- Annually test sections of the transmission systems for pressure losses.

10.2.2.2 Preventive Maintenance

This is an aspect of vital importance which, unfortunately, is rarely given sufficient emphasis by many water authorities. An efficient program of preventive maintenance is useful anywhere, but particularly in countries which have to first import almost all the machinery and equipment needed for a water system and later must follow it up by importing the spares needed for maintenance and repairs. The latter aspect is often particularly frustrating to the maintenance and workshop staff because it is not uncommon to find frequently needed and important spare parts unavailable, while the stores have large quantities of relatively unneeded items. The situation becomes worse if such a situation finally leads to a break-down in any part of the system.

A well planned and efficiently implemented preventive maintenance program will not only help avoid such situations but will also prevent the waste of scarce foreign resources by ill-planned over-stocking. It is therefore recommended that while day-to-day maintenance and minor repairs of the various pieces of machinery and equipment be done by the operating staff themselves, a separate Preventive Maintenance Unit directly responsible to the Chief Engineer (Operation and Maintenance) be established. It should be headed by an electrical/mechanical engineer and should consist of a group of experienced and well trained employees possessing a detailed knowledge of the equipment in the system.

When the unit is established it should prepare a catalog card for each and every item of machinery and electrical equipment large or

small, in every site or division of the organization. A glance at any such card should enable one to know the make, age, technical specification, date of last servicing, the due date for the next inspection of the item, etc. The unit should after a few months of operation, establish a strict schedule indicating its program of visits and inspections of the various sites, thus enabling the officer-in-charge to be ready and thereby be able to give the inspections all possible assistance. Thereafter, the unit should be in a unique position to advise the stores-manager when and in what quantities spares should be ordered.

10.2.2.3 Repairs

The establishment of a central workshop is essential. It should be capable of handling any feasible repair that may become necessary anywhere in the system. To avoid duplication of senior staff, it is recommended that, at least to start with, the central workshop be in charge of the engineer heading the Preventive Maintenance Unit.

The central workshop should preferably have separate sub-divisions for repairs of:

- Mechanical equipment and machinery
- Electrical equipment and machinery
- Water works appurtances and equipment
- Water meters, both large and small

The central workshop should be adequately staffed and be provided with sufficient vehicles and equipment to transport equipment to the workshop.

10.2.3 Water Quality Monitoring and Control

Operation of any large water supply system requires a large system of sampling, analysing, and assessing the water quality of the sources, the discharges to the distribution system, and the water delivered to the users. Raw water quality determines the treatment requirements necessary to maintain acceptable potable water standards and those levels of treatment processes which will make most efficient use of facilities and materials. Treated water quality analysis verifies the treatment operation and may indicate potentials for corrosion or incrustation in the transmission and distribution systems. Delivered water quality

must be completely acceptable for municipal water supply for human use without additional individual treatment (e.g. boiling and filtering).

10.2.3.1 Springs and Surface Waters

Existing monthly and twice-monthly water quality analyses at the Sibolangit Springs and Sunggal Water Plant should be continued and extended to the Deli Tua Plant and its diversions. Recommended additions to the existing programs include the following:

- Monthly tests for all parameters required by Potable Water Supply Regulation of the Department of Public Health (1975)
- On site daily analyses of the springs by operating staff for pH, temperature, total dissolved solids, alkalinity, acidity and carbon dioxide (CO_2).
- Daily analyses at the Sunggal and Deli Tua system raw water intakes for turbidity and the above parameters.
- Semi-annual analyses of alkyl benzene sulphonates (ABS), phenolic substances, chemical oxygen demand (COD). carbon chloroform extract (CCE), and grease oils.

10.2.3.2 Groundwater

Monthly complete water quality analyses for the large number of wells included in the recommended groundwater program would exceed the practical limits of the laboratory. Existing monthly well monitoring should consist of an abbreviated list of important parameters: pH, temperature, total dissolved solids, hardness, alkalinity, carbon dioxide calcium and magnesium, iron, chlorides and coliforms. These parameters would be analysed each month for 100 wells.

