CHAPTER VIII FINANCIAL AND ECONOMIC EVALUATION

8.1 Financial Evaluation

8.1.1 General

This section of the Feasibility Study provides an assessment of the capacity-to-pay for water, focusing on the Phase I Supply Area of the proposed Meru water supply scheme. The financial evaluation of the project was then undertaken in order to assess the financial viability of the project by calculating a rate of FIRR (Financial Internal Rate of Return) on the basis of the estimated revenue and O&M costs.

8.1.2 Capacity-to-Pay for Water

The capacity-to-pay for the water at current tariff was assessed on the basis of the household data obtained from the Public Awareness Survey conducted by JICA Study Team.

(1) Income Distribution

For the assessment of consumers' capacity-to-pay for water, income distribution of households in the Phase I and II Supply Areas was examined, and the results are summarised *in* ***Table 8.1-1.***

Table 8.1-1 Household Composition by Monthly Average Income
- Meru Water Supply Scheme -

Area	Low Income		Middle Income		High Income		Total
	Average Income (Ksh)	Share (%)	Average Income (Ksh)	Share (%)	Average Income (Ksh)	Share (%)	Share (%)
Phase I Supply Area	3,409	**30.8**	9,597	**65.4**	18,941	**3.8**	100
Phase II Supply Area	3,300	**25.0**	9,775	**62.5**	19,491	**12.5**	100

Source: Public Awareness Survey Conducted by JICA Study Team

Note: Low Income: I < Ksh 4,999
Middle Income: Ksh 5,000<I<15,999
High Income: I > Ksh 16,000 -

Most households in the Phase I Supply Area under this classification are either low-income households (30.8%) or middle-income households (65.4%), together accounting for 96.2%. The weighted average income was estimated at approximately Ksh 8,600. The same trend can be also observed in the Phase II Area as well, althought the proportion of low-income households was slightly larger in the Phase I Supply Area (30.8%) than the

Phase II Supply Area (25.0%).

(2) Assumptions

Having obtained an average of monthly household incomes, capacity-to-pay for water was assessed using the following assumptions.

1) The present water tariff was applied for estimating the average monthly costs of households, and

2) Monthly per capita consumption by income level was estimated to be 1.97m3 for low-income households, 2.46m3 for middle-income households and 2.95m3 for high-income households, according to the data obtained from the District Water Offices.

(3) Results

According to these assumptions, the average monthly household water costs were estimated, thereby coming up to the proportion of monthly household income spent on water. ***Table 8.1-2*** presents the results of the analysis of the capacity-to-pay for water.

Table 8.1-2 Capacity-to-Pay for Water by Monthly Income Level - Meru Water Supply Scheme -

Area	Low Income				Middle Income				High Income			
	Avg. Income (Ksh)	Water Consum. (m3)	Avg. Cost (Ksh)	Income Share (%)	Avg. Income (Ksh)	Water Consum. (m3)	Avg. Cost (Ksh)	Income Share (%)	Avg. Income (Ksh)	Water Consum. (m3)	Avg. Tariff (Ksh)	Income Cost (%)
Phase I Supply Area	3,409	15.9	161	4.7	9,597	19.9	209	2.2	18,941	23.9	257	1.4
Phase II Supply Area	3,300	15.9	161	4.9	9,775	19.9	209	2.1	19,491	23.9	257	1.3

Source: Public Awareness Survey Conducted by JICA Study Team

Note: Low Income: I < Ksh 4,999
Middle Income: Ksh 5,000<I<15,999
High Income: I > Ksh 16,000 –
Average family size: 7.36

As indicated in ***Table 8.1-2***, an average payment in the Phase I Supply Area accounts for 4.7% in low-income households, 2.2% in middle-income households and 1.4% in high-income households. In the Phase II Supply Area, the same trend can be also observed. These findings clearly revealed that the proportion of household income spent on water is slightly high in low-income households, while middle-income and high-income households still have some more capacity.

In the meantime, criteria generally accepted worldwide suggests a rate of 5% as a maximum of household income to be spent on water. The present water tariff is therefore considered to be justifiable.

8.1.3 Financial Cash Flow Analysis

Financial cash flow analysis was undertaken in order to assess the financial viability of the project.

(1) Measure

The financial cash flow presented in ***Table 8.1-4*** was prepared on an annual basis, using the following three evaluation measures: (1) a rate of FIRR (Financial Internal Rate of Return), (2) a value of NPV (Net Present Value), and (3) a ratio of RER (Revenue Expenditure Ratio).

(2) Assumptions

The following assumptions were made for financial cash flow analysis.

1) The estimation assumes a reduction of UFW derived from rehabilitation measures taken by the project,

2) The financial cash flow was prepared on the basis of the estimated revenue (detail of which is presented in ***Table 8.1-5***) and O&M costs, and

3) The analysis was based on an averaged present unit tariff of 12Ksh/m3, estimated by taking account of individual, institutional, industrial and commercial consumers.

(3) Results

Based on the assumptions, the financial cash flow analysis was carried out. A summary of the results is shown in ***Table 8.1-3***.

Table 8.1-3 Financial Evaluation for Meru Water Supply Scheme (Phase I)

FIRR		NPV		RER	
Rate	Viability	Rate	Viability	Rate	Viability
n.a.	-	-7,646	-	2.2	●

Symbols
● = *Financial Viable*
- = *Not financial viable*

As presented in ***Table 8.1-3***, all evaluation measures indicate that the total costs of investment and O&M cannot be covered by the water revenue, due mainly to the relatively high investment costs. The evaluation measures returned unacceptable results, indicating that the project cannot become financially viable under the present tariff on the basis of the full cost recovery.

Nevertheless, the project can afford at least the expenses of O&M costs at the present tariff.

8.2 Economic Evaluation

8.2.1 General

The project was further evaluated in order to verify the economic viability of the project. The viability of the project was mainly evaluated by quantifiable benefits, as discussed in the subsequent section.

8.2.2 Identification of Economic Benefits

With the data and information collected in the field surveys, the following are identified as the key economic benefits of the project.

(1) Key Economic Benefits

Socio-economic Benefits:

1) The proposed water supply scheme will improve access to water, reducing the time spent for water collection by women who have the traditional responsibilities for water collection and providing extra time and opportunities for women to spend on other activities,

2) Increased quantity of available water will ensure the provision of reliable water for the local residents, and

3) Improved quality water will save the costs of fuels, particularly fire wood, consumed for boiling unsanitary water.

Public Health Benefits:

4) Improved quality and quantities of water will contribute to improving the public health conditions of local residents, thereby decreasing water-borne diseases, and

5) Improved access to water will save women from carrying water, resulting in enhancement of public welfare.

(2) Quantifiable Benefit

Among the key economic benefits stated above, only the time-saving benefit through water carrying was selected as quantifiable benefit for the EIRR calculation.

8.2.3 Estimate of Quantifiable Benefit

In order to estimate the value of the time saved through the reduction in water carrying, the following data, background, assumptions and method were applied and used.

(1) Data Used

The data for the Phase I Supply Area of Meru water supply scheme are based on the randomly selected samples in the Public Awareness Survey and also information obtained from direct interviews with local residents. It therefore provides quite reliable data for the estimate, fairly reflecting the actual socio-economic conditions in the Phase I Supply Area.

(2) Background

Traditionally, it has been the women in Kenya that are fully involved in all domestic chores and farm activities in their households. A large part of women's labour is therefore considered to be either subsistence or unpaid work. This implies that the present contribution of women to economic activities is quite low in principle. In line with this, it was acknowledged in the field surveys that most women, particularly women farmers in rural areas, tend to spend more time on economic activities for supplemental income when they are freed from their burden of domestic duties which are traditionally imposed on them in their households.

(3) Assumptions

The following are the assumptions made for estimating economic benefit, all of which are concerned with the current status of women in the Study Area.

1) Women are the ones who collect water to be used in the household,

2) In terms of contribution to household income, total working hours by both men and women in each household are assumed to be 10 hours a day, and they work 6 days a week, considering that most households (approximately 80%) in the Phase I Supply Area are farming households,

3) Women who are freed from water carrying spend more time on economic activities in order to have supplemental income for their families, such as agricultural activities in farmer households and informal business activities in non-farmer households, and

4) A workload coefficient was applied to adjust an hourly opportunity cost depending on whether it is a farmer household or a non-farmer household.

(4) Method

In quantifying the benefit, it is the unit opportunity cost that determines the basic value of the selected benefit. For the project, the unit opportunity cost is valued as hourly household income. Women who save a couple of hours a day through water carrying are presumed to involve in economic activities for supplemental income for their households.

(5) Procedures

The estimate procedures were undertaken in the following order.

1) Daily hours saved through water carrying per household were calculated as follows.

Tsd = T * F

Tsd: Time saved daily per household (hours)
T: Time spent for water carrying (hours/day/household)
F: Frequency of water carrying (times/day/household)

2) Hourly opportunity cost per household is valued as follows.

Hoc = (Dhi / 10 hours) * Wlc

Hoc: Hourly opportunity cost (ksh)
Dhi: Daily household income (ksh/day/household)
Wlc: Workload coefficient (maximum rate = 1.0)

3) Annual household benefit saved through water carrying is expressed as follows:

Abs = Tsd * Hoc * 310 days

Abs = Annual benefit saved per household (ksh)

(6) Key Figures

The following two tables clarify the key figures, which were used for estimating the time-saving benefit such as time saved by water carrying and the hourly opportunity cost.

Time saved through water carrying in the Phase I Supply Area averaged at 4.0 hours a day per household, as presented in ***Table 8.2-1***. This value reflects the characteristics of existing water supplies in the Phase I Supply Area, such as service coverage of water supply and geographical setting.

Table 8.2-1 Estimated Time Saved through Water Carrying

Time	Frequency	Time Saved
1.1	3.8	4.0

In ***Table 8.2-2***, the estimated unit opportunity cost for water carrying is presented, averaging at 27.5 Ksh an hour per household. This value is the basis for estimating economic benefit from water carrying.

Table 8.2-2 Estimated Unit Opportunity Cost through Water Carrying

Daily Income	Workload Coefficient	Hourly Opportunity Cost
347	0.88	27.5

Regarding women's opportunity to participate in economic activities, the workload coefficient is assumed to be different from farm households to non-farm households to arrive at more realistic estimation. This reflects the fact that women in farm households have more opportunities to be involved in farming their own fields nearby their homesteads. On the other hand, women in non-farm households have more limited opportunities to engage in economic activities. For this reason, women, particularly in rural areas, have more opportunities for education. In addition, property ownership is constrained by hereditary traditions. It is therefore assumed that a coefficient of 0.5 was applied to non-farm households, and 1.0 was given to farm households.

(7) Results

Based on the key figures explained above, the estimated time-saving benefit through water carrying is presented in the ***Table 8.2-6*** and summarised in ***Table 8.2-3***.

Table 8.2-3 Estimated Annual Benefit by Time Saved through Water Carrying

Time Saved	Hourly Opportunity Cost	Annual Household Benefit
4.0	**27.5**	**39,947**

8.2.4 Economic Cash Flow Analysis

Based on these estimated economic benefits, an economic cash flow analysis was undertaken in order to assess the economic viability of the project.

(1) Measures

The economic cash flow presented in ***Table 8.2-7*** was prepared on an annual basis, using the following three evaluation measures: (1) a rate of EIRR (Economic Internal Rate of Return), (2) a value of NPV (Net Present Value), and (3) a ratio of CBR (Cost Benefit Ratio).

(2) Assumptions

The following assumptions were made for economic cash flow analysis.

1) The economic cash flow was prepared on the basis of the estimated economic benefit and economic investment costs,

2) Economic benefit was estimated on the basis of "with and without project principle",

3) A conversion factor of 0.9 was applied to the local cost component,

4) The opportunity cost of capital of 10% was used, discounting project costs and benefits, and

5) Only the quantifiable benefit of time-saving was included in the calculation.

(3) Results

The economic analysis was undertaken, according to these assumptions. The results of the cash flow analysis are summarised in ***Table 8.2-4***.

Table 8.2-4 Economic Evaluation for Meru Water Supply Scheme (Phase I)

EIRR		NPV		CBR	
Rate	**Viability**	**Rate**	**Viability**	**Rate**	**Viability**
6.3%	●	-1,847	-	0.83	-

Symbols
● = Economically viable
- = Not economically viable

In terms of the economic return of the project, the results of the analysis indicate that the project was found to be economically viable with an acceptable EIRR rate.

Aside from the economic return, the CBR evaluation identifies the project to be economically viable, while the NPV evaluation could not obtain a positive value.

8.2.5 Sensitivity Analysis

According to the EIRR calculation done in the previous section, a sensitivity analysis was carried out in order to check if the project would be economically viable under the uncertain conditions of assumed changes in investment costs and O&M costs. The economic cash flows made for the analysis are presented in ***Table 8.2-8*** to ***8.2-10***.

(1) Assumptions

The following are the assumptions made for the sensitivity analysis.

1) Case 1: Investment costs increased by 15%,
2) Case 2: O&M costs increased by 15%, and
3) Case 3: Investment and O&M costs both increased by 15%.

(2) Results

The results of the sensitivity analysis for the above three assumptions are summarised in ***Table 8.2-5***.

Table 8.2-5 Sensivity Analysis by EIRR for Meru Water Supply Scheme (Phase I)

	Base Case	Case I	Case II	Case III
Increase in Investment Costs	-	15.0%	-	15.0%
Increase in O&M Costs	-	-	15.0%	15.0%
EIRR	**6.3%**	**4.3%**	**5.6%**	**3.7%**

The table clearly indicates that the economic viability of the project is quite sensitive to increases in investment costs rather than O&M costs. The project, however, still maintains marginally acceptable economic return at 3.7% even under the worst scenario as a Case III.

8.3 Social Concerns

8.3.1 General

Social concerns of the project which are closely related to the public welfare of the local residents in the Phase I Supply Area were also included in the project evaluation. The two water-related factors of public health and water shortage are significant when evaluating the needs of local residents for improved water supplies in terms of both quality and quantity. The data used to evaluate these factors were taken from the results of the Public Awareness Survey.