Once a year, a complete chemical analysis should be conducted for each well. The analyses should be identical to those conducted for surface water sources.

10.2.3.3 Distribution System

The World Health Organization's International Standards for Drinking Water have been adopted for this scheme. The tests to determine the absence or presence within permissible limits of compounds affecting the potability of the water, components hazardous to health, and

substances and chemical indications of pollution are generally made at the source.

The one important test carried out on water obtainable from the distribution system is the bacteriological test. Sufficient chlorine should be added after filtration to ensure a residual of 0.8 to 1.0 mg/l in the far end of the clear water tank at the treatment plant and a coliform count of any 100 ml sample taken from any transmission main close to the treatment plant should be zero.

Bacterial contamination, however, can and does sometimes occur after the water leaves the treatment station. It is unlikely to occur when the pipelines are full and under pressure, but the danger is greater when the pressures are very low or zero which would be the case after a pipe burst. In such situations infiltration of water from the ground into the pipe through the cracks or through defective joints can pollute the water in the network. Only vigilance and regular tests can guard the consumers against this danger.

The number of samples collected and tested per month depends on the magnitude of the system and the population served. It is strongly recommended that not less than 300 samples, collected from representative points throughout the service area according to accepted principles of sampling be tested each month. This number should be increased progressively to 375 or more per month in the year 2000.

An additional requirement, is the test for residual chlorine that should be carried out at each storage reservoir in the system at least once during each shift, and from each tap in the system when it is sampled for bacteriological quality. The residual chlorine at the reservoir or in any sample of water collected from any tap in the system should not be less than 0.1 mg/l.

It is recognized that the number of bacteriological tests per month recommended represents a major effort considering the almost total lack of testing at the present. However, it is extremely important that this recommendation be implemented. The frequency of tests recommended above is not excessive; similar standards have been followed by water utilities in developed countries for many years. In Medan, such standards can only

be considered a bare minimum in view of (1) the prevailing sanitary conditions, (2) the extremely high incidence of enteric diseases, (3) the larger number of uncontrolled cross-connections in the system, and (4) the present impossibility of maintaining adequate system pressures. Any one of these conditions would, by itself, be reason for increasing the frequency of bacteriological testing above that recommended.

A test for viral contamination has been devised lately, but it is not recommended for adoption in the system at this stage.

10.2.3.4 Laboratory requirements

An adequate laboratory is essential for quality control and also for carrying out tests that have to be made for proper treatment of surface and ground waters. It should preferably be equipped to carry out the following examinations:

1. Complete physical, chemical and bacteriological analyses of water.
2. Tests for process control:
   a. jar test for coagulant dosages
   b. raw water algal characteristics
   c. Chlorine demand.

The emphasis should be on the common testing facilities for efficient treatment. Radiological tests, for example, require expensive equipment and often can be done through other organizations better equipped to do them..

Other features that should be given consideration include:

1. Laboratory space, furniture and layout; and
2. Heating, air-conditioning, ventilation and lighting. It is often important to have strict control over one or more of these characteristics for specific tests.

10.3 SAFE YIELDS AND ALLOCATIONS

The entire recommended plan for development of local water sources requires a major monitoring program of both surface and ground water

sources. Based upon its results, the safe yields of the rivers and the local aquifers can be more accurately projected. These general safe yield estimates should be based upon the projected yields of the river sub-basins and local groundwater yields. From the results of these safe yield analyses, a reasonable and implementable allocation of available water sources can be made, and thus, water rights could be established for all basin and aquifer users. Part of this allocation requires that private water production be measured.

10.3.1 Monitoring and Analyses

The major limitation for water supply planning in Medan has been the absence of long-term, reliable data. PAM Tirtanadi and the Department of Irrigation have primary responsibility for supplying water. Therefore the two agencies should develop a flow monitoring program to accurately measure low flows in the Belawan, Babura, Deli, and Percut Rivers. Although the Hydrological Design Unit of North Sumatra has responsibility for the gages on the Deli and Belawan Rivers, Tirtanadi should begin accurate measurement of water levels of the raw water intake of the Sunggal Plant and corresponding production levels. The weir at the Sunggal Plant provides the most stable cross-section of the Belawan River which is daily and hourly inspected.