8.3.2 Key Factors

The analysis of the social concerns were particularly focused on looking into the severity of public health and water shortage conditions, thereby providing an important decisive evaluation measure for the project. These key factors have significant implication on the project, since provision of water, particularly in rural areas, is considered to be one of the most important basic human needs, and therefore expected to have a direct influence on the quality of the daily life of the local residents.

8.3.3 Measures

Public health and water shortage factors were valued using the data from the Public Awareness Survey. The procedures to calculate these factors were simply applied in accordance with the same methods used for deciding on the prioritised water supply area, the details of which are indicated in **Appendix N (Analysis of Prioritised Supply Area)**.

8.3.4 Results

By applying the above measures, the analysis of the key factors was undertaken, and then the results of the analysis are presented in ***Table 8.3-1***.

Table 8.3-1 Social Evaluation by Water Supply Scheme

Scheme	Public Health		Water Shortage	
	Rate	Severity	Rate	Severity
Phase I Supply Area	**2.02**	●	**1.44**	▲
Study Area Average	1.66	-	1.75	-

Symbols
● = Highly concerned for improvement
▲ = Improvement recommended

The table clearly shows that the Phase I Supply Area is experiencing a more severe situation in terms of both public health and water shortage, compared to the whole Study Area. This implies that a large section of the population in the Phase I Supply Area, particularly in the remote area, need to be provided improved drinking water facilities both in terms of quality and quantity to improve the current poor public health and water shortage situations.

8.4 Overall Financial/Economic Evaluation

Based on the previous analyses, the overall financial and economic evaluation of the project was examined, and the results are summarised in ***Table 8.4-1***.

Table 8.4-1 Overall Financial and Economic Evaluation

Financial Evaluation			Economic Evaluation			Social Concerns		Overall
FIRR	NPV	RER	EIRR	NPV	CBR	Health Needs	Water Needs	Evaluation
-	-	●	●	-	-	●	●	◎

Symbols for financial/economic evaluation
● = *Viable*
▲ = *Justifiable*
\- = *Not viable*
Symbols for social concerns
● = *Highly concerned for improvement*
▲ = *Improvement recommended*
Symbols for Overall evaluation
◎ = *Socio-economically investmeny justifiable*
△ = *Socio-economically investment considarable*

8.4.1 Financial Evaluation

As examined previously, the negative or marginal results of the financial evaluation indicate that the project cannot become financially viable at the present tariff on the basis of full-cost recovery, indicating that the project would not be qualified to be financially manageable using a loan scheme for its implementation. However, since the project can generate enough revenue to cover at least the O&M costs, the project would be sustainable if funds for investment costs can be financed either by subsidy or external grants.

Having established the basic financial situation of the project, it should be noted here, as a part of the financial evaluation, the issue of possibly raising the present tariff to increase project cost recovery from revenue collected. However, taking account of desirability of maintaining an equal water tariff over the whole country, it was decided that the Study should keep the present tariff for the financial evaluation of the project.

8.4.2 Economic Evaluation

Unlike the financial evaluation, the results of the economic evaluation revealed that the project is considered as economically viable with the acceptable economic return rate of 6.3%. This means that the project economic benefits as providing access to quality and reliable drinking water in the Phase I Supply Area exceed the economic costs by an acceptable margin.

8.4.3 Social Evaluation

Aside from both the financial and economic evaluations, the results of the social evaluation indicate the urgent need for water by the local residents. This clearly shows the acute need for water and the project should be eligible for implementation, based on the considering of public health and water shortage factors.

8.4.4 Overall Evaluation

The justification of water supply projects, particularly rural water supply projects is said to be quite difficult financially and economically, unless the project meets a certain scale of economy.

However, as long as a water supply project is considered to be necessary and therefore priority project, the implementation of the project is justifiable as it satisfies one of the most important basic human needs.

Considering all the above, the overall evaluation of the project finally comes to conclude that investment in the project is considered to be socio-economically justified.

CHAPTER IX CONCLUSIONS AND RECOMMENDATIONS

Of the seven projects considered in Eastern Projects, the Master Plan identified Meru Water Supply Project, as the most urgent project for implementation. Out of Meru's total supply area of 185 km2, the Master Plan also identified approximately 85 km2, including the urban and peri urban areas and the rural areas surrounding the Municipality, as being in most urgent need of improved water supplies. These prioritised areas are therefore the target for this feasibility study, for implementation in Phase 1 of the Project

9.1 Conclusions

(1) Population Projections

1) The demographic analysis indicated that urban areas were growing at a higher rate than rural areas, *i.e;* at 5.0% and 2.8% per annum respectively.

2) Future growth rates are predicted to decline in rural areas where 72% of the supply area population live, but are predicted to remain similar to present in the urban areas, where 28% of the current population live.

3) The proportion of the population living in urban areas will therefore increase over the design horizon to almost 40% by 2010.

4) The current estimated population of 165,000 is projected to reach 215,000 by 2005 and 250,000 by 2010. The population estimated to be supplied by 2005 is 129,200.

(2) Water Demand Projections

1) The Ministry guideline values for per capita consumption rates and service levels were assessed by the study to be a reasonable basis for estimating water demand. These rates however assume effective metering of all water supply connections. Without such metering, the consumer survey indicated that consumption could be many times higher.

2) The projections assume a level of 20% for unaccounted water. This assumes a considerable improvement on current levels.

3) The theoretical water demand for the whole supply area was estimated at 17,500 m3/d by 2005 and 22,725 by 2010.

4) Construction of smaller distribution pipelines, and household connections, are assumed to be implemented gradually over the design horizon, to reflect actual demand growth. The actual 2005 demand therefore will be less than that for the full supply area and, assuming 60% of the households are covered, comes to approximately 10,500 m3/d.

(3) Water Resources

1) An intake located on the Kathita River within the Mount Kenya Forest was identified as having the capacity to provide water for this project and other existing users, at an elevation that can provide the whole supply area by gravity. However, careful liaison with existing and potential future users needs to be maintained to ensure adequate quantities of water remain available.

2) The good raw water quality at the intake is due to the natural characteristics of the catchment area, and requires minimum treatment. Deforestation and development within the catchment, as occurring in adjacent areas, could however cause considerable deterioration to raw water quality and necessitate full treatment.

(4) Specification of Facilities

Preliminary designs to meet the 2005 water demands of the prioritized area have been prepared, and cost estimates made as given below. Finalisation of these designs and cost estimates will be prepared in the subsequent stage of this project.

Table 9.1-1 Facilities Features List

Facility	Details	Capacity/quantity
Intake weir	Reinforced concrete weir	22,000 m3/d
Raw water pipeline	5,825 m of 500 dia steel pipe	22,000 m3/d
Treatment plant	Inlet works	10,000 m3/d
	Plain horizontal sedimentation	10,000 m3/d
	Chlorination	20,000 m3/d
	Clear water reservoir	300 m3
	Administration building	-
Transmission mains	400 mm dia steel pipeline	3,800 m
	350 mm dia steel pipeline	6,800 m
	315 mm dia uPVC pipeline	8,500 m
	280 mm dia uPVC pipeline	5,800 m
	225 mm dia uPVC pipeline	11,800 m
	160 mm dia uPVC pipeline	12,900 m
	110 mm dia uPVC pipeline	8,200 m
	90 mm dia uPVC pipeline	3,400 m
Reservoirs	Reinforced concrete - Location 1	4,500 m3
	Reinforced concrete - Location 7	200 m3
	Reinforced concrete - Location 11	400 m3
	Reinforced concrete - Location 12	250 m3
	Reinforced concrete - Location EX1	1,500 m3

(4) Construction Costs

1) Cost estimates are based on March 1997 construction prices, using an exchange rate of 1 US $ = 56 Kshs

2) The cost of constructing Phase 1, to meet the projected 2005 demand was estimated at US$ 10,099 million, as summarized below.

3) Additional investments are required annually during operation of the scheme for extensions to the distribution and for replacement of operational equipment. These have been assumed to come out of the Project's operational budget, and therefore funded from Project revenue. Funding for Phase 2 will depend upon the financial performance of the Project at that time.

4) The total investment costs over the Master Plan horizon average at US $ 60 per capita with 70% in Phase 1 and 30% in Phase 2. The cost per capita over the feasibility study horizon to the year 2005 however comes to US $ 81.

5) Operation and maintenance costs are minimised by the design of the project. However, annual costs are estimated to rise from US$ 250,000 initially to 335,000 by 2005 and 400,000 by the year 2010. Discounted at 12% per annum, the average incremental O&M costs amount to US $ 0.14/m3 of water supplied, compared to US $ 0.75/m3 for total costs, including all investments.

Table 9.1-2 Cost Estimates for Meru Water Supply (US $ x 1,000)

Item	Phase 1 Initial investments (1998-1999)	Phase 1 extensions (2000-2005)	Phase 2 Initial investments (2006)	Phase 2 extensions (2006-2010)
Rehabilitation and equipment	179	-	-	-
Intake	224	-	-	-
Raw water pipeline	1,327	-	-	-
Treatment plant	949	-	703	-
Staff housing	106	-	35	-
Branch offices	75	-	0	-
Reservoirs	651	-	854	-
Pipelines	3,870	696	1,059	1,144
Ancillaries & contingencies	1,107	-	398	-
Preliminaries & general	1,273	-	457	-
Operational equipment	338	359	-	718
Total	10,099	1,055	3,506	1,862

(5) Financial and Economic Evaluation

1) The current water tariff is a National tariff that applies throughout Kenya for similar water supplies. For equity reasons therefore it is not seen as viable to change Meru's tariff in isolation to the rest of the country. However the findings of the study do suggest that this tariff needs to be reviewed, attention paid to tariff band increments and serious consideration given to linking the tariff to a cost of living (or, cost of production) index.

2) Using the current tariff, water will be affordable to the large majority of the population but the scheme will not be financially viable. The financial performance can be improved by increasing the tariff, but careful attention to tariff band increments is required to avoid the service becoming unaffordable to lower income households.

3) The annual recurrent operation and maintenance costs can be recovered

using current tariff rates.

4) The project can be considered viable on both social and economic grounds

(6) Environmental Impact Assessment

There are no significant negative impacts that cannot be mitigated by appropriate actions. Areas that do need attention include traffic control, conservation of the habitat in Mount Kenya forest and, appropriate sanitation to dispose of the additional quantities of wastewater which will result from the project, particularly in urban areas.

9.2 Recommendations

(1) Policy Considerations

1) A policy of full metering of all connections needs to be implemented and strictly enforced.

2) A leak detection system should be established.

3) Water Kiosks should be constructed after communities identify the need, participate in the design and location, contribute to the costs and, undertake the responsibility for operation, maintenance and payment of charges for consumption.

4) The water resources of the Kathita River need to be protected by control of river abstractions and by conservation of the catchment area.

(2) Institutional Matters

Construction of Phase 1, which includes an element for rehabilitation of the existing system, and repair and replacement of existing meters, should run parallel with corresponding initiatives to reduce levels of unaccounted water, and improve institutional capacity for management and operation.

(3) Environmental Impact Mitigation

Mitigation measures to avoid negative environmental impacts include:

1) traffic control during construction of pipelines especially in urban areas,

2) careful attention to methods of work within the Mount Kenya Forest and,

3) the provision of appropriate sanitation facilities for the disposal of the additional wastewater that will be generated by the scheme. In Urban areas, the Municipality should give consideration to provisions for enforcing such requirements and for improving the existing sewage disposal facilities.

(4) Financial and Economic Matters

1) The financial management of the project needs strengthening with the specific target of increasing the level of cost recovery to the extent that all Phase 2 costs should be recovered from revenue generated from the project.

2) It is recommended that the existing water tariff is reviewed and updated annually to reflect the impact of inflation on costs.

The project is socially and economically viable, but cannot recover the full financial costs of implementation. There would therefore appear to be some justification in considering this Project for a soft loan or grant to cover at least a proportion of the investment costs.

TABLES

Table 3.2-4 Water Demand Projection for Meru Water Supply

MERU WATER SUPPLY — *Baseline data for area to be fed from combined intake and treatment works*

Baseline Data		Town	Nanu U.Iyoki	Nanu Ntakira	Ntima L.Iroki	Ntima Nthimbiri	Ntima Mpuri	Ntima Ngonyi	Nyika Mulathankari	Nyika Thuura	Nyika Chugu	Nyika Murutu	Nyika Ntabune	U.Abothuguchi Katheri	Githongo	Kithirune	Total Base-line	Projection assumptions: Assume varying growth rates as follows: 1997	2000	2010
Locations / Sub Locations		5	56	10	6	9	6	0	5	45	18	16	8	28	15	18				
1989 Census figures																				
1989 population			26913	9414	4759	5324	4492	5227	5054	8879	13499	8021	3645	14172	7094	8698	125,191			
Population distribution & growth (WRAP 1988 estimates)																				
Rural areas	High		0%	77%	80%	100%	100%	100%	0%	100%	100%	100%	100%	100%	100%	100%	72.0%	3.0%	2.5%	2.0%
Land potential:..............	Med		0%	0%	0%				0%								0.0%	2.5%	2.0%	1.0%
	Low		0%	0%	0%				0%								0.0%	2.0%	2.0%	1.0%
Urban area	High		10%	2%	2%				10%								2.8%	5.0%	5.0%	5.0%
housing class:..........	Med		30%	7%	6%				30%								8.4%	5.0%	5.0%	5.0%
	Low		60%	14%	12%				60%								16.8%	5.0%	5.0%	5.0%
Livestock numbers:	Grade	1076	716	1454	850	1554	874	633	614	2196	333	3547	932	5000	1440	3500	24,719			
	Indig								153	549	83	549	233		360		1,927			
	Shoats	703	704	616	946	763	729	675	330	2770	420	4566	1175	325	504	562	15,788			
Total Livestock Units......................		1123	763	1495	913	1605	923	678	687	2564	389	4034	1088	5022	1594	3537	26,414	2.0%	2.0%	2.0%
Note: The following are assumed to increase in proportion with the population, within the limits specified:																		Projection constraints		
Industry	ha	450										1					451			
Institutions																	26%	Pupil/pop ratio......		30%
Day pupils with WC																		% of schools:	with WC..	0%
Day pupils without WC		655	3908	2221	1335	1280	2123	1600	981	2446	2772	2650	0	3318	1460	2421	29,170		no WC.....	90%
Boarding pupils			61	336	217	0	143				298			723	1247	329	3,354		Boarding..	10%
Admin office staff		1000	0	0					10	5		3			5	3	1,026			
Hlth Health Cntr/Disp'ry	Nr	2	2	0								1	1		2		8			
Regional Hospitals	Beds	0	0	0													-	% of Hospital Beds	Regional..	0%
District Hospitals	Beds	311	0	0													311		District....	85%
Other Hospitals	Beds	57	0	0													57		Other.......	15%
Outpatients per day	Nr	1254	121	0								170	13		270		1,828			
Commercial Hotel class: High	Beds	120	0	0													120	% of Hotel Beds:	High......	18%
Med	Beds	100	0	0	30												130		Medium ...	20%
Low	Beds	400	0	0													400		Low........	62%
Bars		25	0	0	3				3	10		9		15	20	9	94			
Shops		354	0	0					12	49		40		52	58	68	633			

Service Levels — 1997/9/26

			Service Levels: Percentage connections 1997	2000	2010	Rate l/c/d	Peak Factor
Domestic Demand							
ICs	Rural	High	20%	40%	80%	60	2
		Med	10%	20%	40%	50	
		Low	5%	10%	20%	40	
	Urban	High	100%	100%	100%	250	2
		Med	100%	100%	100%	150	
		Low	10%	30%	50%	75	
WKs	Rural unconnected supplies					10	3
	Urban unconnected supplies					20	3
Livestock							1.5
	Total Livestock Unit		15%	15%	15%	50	
Industry	ha			20%		20000	1.8
Institutions							2
	Day pupils with WC			100%		25	
	Day pupils without WC			100%		5	
	Boarding pupils			100%		50	
	Admin office staff			100%		25	
Hlth	Centre/ Nr			100%		5000	2
	Regiona Beds			100%		400	
	District Beds			100%		200	
	Other H Beds			100%		100	
	Outpatie Nr			100%		20	
Commerc	High	Beds		100%		600	1.8
	Med	Beds		100%		300	
	Low	Beds		100%		50	
	Bars			100%		500	
	Shops			100%		100	

Annual projections

	Rural Population Land potential: High	Medium	Low	Urban Population Housing classification High	Medium	Low	Total Population	Livestock Pop'n LU	Ind-ustry ha	Pupil Pop'n	Admin staff	Health Facilities Cntrs	Hosp' Beds	Out-patients	Hotels Total beds	Bars	Shops
1997	114,145			5,142	15,564	31,129	165,980	31,567	597.9	49,794	1,360	11	488	2424	861.78	125	839
1998	117,379	.		5,399	16,343	32,685	171,806	32,198	618.3	51,542	1,407	11	505	2506	891.14	129	868
1999	120,509	.	.	5,669	17,160	34,320	177,657	32,842	639.4	53,297	1,455	11	522	2592	921.49	133	897
2000	123,522	.		5,952	18,018	36,036	183,527	33,499	661.2	55,058	1,504	12	539	2680	952.89	138	928
2001	126,548		.	6,250	18,919	37,837	189,554	34,159	682.4	56,866	1,552	12	557	2766	983.45	142	958
2002	129,585	.	.	6,562	19,865	39,729	195,741	34,853	704.3	58,722	1,602	12	575	2854	1015	147	988
2003	132,630	.		6,890	20,858	41,716	202,094	35,550	726.8	60,628	1,654	13	593	2946	1047.6	151	1020
2004	135,681	.	.	7,235	21,901	43,801	208,618	36,261	750.2	62,585	1,707	13	612	3041	1081.2	156	1053
2005	138,734	.	.	7,597	22,996	45,992	215,318	36,986	774.2	64,595	1,761	14	632	3138	1115.8	161	1087
2006	141,786	.		7,977	24,146	48,291	222,199	37,726	799.1	66,660	1,818	14	652	3239	1151.6	167	1122
2007	144,834		.	8,375	25,353	50,706	229,268	38,480	824.7	68,780	1,876	15	673	3343	1188.6	172	1157
2008	147,876	.	.	8,794	26,620	53,241	236,531	39,250	851.2	70,959	1,936	15	695	3450	1226.7	177	1195
2009	150,907	.		9,234	27,951	55,903	243,996	40,035	878.5	73,199	1,998	16	717	3561	1266.1	183	1233
2010	153,925	.		9,696	29,349	58,698	251,668	40,835	906.6	75,500	2,063	16	740	3675	1306.7	189	1273
2011	157,004	.		10,180	30,817	61,623	259,634	41,652	935.7	77,890	2,129	17	764	3793	1348.6	195	1313
2012	160,144	.	.	10,689	32,357	64,715	267,905	42,485	965.7	80,372	2,197	17	788	3914	1391.9	201	1355
2013	163,347	.	.	11,224	33,975	67,950	276,496	43,335	996.7	82,949	2,267	18	813	4040	1436.5	208	1399
2014	166,614		.	11,785	35,674	71,348	285,421	44,201	1,028.7	85,626	2,340	18	839	4169	1482.6	214	1444
2015	169,946		.	12,374	37,458	74,915	294,693	45,085	1,061.7	88,408	2,415	19	866	4303	1530.1	221	1490
2016	173,345	.	.	12,993	39,331	78,661	304,330	45,987	1,095.7	91,299	2,493	19	894	4441	1579.2	228	1538
2017	176,812		.	13,643	41,297	82,594	314,346	46,907	1,130.9	94,304	2,573	20	923	4584	1629.9	236	1587

Water Demand Projections

Year	Rural Demand ICs m3/d	Kiosks m3/d	Urban demand ICs m3/d	Kiosks m3/d	Total m3/d	Live-stock m3/d	Indu-stry m3/d	Instit-utional m3/d	Health m3/d	Comm-cial m3/d	Total Avg m3/d	Overall Peak Factor
1997	1,370	913	3854	560	6,697	237	2,392	514	143	320	10,302	2.08
1998	1,878	861	4210	545	7,493	241	2,473	532	148	331	11,219	2.06
1999	2,410	803	4592	526	8,332	246	2,558	550	153	342	12,181	2.05
2000	2,965	741	5002	504	9,212	251	2,645	568	158	354	13,188	2.04
2001	3,341	709	5308	515	9,872	256	2,729	587	163	365	13,974	2.03
2002	3,732	674	5633	524	10,564	261	2,817	606	168	377	14,794	2.03
2003	4,138	637	5978	534	11,286	267	2,907	626	174	389	15,649	2.02
2004	4,559	597	6342	543	12,041	272	3,001	646	179	401	16,541	2.02
2005	4,994	555	6728	552	12,830	277	3,097	667	185	414	17,470	2.02
2006	5,445	510	7137	560	13,652	283	3,196	688	191	428	18,438	2.01
2007	5,909	463	7570	568	14,511	289	3,299	710	197	441	19,447	2.01
2008	6,388	414	8028	575	15,406	294	3,405	732	204	455	20,496	2.00
2009	6,881	362	8514	581	16,339	300	3,514	756	210	470	21,589	2.00
2010	7,388	308	9027	587	17,311	306	3,627	779	217	485	22,725	2.00
2011	7,536	314	9479	616	17,945	312	3,743	804	224	501	23,529	2.00
2012	7,687	320	9953	647	18,607	319	3,863	830	231	517	24,366	2.00
2013	7,841	327	10450	680	19,297	325	3,987	856	238	533	25,237	2.00
2014	7,997	333	10973	713	20,017	332	4,115	884	246	550	26,144	2.00
2015	8,157	340	11522	749	20,768	338	4,247	913	254	568	27,088	2.00
2016	8,321	347	12098	787	21,551	345	4,383	942	262	586	28,070	2.00
2017	8,487	354	12703	826	22,369	352	4,524	973	271	605	29,094	2.00

Table 3.2-5 Water Demand Projection in 2005

Sub Location	Rural ICs m3/d	Rural Kiosks m3/d	Urban ICs m3/d	Urban Kiosks m3/d	Total Domestic m3/d	Live-stock m3/d	Indu-stry m3/d	Instit-utional m3/d	Health m3/d	Comm-cial m3/d	Total Avg m3/d
Town	-	-	-	-	-	12	3,090	43	134	292	3,570
Ntima											
U.Igoki	-	-	5,170	423	5,593	8	-	170	17	-	5,788
Ntakira	402	45	405	35	886	16	-	46	-	-	947
L.Igoki	211	23	183	15	432	10	-	23	-	18	483
Nthimbiri	295	33	-	-	328	17	-	24	-	-	368
Mpuri	249	28	-	-	277	10	-	20	-	-	306
Ngonyi	290	32	-	-	322	7	-	23	-	-	352
Total Ntima	1,447	161	5,757	472	7,837	67	-	306	17	18	8,245
Nyaki											
Mulathanka	-	-	971	79	1,050	7	-	32	-	5	1,094
Thuura	492	55	-	-	547	27	-	40	-	17	630
Chungu	748	83	-	-	831	4	-	60	-	-	896
Munthu	445	49	-	-	494	42	7	36	9	15	602
Nkabune	202	22	-	-	224	11	-	16	9	-	261
Total Muthambi	1,887	210	971	79	3,147	92	7	184	17	36	3,483
Upper Abothoguchi											
Katheri	786	87	-	-	873	53	-	63	-	22	1,010
Githongo	393	44	-	-	437	17	-	32	17	27	530
Kithrune	482	54	-	-	536	37	-	39	-	19	631
Total Mwonge	1,661	185	-	-	1,845	107	-	134	17	68	2,171
Total Scheme	4,994	555	6,728	552	12,830	277	3,097	667	185	414	17,470

Table 3.2-6 Water Demand Projection in 2010

Sub Location	Rural ICs m3/d	Rural Kiosks m3/d	Urban ICs m3/d	Urban Kiosks m3/d	Total m3/d	Live-stock m3/d	Indu-stry m3/d	Instit-utional m3/d	Health m3/d	Comm-cial m3/d	Total Avg m3/d
Town	-	-	-	-	-	13	3,618	50	157	342	4,180
Ntima											
U.Igoki	-	-	6,936	450	7,385	9	-	217	20	-	7,631
Ntakira	594	25	544	37	1,200	17	-	53	-	-	1,271
L.Igoki	312	13	245	16	586	11	-	26	-	21	645
Nthimbiri	437	18	-	-	455	19	-	26	-	-	500
Mpuri	368	15	-	-	384	11	-	22	-	-	417
Ngonyi	429	18	-	-	446	8	-	26	-	-	480
Total Ntima	2,140	89	7,725	502	10,457	74	-	371	20	21	10,943
Nyaki											
Mulathanka	-	-	1,302	84	1,387	8	-	41	-	5	1,442
Thuura	728	30	-	-	758	30	-	44	-	20	852
Chungu	1,107	46	-	-	1,153	5	-	67	-	-	1,224
Munthu	658	27	-	-	685	47	8	40	10	17	807
Nkabune	299	12	-	-	311	13	-	18	10	-	352
Total Muthambi	2,791	116	1,302	84	4,295	102	8	210	20	42	4,677
Upper Abothoguchi											
Katheri	1,162	48	-	-	1,210	58	-	70	-	26	1,364
Githongo	582	24	-	-	606	18	-	35	20	32	712
Kithrune	713	30	-	-	743	41	-	43	-	23	850
Total Mwonge	2,457	102	-	-	2,559	118	-	148	20	80	2,926
Total Scheme	7,388	308	9,027	587	17,311	306	3,627	779	217	485	22,725

Table 4.1-2 Hydraulic Calculation Sheet for Each Pipeline by Colebrook White Formula

uPVC Pipes (K = 0.1 mm)

Nominal Diameter	Flow m3/d	Length m	Diameter m	Flow l/sec	Flow m3/h	Losses m/km	Velocity m/s
90 mm	180	1000	0.0816	2.08	7.50	2.592	0.40
110 mm	279	1000	0.0998	3.23	11.63	2.149	0.41
	352	1000	0.0998	4.07	14.67	3.311	0.52
160 mm	541	1000	0.1456	6.26	22.54	1.129	0.38
	678	1000	0.1456	7.85	28.25	1.717	0.47
	684	1000	0.1456	7.92	28.50	1.745	0.48
	766	1000	0.1456	8.87	31.92	2.156	0.53
	930	1000	0.1456	10.76	38.75	3.103	0.65
	1,120	1000	0.1456	12.96	46.67	4.407	0.78
225 mm	1,396	1000	0.207	16.16	58.17	1.151	0.48
	1,384	1000	0.207	16.02	57.67	1.132	0.48
	1,390	1000	0.207	16.09	57.92	1.141	0.48
	2,001	1000	0.207	23.16	83.38	2.262	0.69
280 mm	2,392	1000	0.2578	27.69	99.67	1.059	0.53
	2,594	1000	0.2578	30.02	108.08	1.233	0.58
	2,792	1000	0.2578	32.31	116.33	1.416	0.62
	2,931	1000	0.2578	33.92	122.13	1.552	0.65
315 mm	3,549	1000	0.2898	41.08	147.88	1.241	0.62
	3,861	1000	0.2898	44.69	160.88	1.455	0.68
	4,090	1000	0.2898	47.34	170.42	1.622	0.72

Table 4.1-3 Hydraulic Calculation Sheet for Each Pipeline by Colebrook White Formula (K=1 mm)

Steel Pipes (K = 1 mm)

Nominal Diameter	Flow m3/d	Length m	Diameter m	Flow l/sec	Flow m3/h	Losses m/km	Velocity m/s
350 mm	6,445	1000	0.344	74.59	268.54	2.524	0.80
	6,953	1000	0.344	80.47	289.71	2.933	0.87
400 mm	6,653	1000	0.394	77.00	277.21	1.321	0.63
	6,953	1000	0.394	80.47	289.71	1.441	0.66

Table 4.1-4 Hydraulic Calculation Sheet for Pipeline from Proposed Treatment Plant to Storage Tank (ST-2)