The surface water monitoring will require ten or more years of recordings before reasonably accurate projections of low flows can be made. Initial development of the Deli River source will require construction and production based upon preliminary estimates from a five year record, but the Percut and Babura rivers would have more reliable projections. In 1985, site acquisition and initial construction will begin, and Tirtanadi should assume responsibility for further monitoring of the Deli River.

Tirtanadi should further expand the program by adding two additional low flow stations on the major tributaries of both the Belawan and Deli Rivers. The additional sites would indicate potential areas for future low flow control reservoirs and for surveys for unknown springs.

Tirtanadi should establish one or two gage stations at or near the confluence of the Bekala and main Babura rivers in Kampung Kwala Gekala.

The stations would provide data for design of the Babura diversion in 1993/94. One station on the Percut near Haryo Sari (Siantar Road) should be operated by Tirtanadi to obtain data necessary to estimate the feasibility of either a third medium-sized water plant or a diversion seven kilometres further upstream.

Groundwater monitoring by Tirtanadi should begin immediately. All existing municipal and major public and institutional wells in Medan and Belawan should be monitored for pumping and static water levels. To thoroughly document the coastal aquifer, water levels in Tirtanadi wells should be measured three times daily, before pumping in morning, at mid-day, and before stopping the pumps in the evening. Tidal water levels, exact time of pump stoppages, and daily production should be recorded. At weekly intervals, pumping and static water levels should be taken in all Port of Belawan Wells, and at least 20 wells of 30 m or greater depth in Medan. The flow meters should be installed on all wells used for monitoring water levels. When the wells of the Recommended Drilling Program have been completed, these wells should be included in the monitoring program.

This groundwater monitoring effort should be included within the normal operations of all Tirtanadi and Port of Belawan wells and would require some additional staff time only for weekly monitoring of Medan wells and analyzing the recovered data. No extra facilities would require construction, and only 20 meters would be installed. Because of the less variable state of the groundwater aquifers compared to surface water sources, the recommended monitoring of groundwater and especially of the new wells drilled for Tirtanadi under the Recommended Drilling Program and in 1980/81 could determine the most productive sites for the remaining 40 well of the first phase program (1981/82-1983/84). In the period from 1980 to 1986, monitoring and well testing would accurately establish the available ground water production.

10.3.2 User Inventory

An important element of the analyses of safe yields and allocation of surface and subsurface water is an inventory of existing and planned uses, production, and water quality requirements of individual well and surface water users. The water allocation must reflect the existing uses.

Tirtanadi, the Department of Irrigation, and the Hydrological Design Unit for North Sumatra should coordinate an inventory of all formal river and groundwater users.

After initial inventory efforts, public announcements should invite unlisted users to inform the agencies of their water use and requirements so that allocations could be considered. Following the collection of a user inventory, all subsequent new uses or expansions should be subject to the availability of estimated supplies. Any uses which exceed the safe yields of low flows in the rivers should be limited to production only from above average flows or should be considered as interruptible uses during times of low flows in the rivers.

Regulation of groundwater use will be more strict, and the inventory of groundwater users will require more reliable information. Few private wells have meters, and part of the inventory will require installation of meters on large production wells at major institutions and at commercial buildings. From the inventory of users and the monitoring of their use (averaged over a year), allocations may be made based on their known use.

10.3.3 Water Rights and Allocations

Existing water rights are poorly developed and not coordinated. Once initial safe yields have been established and compared to user requirements, allocations could be established. If users' demands exceed supplies, priorities for future allocations or re-allocations would have to be made or historic water rights would have to be defined.

10.3.3.1 Water Rights

Historically, questions of water rights in and around Medan have been resolved by informal discussions and compromise. No formal rights or allocations have been made, because no legal instruments exist for such allocations, and no severe shortages or conflicts have arisen.