No.	Distance	Height	Flow Rate	Pipe Dia.	Loss		Head
	(m)	(m)	(m3/day)	(mm)	(m/km)	(m)	(m)
WTP	0.0	2,235.0					2,235.0
1	102.5	2,227.0	6,953	400	1.321	0.1	2,234.9
2	206.0	2,224.8	6,953	400	1.321	0.1	2,234.7
3	304.2	2,223.5	6,953	400	1.321	0.1	2,234.6
4	403.5	2,221.6	6,953	400	1.321	0.1	2,234.5
5	507.6	2,219.5	6,953	400	1.321	0.1	2,234.3
6	605.4	2,218.1	6,953	400	1.321	0.1	2,234.2
7	699.4	2,217.7	6,953	400	1.321	0.1	2,234.1
8	795.4	2,216.2	6,953	400	1.321	0.1	2,233.9
9	896.4	2,215.8	6,953	400	1.321	0.1	2,233.8
10	994.4	2,214.3	6,953	400	1.321	0.1	2,233.7
11	1,094.4	2,214.5	6,953	400	1.321	0.1	2,233.6
12	1,187.4	2,215.2	6,953	400	1.321	0.1	2,233.4
13	1,280.4	2,214.9	6,953	400	1.321	0.1	2,233.3
14	1,380.4	2,207.8	6,953	400	1.321	0.1	2,233.2
15	1,474.4	2,206.2	6,953	400	1.321	0.1	2,233.1
16	1,578.4	2,203.8	6,953	400	1.321	0.1	2,232.9
17	1,676.4	2,197.3	6,953	400	1.321	0.1	2,232.8
18	1,775.4	2,192.2	6,953	400	1.321	0.1	2,232.7
19	1,871.4	2,188.6	6,953	400	1.321	0.1	2,232.5
20	1,973.4	2,179.9	6,953	400	1.321	0.1	2,232.4
BPT1	1,973.4	2,179.9	6,953	400	1.321	0.0	2,179.9
21	2,073.4	2,173.1	6,953	350	2.933	0.3	2,179.6
22	2,173.4	2,164.3	6,953	350	2.933	0.3	2,179.3
23	2,277.4	2,151.7	6,953	350	2.933	0.3	2,179.0
24	2,378.0	2,144.9	6,953	350	2.933	0.3	2,178.7
25	2,475.0	2,143.3	6,953	350	2.933	0.3	2,178.4
26	2,580.3	2,138.6	6,953	350	2.933	0.3	2,178.1
27	2,675.0	2,133.2	6,953	350	2.933	0.3	2,177.8
28	2,774.3	2,125.7	6,953	350	2.933	0.3	2,177.6
29	2,870.5	2,124.0	6,953	350	2.933	0.3	2,177.3
BPT2	2,870.5	2,124.0	6,953	350	2.933	0.0	2,124.0
30	2,968.9	2,112.2	6,953	350	2.933	0.3	2,123.7
31	3,067.7	2,107.4	6,953	350	2.933	0.3	2,123.4
32	3,169.1	2,100.9	6,953	350	2.933	0.3	2,123.1
33	3,266.0	2,094.8	6,953	350	2.933	0.3	2,122.8
34	3,365.8	2,088.0	6,953	350	2.933	0.3	2,122.5
35	3,468.7	2,081.0	6,953	350	2.933	0.3	2,122.2
36	3,565.7	2,075.1	6,953	350	2.933	0.3	2,122.0
37	3,665.3	2,065.2	6,953	350	2.933	0.3	2,121.7
38	3,764.3	2,061.0	6,953	350	2.933	0.3	2,121.4
BPT3	3,764.3	2,061.0	6,953	350	2.933	0.0	2,061.0
39	3,865.2	2,053.3	6,445	350	2.524	0.3	2,060.7
40	3,961.4	2,046.2	6,445	350	2.524	0.2	2,060.5
41	4,061.8	2,046.7	6,445	350	2.524	0.3	2,060.2
42	4,161.6	2,043.6	6,445	350	2.524	0.3	2,060.0
43	4,262.6	2,041.3	6,445	350	2.524	0.3	2,059.7
44	4,363.8	2,036.8	6,445	350	2.524	0.3	2,059.5

No.	Distance	Height	Flow Rate	Pipe Dia.	Loss		Head
	(m)	(m)	(m3/day)	(mm)	(m/km)	(m)	(m)
45	4,463.4	2,031.4	6445	350	2.524	0.25	2,059.2
46	4,562.0	2,024.7	6,445	350	2.524	0.2	2,059.0
47	4,658.0	2,022.7	6,445	350	2.524	0.2	2,058.7
48	4,758.8	2,016.1	6,445	350	2.524	0.3	2,058.5
49	4,852.5	2,004.0	6,445	350	2.524	0.2	2,058.3
BPT4	4,852.5	2,004.0	6,445	350	2.524	0.0	2,004.0
50	4,952.6	1,989.0	6,445	350	2.524	0.3	2,003.7
51	5,052.2	1,984.5	6,445	350	2.524	0.3	2,003.5
52	5,146.6	1,982.7	6,445	350	2.524	0.2	2,003.3
53	5,244.5	1,985.2	6,445	350	2.524	0.2	2,003.0
54	5,341.7	1,982.9	6,445	350	2.524	0.2	2,002.8
55	5,442.2	1,984.0	6,445	350	2.524	0.3	2,002.5
56	5,539.7	1,979.8	6,445	350	2.524	0.2	2,002.3
57	5,640.5	1,971.8	6,445	350	2.524	0.3	2,002.0
58	5,740.9	1,967.9	6,445	350	2.524	0.3	2,001.8
59	5,839.9	1,964.2	6,445	350	2.524	0.2	2,001.5
60	5,938.6	1,960.1	6,445	350	2.524	0.2	2,001.3
61	6,038.2	1,958.2	6,445	350	2.524	0.3	2,001.0
62	6,132.8	1,955.8	6,445	350	2.524	0.2	2,000.8
63	6,231.3	1,953.8	6,445	350	2.524	0.2	2,000.5
64	6,343.0	1,942.7	6,445	350	2.524	0.3	2,000.2
BPT5	6,343.0	1,942.7	6,445	350	2.524	0.0	1,942.7
65	6,435.3	1,933.9	6,445	350	2.524	0.2	1,942.5
66	6,542.1	1,926.1	6,445	350	2.524	0.3	1,942.2
67	6,641.0	1,925.0	6,445	350	2.524	0.2	1,941.9
68	6,747.0	1,920.1	6,445	350	2.524	0.3	1,941.7
69	6,844.7	1,914.4	6,445	350	2.524	0.2	1,941.4
70	6,939.6	1,913.2	6,445	350	2.524	0.2	1,941.2
71	7,036.9	1,912.7	6,445	350	2.524	0.2	1,940.9
72	7,133.5	1,909.9	6,445	350	2.524	0.2	1,940.7
73	7,234.5	1,905.4	6,445	350	2.524	0.3	1,940.4
74	7,331.9	1,905.5	6,445	350	2.524	0.2	1,940.2
75	7,433.0	1,903.0	6,445	350	2.524	0.3	1,939.9
76	7,534.3	1,903.1	6,445	350	2.524	0.3	1,939.7
77	7,641.0	1,899.6	6,445	350	2.524	0.3	1,939.4
78	7,738.1	1,896.1	6,445	350	2.524	0.2	1,939.2
79	7,836.6	1,893.4	6,445	350	2.524	0.2	1,938.9
80	7,939.6	1,890.5	6,445	350	2.524	0.3	1,938.7
81	8,033.6	1,888.7	6,445	350	2.524	0.2	1,938.4
82	8,134.6	1,886.6	6,445	350	2.524	0.3	1,938.2
83	8,230.3	1,884.2	6,445	350	2.524	0.2	1,937.9
BPT6	8,230.3	1,884.2	6,445	350	2.524	0.0	1,884.2
84	8,331.3	1,874.8	6,445	350	2.524	0.3	1,883.9
85	8,433.8	1,866.9	6,445	350	2.524	0.3	1,883.7
86	8,528.8	1,858.5	6,445	350	2.524	0.2	1,883.4
87	8,629.6	1,855.4	6,445	350	2.524	0.3	1,883.2
88	8,725.6	1,851.5	6,445	350	2.524	0.2	1,882.9
ST-1	8,725.6	1,851.5	6,445	350	2.524	0.0	1,851.5

Table 5.1-1 Unit Construction Prices

Notes

Exchange rate: Mar-97 — 1US $ = 56 Shs

Preliminaries and General Items are NOT included within the following rates

Costs of Imported materials are assumed to be Tax free.

Tax on salaries, fuel costs and local materials have been Included

Foreign/Local currency breakdown — Cost Breakdown	%F	%L	%Tax
1. Foreign materials	90%	10%	0%
2. Local materials	15%	70%	15%
3. Labour	5%	75%	20%
4 Construction plant	85%	5%	10%

General Items

General Items	Unit	Rate Shs	Materials %F	Materials %L	Lab	Plnt	%F	%L	%Tax
General excavation in normal material not exceeding 3.0m depth	m3	350	0%	0%	75%	25%	25%	58%	18%
EO for rock	m3	1,500	0%	0%	50%	50%	45%	40%	15%
Earthworks for dams - Soft	m3	175	0%	0%	25%	75%	65%	23%	13%
Earthworks for dams - Rock	m3	1,000	0%	0%	20%	80%	69%	19%	12%
Earthfill for dams	m3	310	0%	0%	20%	80%	69%	19%	12%
Filter/drainage material for dams	m3	1,550	0%	0%	25%	75%	65%	23%	13%
Rip rap material for dams	m3	1,630	0%	0%	20%	30%	69%	19%	12%
Concrete Class 25	m3	8,000	0%	82%	14%	4%	16%	68%	16%
Concrete Class 30	m3	12,000	0%	83%	13%	4%	17%	68%	15%
Mass concrete for dams	m3	6,000	0%	80%	16%	4%	16%	68%	16%
Reinforcement	tonne	65,000	80%	10%	9%	1%	75%	22%	3%
Formwork F1	m2	475	0%	10%	77%	13%	16%	65%	16%
Formwork F2	m2	750	0%	14%	73%	13%	17%	65%	18%
Blockwork walling	m2	1,200	0%	10%	80%	10%	14%	68%	19%
"All in" cost for reinforced concrete	m3	20,175	25%	45%	25%	5%	35%	53%	12%

Pipework

Assumptions — Type of pipe	uPVC	Steel	DI	Materials %F	Materials %L	Lab	Plnt	%F	%L	%Tax
Manufacturers discount	10%	0%	0%							
Tax and duties	15%	15%	15%							
Transport and handling	15%	15%	20%	0%	0%	20%	80%	69%	19%	12%
Wastage	5%	1%	1%							
Pipe trench width	700 mm + nominal dia.									
Average trench depth	1200 mm + nominal dia.									
Average rock excavation	10%									
Valves & specials - Add to "All in" pipe costs	15%									

uPVC Pipelines

Dia mm	Trench Excav'n Shs/m	Lay, joint etc Shs/m	Materials delivered to site: uPVC 6 bar Shs/m	uPVC 9 bar Shs/m	uPVC 12 bar Shs/m	uPVC 15 bar Shs/m	"All in" pipe costs: uPVC 6 bar Shs/m	uPVC 9 bar Shs/m	uPVC 12 bar Shs/m	uPVC 15 bar Shs/m	Currency breakdown for 12 bar uPVC: Materials %F	Materials %L	Lab	Plnt	%F	%L	%Tax
63	482	40	75	125	155	200	597	647	677	722	9%	14%	58%	19%	30%	55%	16%
90	510	60	187	242	298	365	757	812	868	935	14%	21%	49%	16%	32%	54%	15%
110	531	60	252	362	442	562	843	953	1033	1153	17%	26%	43%	14%	34%	53%	14%
160	585	100	506	747	943	1155	1191	1432	1628	1840	23%	35%	32%	11%	37%	51%	13%
225	659	140	1000	1380	1825	2101	1799	2179	2624	2903	28%	42%	23%	8%	39%	50%	12%
280	725	180	1450	2125	2504	3262	2355	3030	3409	4167	29%	44%	20%	7%	40%	49%	11%
315	769	200	1837	2660	3374	4124	2806	3629	4343	5093	31%	47%	17%	6%	41%	49%	11%
400	880	280	3074	4374			4234	5534									

Steel and DI Pipelines

dia	Trench Excav'n Shs/m	Lay, joint etc Shs/m	Materials delivered to site: Steel Shs/m	DI Shs/m	"All in" pipe costs: Steel Shs/m	DI Shs/m	Currency breakdown for Steel pipes: Materials %F	Materials %L	Lab	Plnt	%F	%L	%Tax
80	499	70		1235		1804							
100	520	90	1115	1518	1725	2128	39%	26%	27%	9%	48%	42%	10%
150	574	140	2049	2285	2763	2999	44%	30%	19%	6%	51%	40%	9%
200	630	200	3154	3080	3954	3910	48%	32%	16%	5%	53%	39%	8%
250	689	260	4408	4073	5357	5022	49%	33%	13%	4%	54%	38%	8%
300	750	320	5794	5166	6864	6236	51%	34%	12%	4%	55%	38%	8%
350	814	380	7301	6386	8495	7580	52%	34%	11%	4%	55%	37%	8%
400	880	450	8921	7663	10251	8993	52%	35%	10%	3%	55%	37%	7%
450	949	510	10036	9097	11495	10556	52%	35%	10%	3%	56%	37%	7%
500	1020	580	11152		12752		52%	35%	9%	3%	56%	37%	7%

Reservoirs

										Materials %F	Materials %L	Lab	Plnt	%F	%L	%Tax
Capacity (m3)	50	100	150	200	250	300	400	500	750							
"All in" costs	550,000	780,000	940,000	1,070,000	1,290,000	1,520,000	1,940,000	2,350,000	3,360,000	25%	45%	25%	5%	35%	53%	12%
Cost/m3	11,000	7,800	6,267	5,350	5,160	5,067	4,850	4,700	4,480							