The National Directorate of Water Research, Department of Irrigation, the Directorate of Public Works, and the Department of Mining have regulations regarding individual aspects of water supplies, water quality, water well drilling, and well pumping. In addition, the Provincial Government and municipal governments may also regulate directly or indirectly the use of water sources. Public Health regulations can be exer-

cised against public or institutional water users. Therefore, administrative regulations or mechanisms exist that can be adopted to regulate water use. In Jakarta, the local municipal government and the water company worked together to regulate, monitor, and allocate pumping from the local aquifers when the number of users and the total use threatened the long-term yield of the aquifers.

In Medan, water rights have not been a major problem. Near the Sibolangit springs, Tirtanadi and local residents have informally allocated spring flow but no regional formal allotments have been made. Apparently, Tirtanadi has accepted no further collection of spring flows above 46,000 m^3/d. The remaining 30,000 m^3/d is allocated for potable, irrigation and recreational users or for water quality maintenance. This informal allocation of 70 to 80,000 m^3/d flow, however, was made based on local users rather than on total basin use. Since 80,000 m^3/d of flow represents nearly 40 percent of the recorded low flow of Deli River near Deli Tua, the significance of such local informal allocation becomes greater to the allocations within the entire basin.

Irrigation projects have been and are being developed on both the Deli and Belawan rivers. The significance of these projects and their water demands will increase as large individual surface water users increase withdrawals. The municipal water supplies will eventually compete with both irrigation and private users near Medan and those users in the upper and lower subbasins of the Belawan, Deli, and Percut rivers. Therefore, informal agreements will eventually be strained by competing uses. Unfortunately, little or no data are available to define the low flows by subbasins and then support wide basin allocations of projected low flows.

Existing and future water plants have been located upstream of significant urban drainage in order to assure potable water quality and reduce costs for additional treatment of urban pollutants. Therefore, for municipal water supplies, the allocation of a volume of projected low flows is only part of the water rights issue. Water quality, interbasin transfers, and return wastewater flows must be taken into consideration. All of these factors can be regulated to various degrees by existing rules for public health, irrigation, and provincial/municipal agencies. The dispersed authorities will create difficult coordination

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for effective control when withdrawals approach the safe yield of the sources.

The Directorate General of Public Works 3 April 1979 has indicated in the Urban Water Supply Program-Repelita III that drinking water should have greatest priority when competitive interests arise over a water source. Furthermore, the DGPW stated the need for regulations, especially for groundwater, to be improved and that in a metropolitan area such as Medan only one water organization should operate to insure orderly development of the safe yield of all water sources.

Groundwater rights controls in Medan and Deli Regency are virtually absent. Several agencies have been involved in regulating drilling contractors and production but enforcement has not been adequate in Medan. Ground water production in Jakarta has been made more closely regulated and both the drilling and production require permits and are monitored. In Medan, the deficient municipal water supply has forced many larger water users and wealthy residents to construct private wells without any regulation or control. Until the municipal supply becomes more adequate, little effective regulation can be enforced. Without established and enforceable water rights, private wells cannot be regulated, but the private well operators have no rights established for their continued production.

The recommended well designs and operations can effectively dominate the groundwater production within a 100 m radius, and therefore the initial well development should have little effect upon existing private wells. As the municipal water supply becomes adequate, many private well operators may not replace poor wells when they decline in production or quality. Where possible, existing private wells may be replaced by Tirtanadi with the original owners supplying the land and receiving well water at a reduced rate, while excess production would flow into the municipal supply.

If the municipal well program is expanded during the 1985-1995 period, the authority of Tirtanadi over groundwater production must be firmly established based upon its predominance during the 1980-1985 period. This authority should be integrated with and recognized by other government agencies and companies first, and then expanded to individual private operators.