Table 5.2-1 Cost Estimates for Meru Water Supply

1. Phased Investment Costs	Exchange rate....... 1 US $ =		56	KShs	Phase 1 1998				Phase 2 2005			
Element	Description dia (mm)/ Size		Unit	Rate US $	Quantity	Civil US $ x 1,000	E&M US $ x 1,000	Pipes US $ x 1,000	Quantity	Civil US $ x 1,000	E&M US $ x 1,000	Pipes US $ x 1,000
Rehabilitation					item	17.9	17.9	142.9				
Intake					item	224.0						
Rawpipeline	500	mm dia steel pipe	m	227.7	5,825			1,326.4				
Treatment	10,000	m3/d capacity plant	nr	949,017	1	806 7	142.4					
	10,000	m3/d expansion	nr	703,083					1	667.9	35.2	
		Staff housing	nr	35,268	3	105.8			1	35.3		
Office	168	m2 floor area	m2	446	168	75.0			-	-		
Reservoirs	4,500	m3 reservoir	nr	360,000	1	360.0			1	360.0		
	750	m3 reservoir	nr	60,000	3	180.0			2	120.0		
	400	m3 reservoir	nr	34,643	2	69.3			2	69 3		
	300	m3 reservoir	nr	27,143	-	-			2	54.3		
	250	m3 reservoir	nr	23,036	1	23 0			5	115.2		
	200	m3 reservoir	nr	19,107	1	19.1			3	57.3		
	150	m3 reservoir	nr	16,786	-	-			3	50.4		
	100	m3 reservoir	nr	13,929	-	-			2	27.9		
Transmission	400	mm dia steel pipe	m	183.1	3,800			695.6				-
	350	mm dia steel pipe	m	151.7	6,800			1,031 5				-
	315	mm dia uPVC (12 bar)	m	77.6	8,500			659.2				-
	280	mm dia uPVC (12 bar)	m	60.9	5,800			353.1				-
	225	mm dia uPVC (12 bar)	m	46.9	11,800			552.9	7,200			337.4
	160	mm dia uPVC (12 bar)	m	29.0	12,900			373.9	24,900			721.7
	110	mm dia uPVC (12 bar)	m	18.4	8,200			151.3				-
	90	mm dia uPVC (12 bar)	m	15.5	3,400			52.7				-
Ancillaries/contingencies				15%		282.1	24.0	800.9		233.6	5.3	158.9
Preliminaries				15%		324.4	27.6	921.1		268.7	6.1	182.7
Total						2,497.3	211.9	7,061.4		2,059.8	46.5	1,400.6
Total phased costs					Phase 1..........			9,760 6	Phase 2..........			3,506.8

2. Annual Investment Costs												
Annual distribution pipes	110	mm dia uPVC (12 bar)	m	18.446	2,650			49	2,650			49
	90	mm dia uPVC (12 bar)	m	15.500	2,010			31	2,010			31
	63	mm dia uPVC (12 bar)	m	12.089	3,000			36	2,000			24
Total								116				104

3. Transport purchase costs			US$x1,000	1998		2003	
	Saloon car	nr	17.9	1	18	1	18
	4WD vehicle	nr	62 5	1	63	1	63
	Pickup	nr	21.4	2	43	3	64
	Lorry	nr	107.1	2	214	2	214

4. Annual O&M costs and Economic life		Transport	Civil	E&M	Pipes
	Annual O&M costs as % of investment costs..........	20%	1.00%	4.00%	1 00%
	Economic life of assets	5	30	10	30

5. Power costs				1998	Fixed	Variable	2005	Fixed	Variable
	Power tariff (Oct 1996)	Power Requirements..........			20	20		20	20
	Unit energy cost	US$/unit	0.08						
	Fixed charge per month	US$/month	7.86						
	kVA demand charge	US$/month	4.46						

6. Human Resources Costs			Rate/yr	1998				2005			
			US$x1,000	TWks 1	TWks2	Dist'n	US$x1,000	TWks 1	TWks2	Dist'n	US$x1,000
	Engineer 1	Shs/yr	3.86			1	3 86			1	3.86
	Engineer II	Shs/yr	3 21			2	6.43			2	6.43
	Inspector	Shs/yr	2.36	2		3	11.79	2	1	3	14.14
	Senior Operator	Shs/yr	1.29	2	1	4	9.00	2	1	5	10.29
	Operator	Shs/yr	0.96	2	2	5	8.68	2	2	5	8 68
	Watchman/Line patrolman/Clerks	Shs/yr	0.64	3	3	20	16.71	3	4	29	23 14
		Shs/yr					56.46				66.54

7. Chemical Costs		US$/kg	1998 Dosage (mg/l)	Cost/m3	2003 Dosage (mg/l)	Cost/m3
	Alum	0.45	0	0 000	0	0.000
	Chlorine	6.25	2	0.013	2	0.013
	Soda ash	0.25	0	0.000	0	0.000
	Total chemical cost per m3..........			0 013		0.013

8. Annual Projection of Costs						Investment Schedule					Annual recurrent costs						
Year	Population	Water Demand m3/d	Population Coverage %	Water Supplied m3/d	Incremental supply m3/d	Treatment Civil US$ x 1,000	E&M US$ x 1,000	Pipes US$ x 1,000	Transport US$ x 1,000	Total Investment US$ x 1,000	O&M Costs US$ x 1,000	Power Costs US$ x 1,000	Labour US$ x 1,000	Transport US$ x 1,000	Chemicals US$ x 1,000	Total Recurrent US$ x 1,000	Total Costs US$ x 1,000
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(15)	(16)	(17)
1997	165,980	10,302	31%	3,194	-												
1999	171,806	11,219	29%	3,253	60	2,487	212	7,061	338	10,098					0	0	10 098
1999	177,657	12,181	30%	3,654	460			116		116	105	14	56	68	2	245	362
2000	183,527	13,188	35%	4,616	1,422			116		116	106	15	56	68	6	251	368
2001	189,554	13,974	40%	5,589	2,396			116		116	107	15	56	68	11	257	374
2002	195,741	14,794	45%	6,657	3,463			116		116	109	16	56	68	16	264	380
2003	202,094	15,649	50%	7,824	4,631			116	359	475	110	16	67	72	21	285	761
2004	208,616	16,541	55%	9,097	5,904			116		116	111	17	67	72	27	293	409
2005	215,318	17,470	60%	10,482	7,288	2,060	46	1,401		3,507	147	17	67	72	33	336	3,843
2006	222,199	18,438	68%	12,538	9,344			104		104	148	18	67	72	43	348	452
2007	229,268	19,447	76%	14,779	11,586			104		104	149	19	67	72	53	360	464
2008	236,531	20,496	84%	17,217	14,023		212	104	359	675	159	20	67	72	64	382	1,057
2009	243,996	21,589	92%	19,861	16,668			104		104	160	22	67	72	76	396	500
2010	251,668	22,725	100%	22,725	19,531			104		104	161	23	67	72	89	411	516
2011	251,668	22,725	100%	22,725	19,531			104		104	162	23	67	72	89	412	517
2012	251,668	22,725	100%	22,725	19,531			104		104	163	23	67	72	89	413	518
2013	251,668	22,725	100%	22,725	19,531			104	359	463	164	23	67	72	89	415	878
2014	251,668	22,725	100%	22,725	19,531			104		104	165	23	67	72	89	416	520
2015	251,668	22,725	100%	22,725	19,531		46	104		151	168	23	67	72	89	418	569
2016	251,668	22,725	100%	22,725	19,531			104		104	169	23	67	72	89	420	524
2017	251,668	22,725	100%	22,725	19,531	-(2,148)	-(80)	-(3,863)	-(72)	-(6,163)	106	23	67	72	89	356	-(5,806)

Note: Residual values in (brackets)

9. Net Present Values			m3 x 1,000	US$ x 1,000	US$ x 1,000	US$ x 1,000
	15%		12,398	10,432	1,661	12,093
	12%		17,335	10,861	2,076	12,957
	9%		24,823	11,295	2,660	13,955
	6%		36,450	11,572	3,504	15,076

10. Average Incremental Costs (Shs/m3)		US$/m3	US$/m3	US$/m3
	15%	0.84	0.13	0.98
	12%	0.63	0.12	0.75
	9%	0.46	0.11	0.56
	6%	0.32	0.10	0.41

Table 5.2-3 Phasing Costs Broken Down in Major Components

Description	Phase 1		1998	Phase 1			Phase 2		2005	Phase 2			Currency breakdown		
	Civil	E&M	Pipes	Local	Foreign	Taxes	Civil	E&M	Pipes	Foreign	Local	Taxes	Foreign	Local	Tax
dia (mm)/ Size	US $ x 1,000	US $ x 1,000	US $ x 1,000	US $ x 1,000	US $ x 1,000	US $ x 1,000	US $ x 1,000	US $ x 1,000	US $ x 1,000	US $ x 1,000	US $ x 1,000	US $ x 1,000			
Rehabilitation	17.9	17.9	142.9	53.6	98.2	26.8	-	-	-	-	-	-	30%	55%	15%
Intake	224.0	-	-	78.4	118.7	26.9	-	-	-	-	-	-	35%	53%	12%
Raw water pipeline				-	-	-				-	-	-			
500 mm dia steel raw water p	-	-	1,326.4	742.8	490.8	92.9	-	-	-	-	-	-	56%	37%	7%
Treatment plant				-	-	-				-	-	-			
10,000 m3/d capacity plant	806.7	142.4	-	332.2	503.0	113.9	-	-	-	-	-	-	35%	53%	12%
10,000 m3/d expansion	-	-	-	-	-	-	667.9	35.2	-	246.1	372.6	84.4	35%	53%	12%
Staff housing	105.8	-	-	26.5	64.5	14.8	35.3	-	-	8.8	21.5	4.9	25%	61%	14%
Branch offices	75.0	-	-	18.8	45.8	10.5	-	-	-	-	-	-	25%	61%	14%
Storage reservoirs				-	-	-				-	-	-			
4,500 m3 reservoir	360.0	-	-	126.0	190.8	43.2	360.0	-	-	126.0	190.8	43.2	35%	53%	12%
750 m3 reservoir	180.0	-	-	63.0	95.4	21.6	120.0	-	-	42.0	63.6	14.4	35%	53%	12%
400 m3 reservoir	69.3	-	-	24.3	36.7	8.3	69.3	-	-	24.3	36.7	8.3	35%	53%	12%
300 m3 reservoir	-	-	-	-	-	-	54.3	-	-	19.0	28.8	6.5	35%	53%	12%
250 m3 reservoir	23.0	-	-	8.1	12.2	2.8	115.2	-	-	40.3	61.0	13.8	35%	53%	12%
200 m3 reservoir	19.1	-	-	6.7	10.1	2.3	57.3	-	-	20.1	30.4	6.9	35%	53%	12%
150 m3 reservoir	-	-	-	-	-	-	50.4	-	-	17.6	26.7	6.0	35%	53%	12%
100 m3 reservoir	-	-	-	-	-	-	27.9	-	-	9.8	14.8	3.3	35%	53%	12%
Transmission pipelines				-	-	-				-	-	-			
400 mm dia steel pipe	-	-	695.6	389.5	257.4	48.7	-	-	-	-	-	-	56%	37%	7%
350 mm dia steel pipe	-	-	1,031.5	567.3	381.7	82.5	-	-	-	-	-	-	55%	37%	8%
315 mm dia uPVC (12 bar)	-	-	659.2	270.3	316.4	72.5	-	-	-	-	-	-	41%	48%	11%
280 mm dia uPVC (12 bar)	-	-	353.1	141.2	173.0	38.8	-	-	-	-	-	-	40%	49%	11%
225 mm dia uPVC (12 bar)	-	-	552.9	215.6	270.9	66.3	-	-	337.4	131.6	165.3	40.5	39%	49%	12%
160 mm dia uPVC (12 bar)	-	-	373.9	138.3	186.9	48.6	-	-	721.7	267.0	360.8	93.8	37%	50%	13%
110 mm dia uPVC (12 bar)	-	-	151.3	51.4	78.7	21.2	-	-	-	-	-	-	34%	52%	14%
90 mm dia uPVC (12 bar)	-	-	52.7	16.9	27.9	7.9	-	-	-	-	-	-	32%	53%	15%
	282.1	24.0	800.9	490.6	503.9	112.6	233.6	5.3	158.9	142.9	206.0	48.9	44%	46%	10%
	324.4	27.6	921.1	564.2	579.5	129.5	268.7	6.1	182.7	164.3	236.9	56.3	44%	46%	10%
Total for major components	2,487.3	211.9	7,061.4	4,325.6	4,442.5	992.5	2,059.8	46.5	1,400.6	1,259.7	1,815.9	431.3	44%	46%	10%
Total phased costs	Phase 1..................		9,760.6			9,760.6	Phase 2..	-	3,506.8						
Annual extensions to transmission system															
110 mm dia uPVC (12 bar)	-	-	48.9	16.6	25.4	6.8	-	-	48.9	16.6	25.4	6.8	34%	52%	14%
90 mm dia uPVC (12 bar)	-	-	31.2	10.0	16.5	4.7	-	-	31.2	10.0	16.5	4.7	32%	53%	15%
63 mm dia uPVC (12 bar)	-	-	36.3	10.9	19.6	5.8	-	-	24.2	7.3	13.1	3.9	30%	54%	16%

Note:

Foreign, local and tax components determined from an analysis of materials, labour and plant requirements for each element, as indicated on Table 5.1

Table 8.1-4 Financial Cash Flow of Meru Water Supply Scheme (Phase I)

(Unit: US$1,000)

Year	Investment Costs	O&M Costs	Total Costs	Water Revenue	Net Revenue
1998	0	0	0	0	0
1999	10,908	0	10,908	0	-10,908
2000	116	250	366	169	-197
2001	116	256	372	284	-88
2002	116	263	379	409	30
2003	475	280	755	546	-209
2004	0	292	292	695	403
2005		292	292	695	403
2006		292	292	695	403
2007		292	292	695	403
2008		292	292	695	403
2009		292	292	695	403
2010		292	292	695	403
2011		292	292	695	403
2012		292	292	695	403
2013		292	292	695	403
2014		292	292	695	403
2015		292	292	695	403
2016		292	292	695	403
2017		292	292	695	403
Total	**11,731**	**5,137**	**16,868**	**11,139**	**-5,729**

Average Unit Value (US$1/m3) :	**0.21**
Current Tariff Rate (Ksh/m3) =	**12**
Exchange Rate (Ksh/US$1) =	**56**

FIRR =	**n.a.**
NPV =	**-7,646**
RER =	**2.2**

Table 8.1-5 Estimated Water Revenue of Meru Water Supply Scheme (Phase I)

Year	Water Supplied	Incremental Water Supply		Water Supply Adjusted by UFW Reduction	Average Unit Value	Water Revenue
	(m3/d)	(m3/d)	(1,000m3/y)	(1,000m3/y)	(US$)	(1,000US$)
1997	3,194	0	0	0	0.00	0
1998	3,253	0	0	0	0.00	0
1999	3,654	0	0	0	0.00	0
2000	4,616	1,444	527	791	0.21	169
2001	5,589	2,417	882	1,323	0.21	284
2002	6,657	3,485	1,272	1,908	0.21	409
2003	7,824	4,652	1,698	2,547	0.21	546
2004	9,097	5,925	2,163	3,244	0.21	695
2005	10,482	5,925	2,163	3,244	0.21	695
2006	10,482	5,925	2,163	3,244	0.21	695
2007	10,482	5,925	2,163	3,244	0.21	695
2008	10,482	5,925	2,163	3,244	0.21	695
2009	10,482	5,925	2,163	3,244	0.21	695
2010	10,482	5,925	2,163	3,244	0.21	695
2011	10,482	5,925	2,163	3,244	0.21	695
2012	10,482	5,925	2,163	3,244	0.21	695
2013	10,482	5,925	2,163	3,244	0.21	695
2014	10,482	5,925	2,163	3,244	0.21	695
2015	10,482	5,925	2,163	3,244	0.21	695
2016	10,482	5,925	2,163	3,244	0.21	695
2017	10,482	5,925	2,163	3,244	0.21	695
Total	**180,150**	**94,948**	**34,656**	**51,984**	-	**11,139**

Average Unit Value (US$1/m3)	**0.21**
Current Tariff Rate (Ksh/m3)	**12**
Exchange Rate (Ksh/US$1)	**56**

Table 8.2-6 Estimated Benefit by Time Saved through Water Carrying

Year	Population Served	Population Coverage	Households Served	Incremental Households Served	Annual Cost Saved per Households (US$)	Estimated Benefit (US$1,000)
1998	42,494	33%	5,253	503	713	359
1999	46,190	36%	5,710	457	713	326
2000	64,234	50%	7,940	2,230	713	1,591
2001	75,822	59%	9,372	1,432	713	1,022
2002	88,083	68%	10,888	1,516	713	1,081
2003	101,047	78%	12,490	1,602	713	1,143
2004	114,740	89%	14,183	1,693	713	1,207
2005	129,191	100%	15,969	1,786	713	1,274
2006	129,191	100%	15,969	1,786	713	1,274
2007	129,191	100%	15,969	1,786	713	1,274
2008	129,191	100%	15,969	1,786	713	1,274
2009	129,191	100%	15,969	1,786	713	1,274
2010	129,191	100%	15,969	1,786	713	1,274
2011	129,191	100%	15,969	1,786	713	1,274
2012	129,191	100%	15,969	1,786	713	1,274
2013	129,191	100%	15,969	1,786	713	1,274
2014	129,191	100%	15,969	1,786	713	1,274
2015	129,191	100%	15,969	1,786	713	1,274
2016	129,191	100%	15,969	1,786	713	1,274
2017	129,191	100%	15,969	1,786	713	1,274
Total	-	-	-	-	-	23,294

US$1 =	56	(Ksh)

Family Size =	8.09	(Persons)

Table 8.2-7 Economic Cash Flow for Meru Water Supply Scheme (Phase I)

(Unit: US$1,000)

Year	Economic Investment Costs	O&M Costs	Total Costs	Economic Benefits	Net Revenue
1998	0	0	0	359	359
1999	10,363	0	10,363	326	-10,037
2000	110	250	360	1,591	1,231
2001	110	256	366	1,022	656
2002	110	263	373	1,081	708
2003	451	280	731	1,143	412
2004	0	292	292	1,207	915
2005		292	292	1,274	982
2006		292	292	1,274	982
2007		292	292	1,274	982
2008		292	292	1,274	982
2009		292	292	1,274	982
2010		292	292	1,274	982
2011		292	292	1,274	982
2012		292	292	1,274	982
2013		292	292	1,274	982
2014		292	292	1,274	982
2015		292	292	1,274	982
2016		292	292	1,274	982
2017		292	292	1,274	982
Total	**11,144**	**5,137**	**16,281**	**23,294**	**7,012**

Average Unit Value (US$1/m3) =	**0.21**
Current Tariff Rate (Ksh/m3) =	**12**
Exchange Rate (Ksh/US$1) =	**56**

EIRR =	**6.3%**
NPV =	**-1,874**
CBR =	**0.83**

Table 8.2-8 Economic Cash Flow for Meru Water Supply Scheme (Phase I)

(Case I: Increse in Investment Costs by 15%)

(Unit: US$1,000)

Year	Economic Investment Costs	O&M Costs	Total Costs	Economic Benefits	Net Revenue
1998	0	0	0	359	359
1999	11,917	0	11,917	326	-11,591
2000	127	250	377	1,591	1,214
2001	127	256	383	1,022	639
2002	127	263	390	1,081	691
2003	519	280	799	1,143	344
2004	0	292	292	1,207	915
2005		292	292	1,274	982
2006		292	292	1,274	982
2007		292	292	1,274	982
2008		292	292	1,274	982
2009		292	292	1,274	982
2010		292	292	1,274	982
2011		292	292	1,274	982
2012		292	292	1,274	982
2013		292	292	1,274	982
2014		292	292	1,274	982
2015		292	292	1,274	982
2016		292	292	1,274	982
2017		292	292	1,274	982
Total	**12,816**	**5,137**	**17,953**	**23,294**	**5,341**

Average Unit Value (US$1/m3) =	**0.21**
Current Tariff Rate (Ksh/m3) =	**12**
Exchange Rate (Ksh/US$1) =	**56**

EIRR =	**4.3%**
NPV =	**-3,231**
CBR =	**0.74**

Table 8.2-9 Economic Cash Flow for Meru Water Supply Scheme (Phase I)

(Case II: Increase in O&M Costs by 15%)

(Unit: US$1,000)

Year	Economic Investment Costs	O&M Costs	Total Costs	Economic Benefits	Net Revenue
1998	0	0	0	359	359
1999	10,363	0	10,363	326	-10,037
2000	110	288	398	1,591	1,193
2001	110	294	405	1,022	617
2002	110	302	413	1,081	669
2003	451	322	773	1,143	370
2004	0	336	336	1,207	872
2005		336	336	1,274	938
2006		336	336	1,274	938
2007		336	336	1,274	938
2008		336	336	1,274	938
2009		336	336	1,274	938
2010		336	336	1,274	938
2011		336	336	1,274	938
2012		336	336	1,274	938
2013		336	336	1,274	938
2014		336	336	1,274	938
2015		336	336	1,274	938
2016		336	336	1,274	938
2017		336	336	1,274	938
Total	**11,144**	**5,908**	**17,052**	**23,294**	**6,242**

Average Unit Value (US$1/m3) =	**0.21**
Current Tariff Rate (Ksh/m3) =	**12**
Exchange Rate (Ksh/US$1) =	**56**

EIRR =	**5.6%**
NPV =	**-2,159**
CBR =	**0.81**

Table 8.2-10 Economic Cash Flow for Meru Water Supply Scheme (Phase I)

(Case III: Increase in both Investment and O&M Costs by 15%)

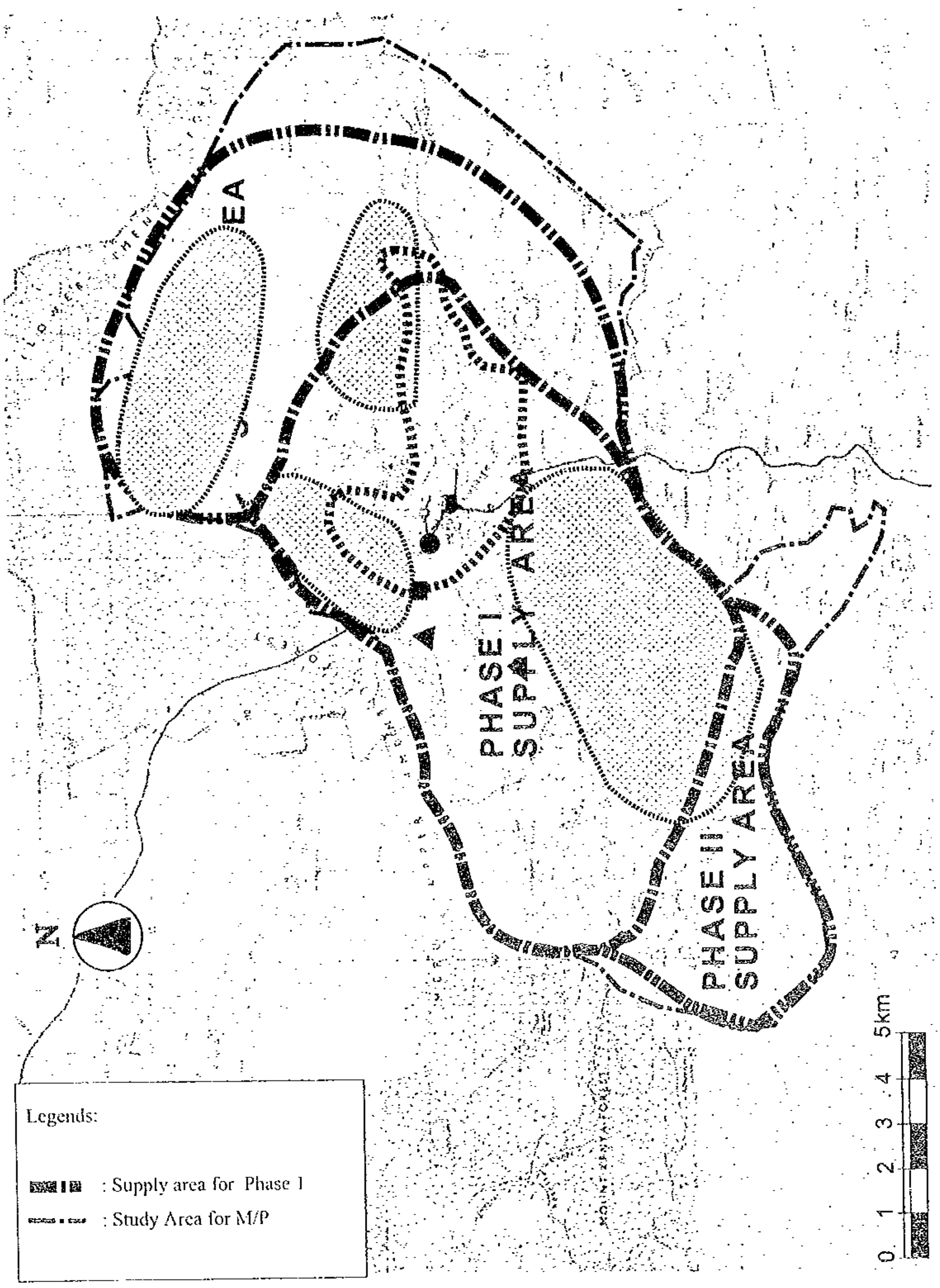
(Unit: US$1,000)

Year	Economic Investment Costs	O&M Costs	Total Costs	Economic Benefits	Net Revenue
1998	0	0	0	359	359
1999	11,917	0	11,917	326	-11,591
2000	127	288	414	1,591	1,177
2001	127	294	421	1,022	601
2002	127	302	429	1,081	652
2003	519	322	841	1,143	302
2004	0	336	336	1,207	872
2005		336	336	1,274	938
2006		336	336	1,274	938
2007		336	336	1,274	938
2008		336	336	1,274	938
2009		336	336	1,274	938
2010		336	336	1,274	938
2011		336	336	1,274	938
2012		336	336	1,274	938
2013		336	336	1,274	938
2014		336	336	1,274	938
2015		336	336	1,274	938
2016		336	336	1,274	938
2017		336	336	1,274	938
Total	**12,816**	**5,908**	**18,724**	**23,294**	**4,570**

Average Unit Value (US$1/m3) =	**0.21**
Current Tariff Rate (Ksh/m3) =	**12**
Exchange Rate (Ksh/US$1) =	**56**