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10.3.3.2 Surface Water Allocations

Allocation of surface water reflects two elements: the amount of water and the beneficial human uses and natural requirements, or the damage that may result from inadequate supplies. Monitoring and user inventories will only establish the supply and demands. During some years and seasons, all users may withdraw their maximum needs. However, during dry periods, surface water flows may be insufficient to supply all users with their total needs. At such time, priorities will be required to allocate the available supplies, or formal water rights will assign a specific quantity based upon historic use. Priorities commonly follow the order given below:

1. Municipal water supplies
2. Water-dependant industries and institutions
3. Agricultural irrigation
4. General industries, and
5. Recreation, wastewater assimilation, and fisheries.

Since potable water supplies should be given highest priority, PAM Tirtanadi should be given necessary regulatory responsibility to insure adequate, safe water supply for Medan. Similarly, Tirtanadi should have primary responsibility for coordinating and funding the monitoring of surface water sources.

Allocations must be coordinated to the flow levels within the rivers. The higher flows during the fall and spring rainy periods would be available for general uses, especially for agricultural irrigation. During a major low flow event, gradual curtailment or stoppage of some uses would be required in the basin, in order to insure adequate potable supplies. Although agricultural irrigation and general industrial users would be first curtailed, the duration may be varied depending upon the stage of plant growth. If flows continued to decline, water-dependant industries would be required to reduce withdrawal. Similarly, major non-potable and non-water dependant uses with the municipal system would be curtailed (e.g. offices, non-essential institution, and swimming pools).

Enforcement of water curtailments of non-municipal water users requires both Tirtanadi's monitoring of their use and coordinated enforcement powers for Tirtanadi and the city and provincial governments.

Without enforcement powers, the regulations, allocations, and monitoring are useless. All three must be developed together with the other concerned agencies. If enforcement powers can not be gained, the location of Tirtanadi Water Plants and diversion would practically dominate the use of water by downstream users.

10.3.3.3 Groundwater Allocation

Allocation of groundwater represents a somewhat easier task than the allocation of surface waters, although the degree of monitoring and enforcement are more important. The groundwater resource represents the most valuable water resource within the regions and therefore its regulation should reflect the greatest benefits for the Medan population. Furthermore, the groundwater aquifers are more sensitive to production and misuse. Once damage occurs in any one location recovery is more difficult.

Use of deep aquifers requires drilling of deep wells, and the drilling requires both large equipment and long time periods. Therefore, regulation of drilling represents the major focal point in the regulation of groundwater use. Permit and reporting requirements for well designs, water quality and production testing should be enforced through the regulations of the Department of Mining, and new wells within the Medan groundwater basin should be approved by both the Department of Mining and Tirtanadi.

The recommended drilling program and the monitoring of existing and recommended first phase production wells for Tirtanadi would provide sufficient data to estimate the safe yield from the deep aquifers. The existing and updated inventory of existing well production would provide an estimate of use of the available safe yield. If the safe yield had not been exceeded, existing uses could be continued.

As Tirtanadi increased production, the safe yield level would be approached, and other uses would have to be re-evaluated. Since many privately drilled wells do not last more than ten years, regulation on the drilling of new wells would gradually curtail unapproved pumping from the deep aquifers. Then, new wells could be evaluated as to their beneficial uses and potential interference with the requirements for the municipal water supplies. Wells to be used for beneficial and water-

dependant public institutions or projects (e.g. hospitals, schools and housing) would be approved, while general industrial use by a private company would be reviewed as to the applicants' alternatives sources, and their needs for human consumption.

Through the existing drilling permit requirements, if enforced, the Department of Mining and Tirtanadi could regulate the production from groundwater sources. Specification in the permit could determine the depth, diameter, and amounts of screens and gravel packs and the size and power of the pump. These factors would establish the maximum production from the well. Specifications for all wells would require flow metres which would be installed and monitored by Tirtanadi.

In some groundwater-dependant areas, the water agency has authority over the groundwater reservoir and pumping. All wells are drilled for the water agency, and non privately controlled well is permitted. However, if an approved user has a very high potable water demand and wishes to insure adequate, supply from the groundwater, the user could provide land for a well and be allowed to receive water from the well, any unused water would enter the general municipal distribution system. The private user would be charged for the delivered water at a rate which reflects the cost of long-term lease of the well and on-going maintenance of the well.