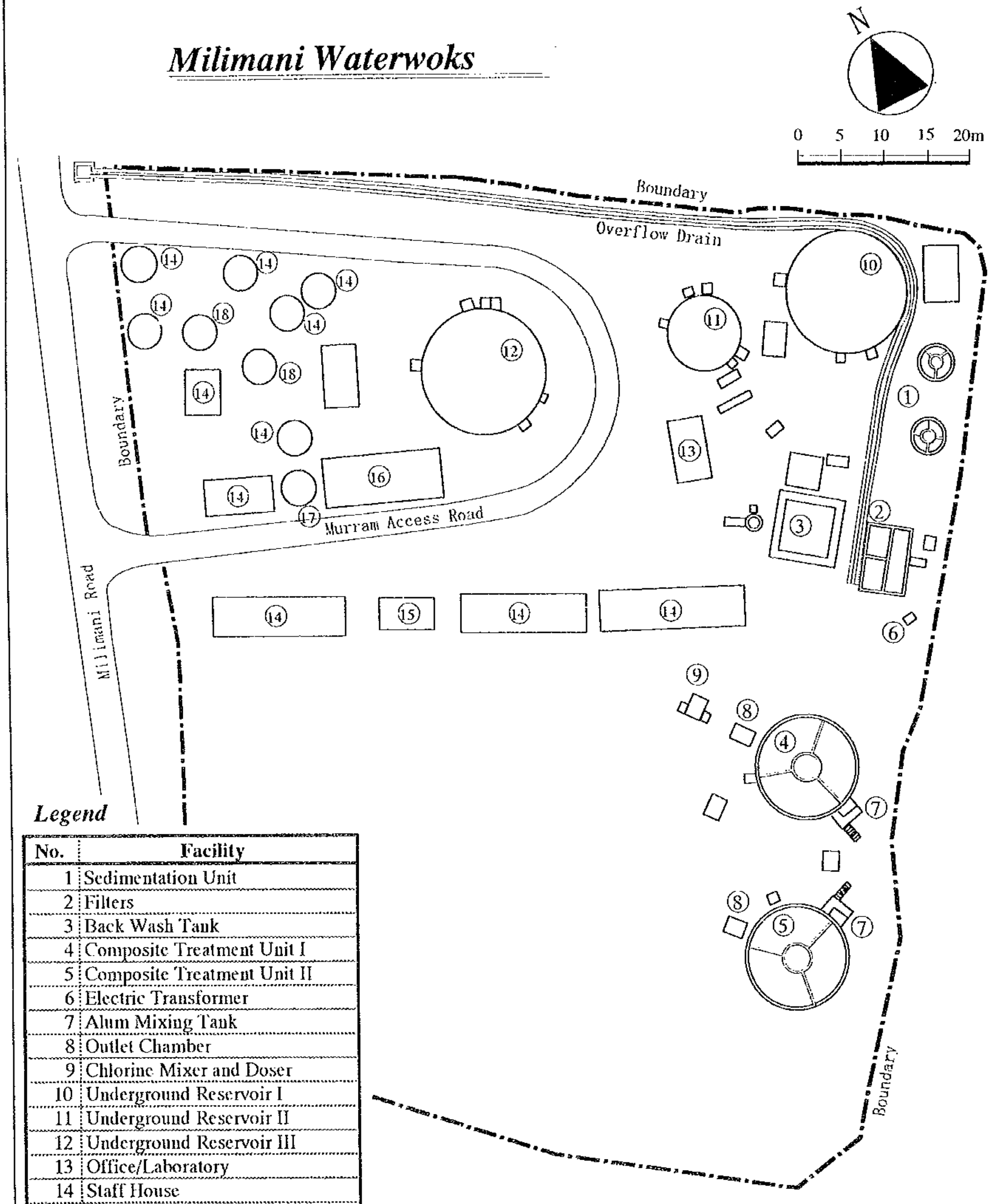
EIRR =	**3.7%**
NPV =	**-3,516**
CBR =	**0.72**

FIGURES



THE STUDY ON THE WATER SUPPLY FOR SEVEN TOWNS IN EASTERN PROVINCE IN THE REPUBLIC OF	Figure 1.3-1
JAPAN INTERNATIONAL COORERATION	Study Area

Milimani Waterwoks

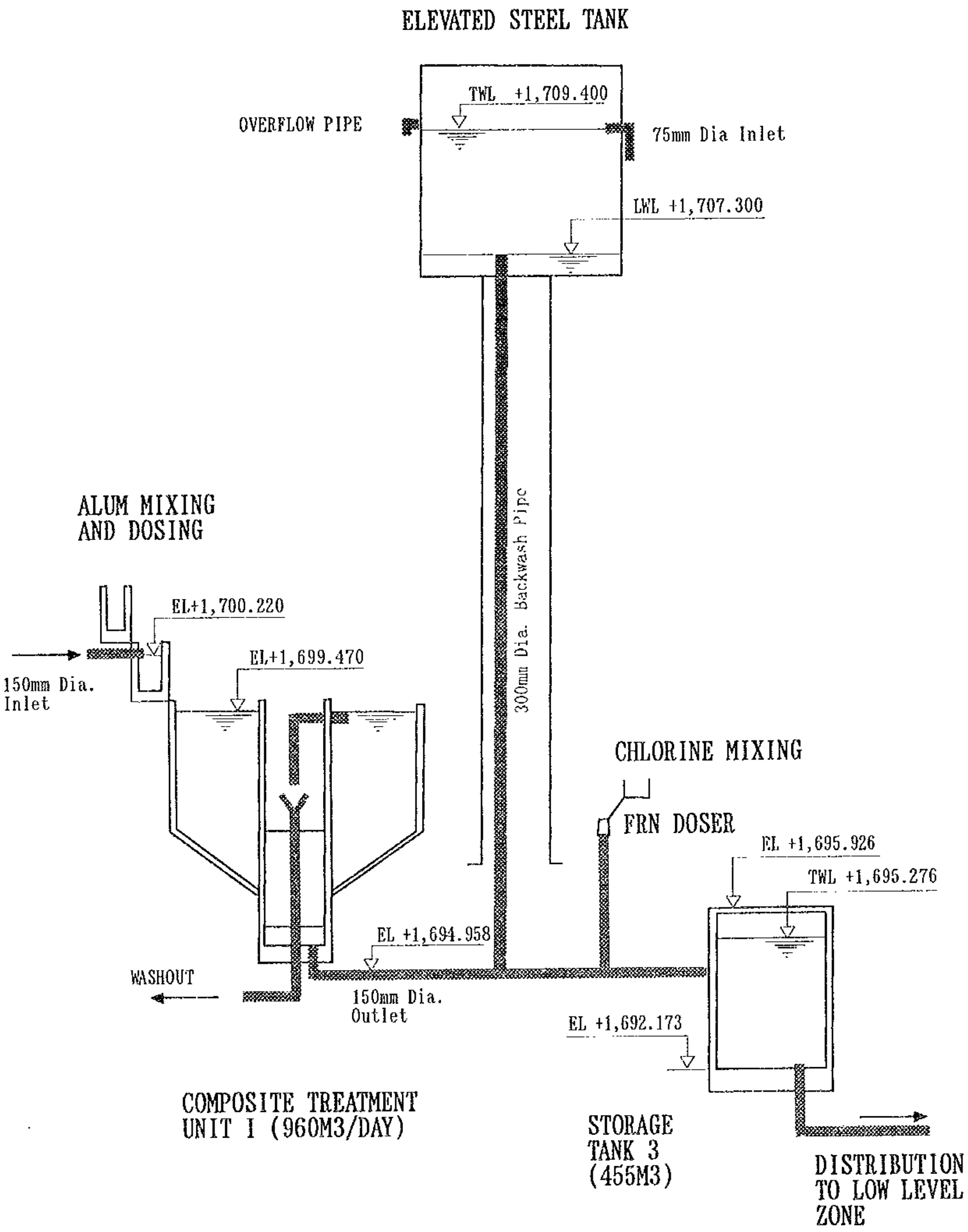


Legend

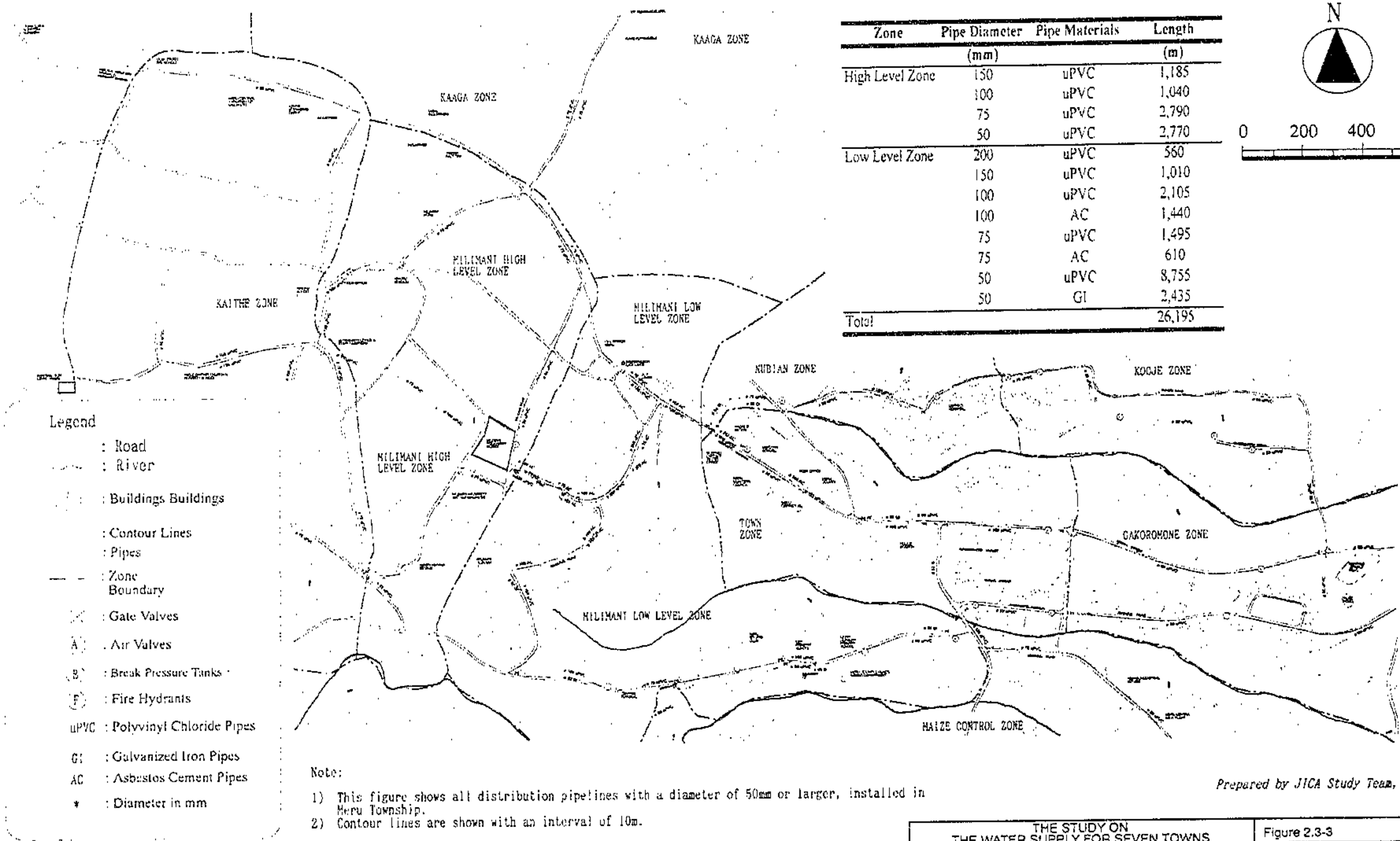
No.	Facility
1	Sedimentation Unit
2	Filters
3	Back Wash Tank
4	Composite Treatment Unit I
5	Composite Treatment Unit II
6	Electric Transformer
7	Alum Mixing Tank
8	Outlet Chamber
9	Chlorine Mixer and Doser
10	Underground Reservoir I
11	Underground Reservoir II
12	Underground Reservoir III
13	Office/Laboratory
14	Staff House
15	Mechanical Store
16	Store for pipes and fittings
17	Chemical Store
18	Hydrological Store

Source: JICA Study Team

THE STUDY ON THE WATER SUPPLY FOR SEVEN TOWNS IN EASTERN PROVINCE IN THE REPUBLIC OF KENYA	Figure 2.3-1
JAPAN INTERNATIONAL COOPERATION AGENCY	General Plan of Milimani Waterworks



THE STUDY ON THE WATER SUPPLY FOR SEVEN TOWNS IN EASTERN PROVINCE IN THE REPUBLIC OF KENYA	Figure 2.3-2
JAPAN INTERNATIONAL COOPERATION AGENCY	Hydraulic Profile of Composite Unit 1



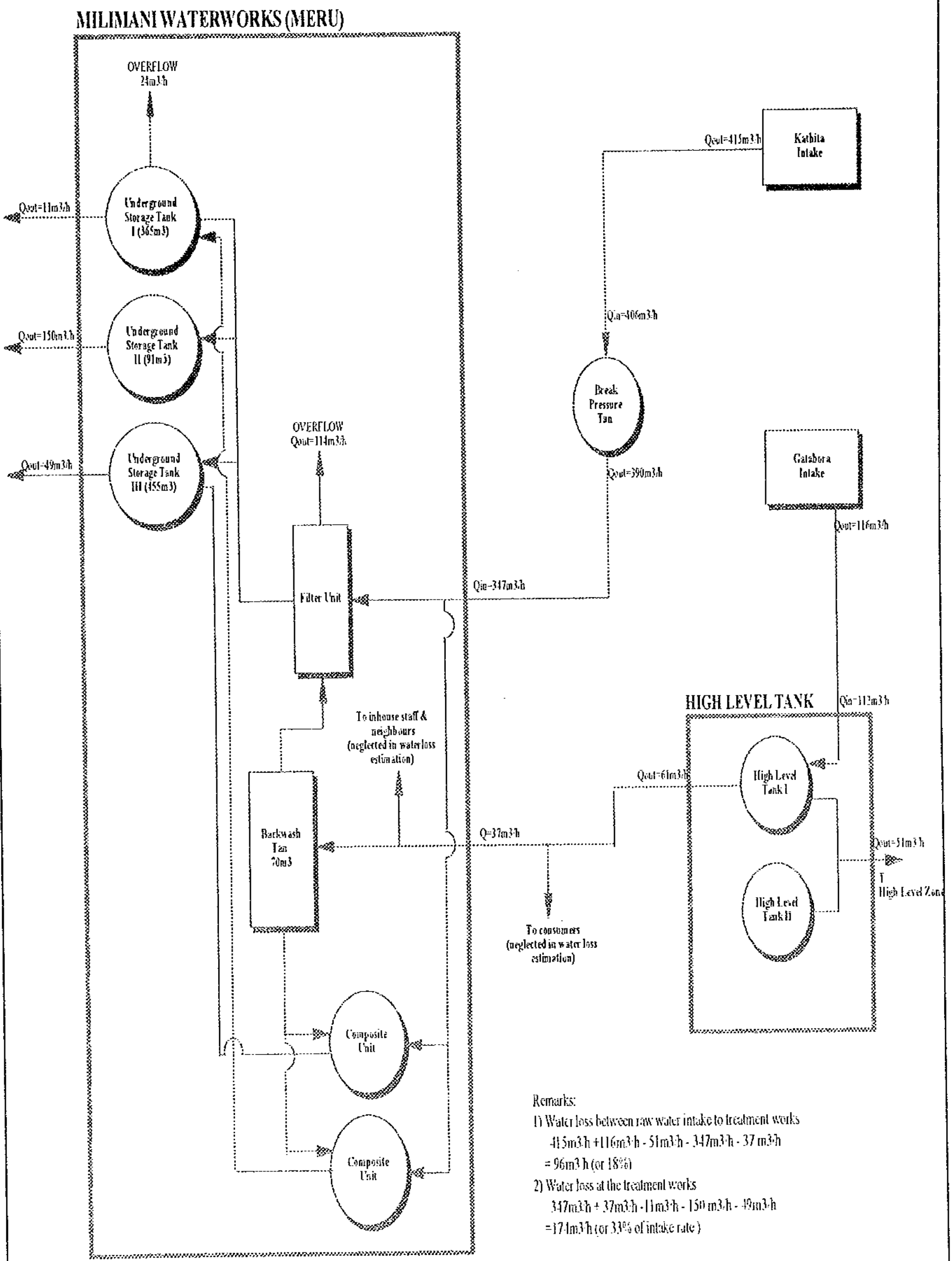
Zone	Pipe Diameter (mm)	Pipe Materials	Length (m)
High Level Zone	150	uPVC	1,185
	100	uPVC	1,040
	75	uPVC	2,790
	50	uPVC	2,770
Low Level Zone	200	uPVC	560
	150	uPVC	1,010
	100	uPVC	2,105
	100	AC	1,440
	75	uPVC	1,495
	75	AC	610
	50	uPVC	8,755
	50	GI	2,435
Total			26,195

Note:

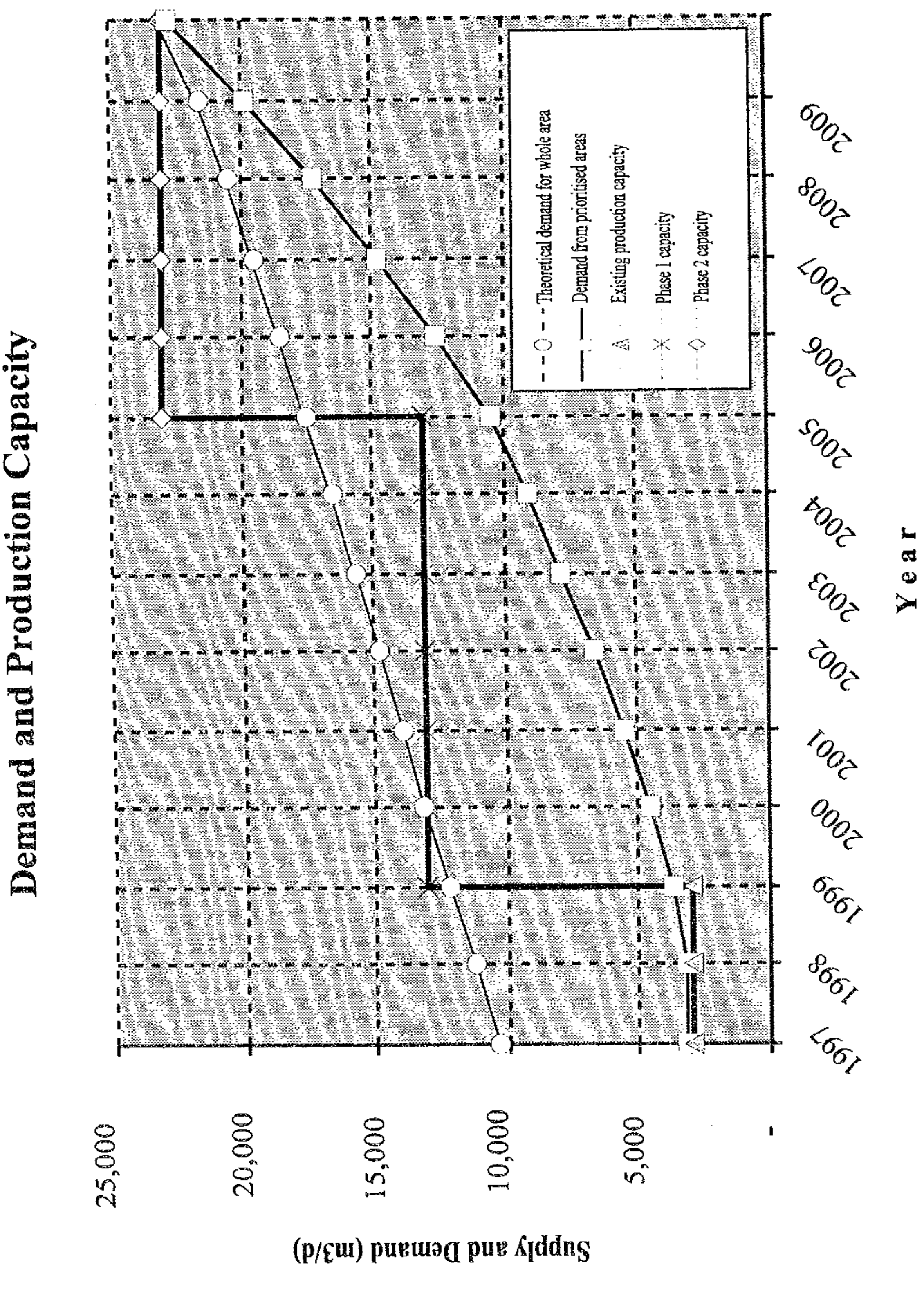
1) This figure shows all distribution pipelines with a diameter of 50mm or larger, installed in Meru Township.
2) Contour lines are shown with an interval of 10m.

Prepared by JICA Study Team,

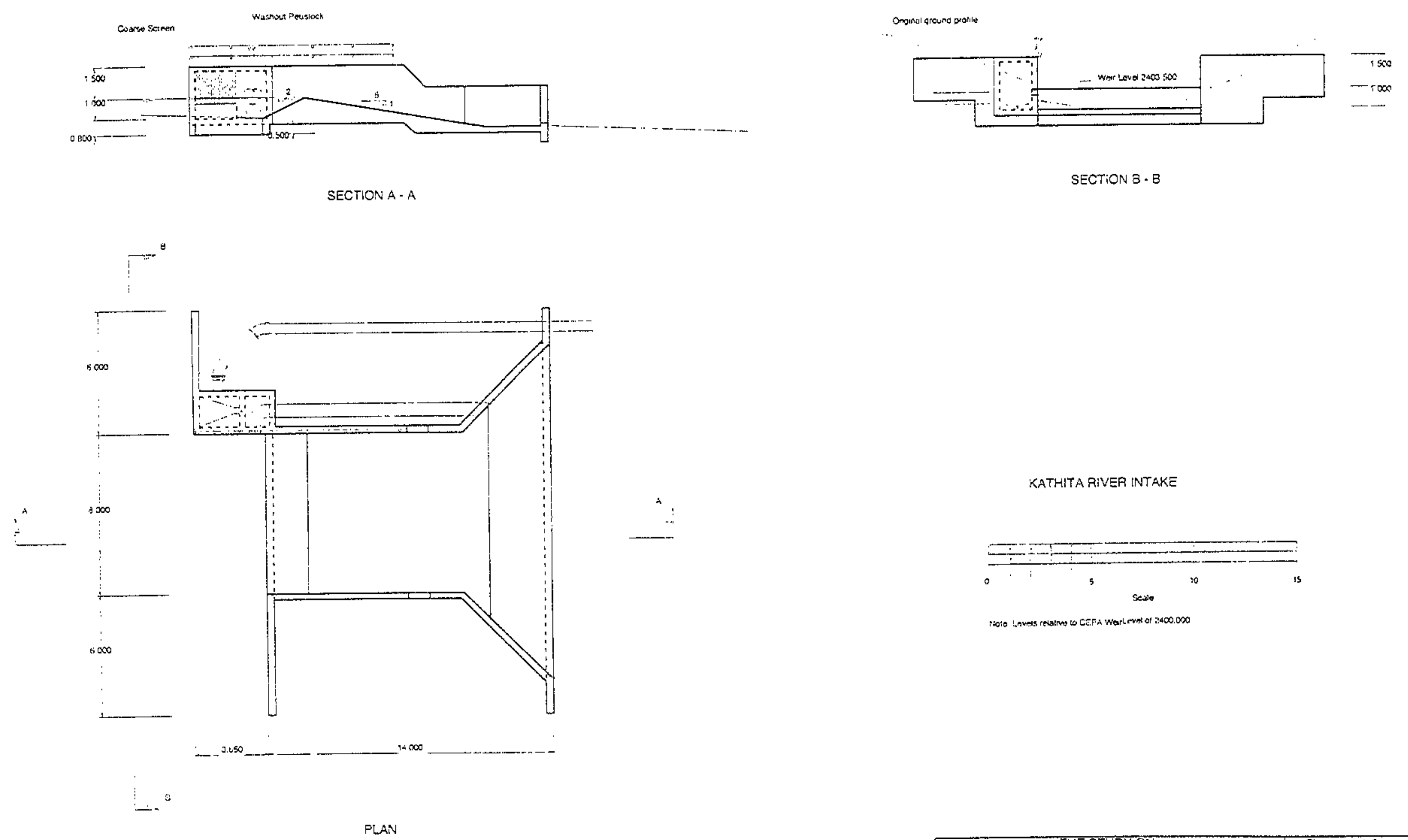
THE STUDY ON THE WATER SUPPLY FOR SEVEN TOWNS IN EASTERN PROVINCE IN THE REPUBLIC OF KENYA	Figure 2.3-3
JAPAN INTERNATIONAL COOPERATION AGENCY	Existing Distribution Pipe Network



THE STUDY ON THE WATER SUPPLY FOR SEVEN TOWNS IN EASTERN PROVINCE, THE REPUBLIC OF KENYA	**Figure 2.3-5** **Intake Rate and Production**
JAPAN INTERNATIONAL COOPERATION AGENCY	



THE STUDY ON THE WATER SUPPLY FOR SEVEN TOWNS IN EASTERN PROVINCE IN THE REPUBLIC OF KENYA	Figure 4.1-1
JAPAN INTERNATIONAL COOPERATION AGENCY	Demand and Production Capacity

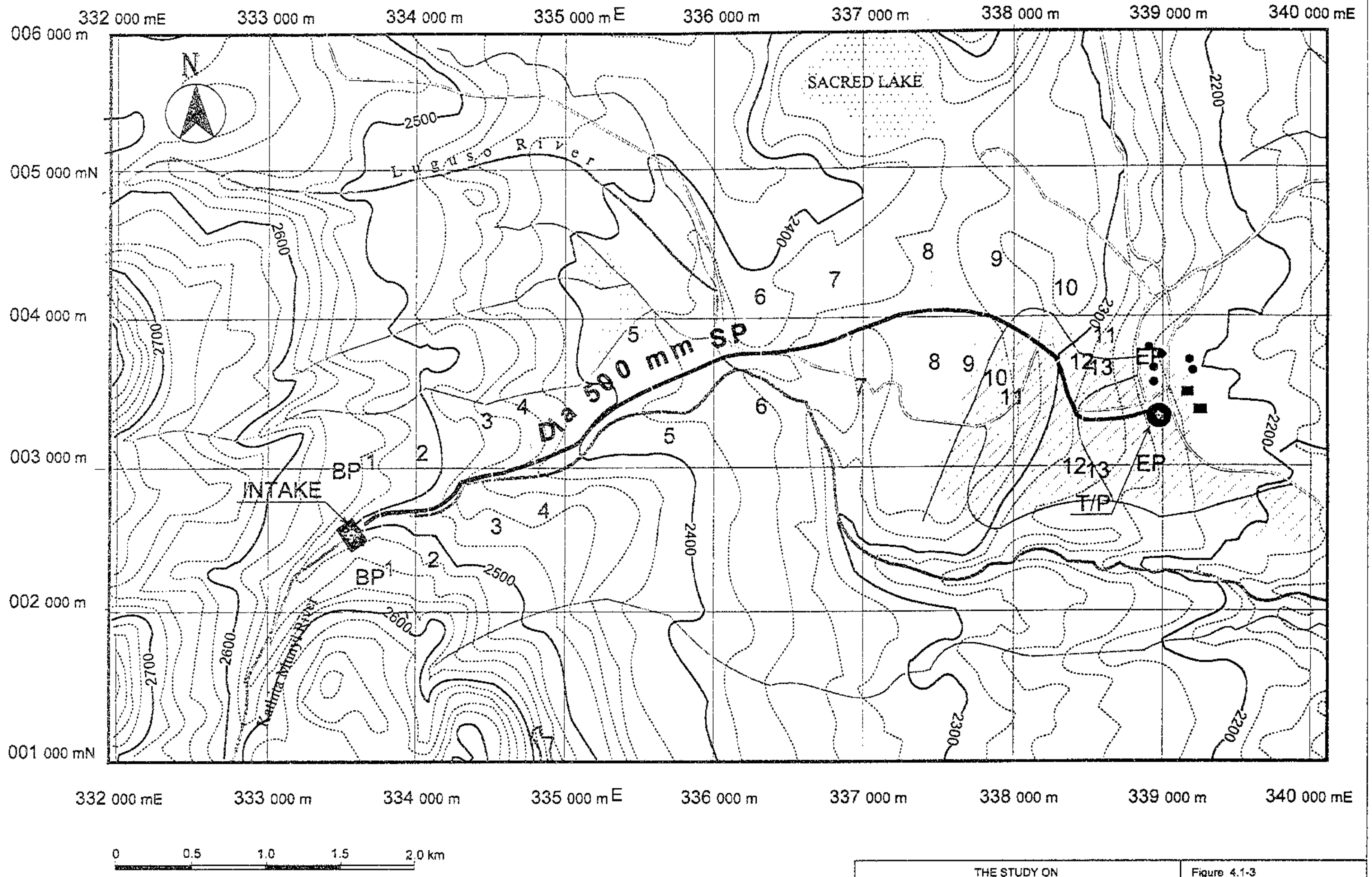


THE STUDY ON
THE WATER SUPPLY FOR SEVEN TOWNS
IN EASTERN PROVINCE IN THE REPUBLIC OF KENYA

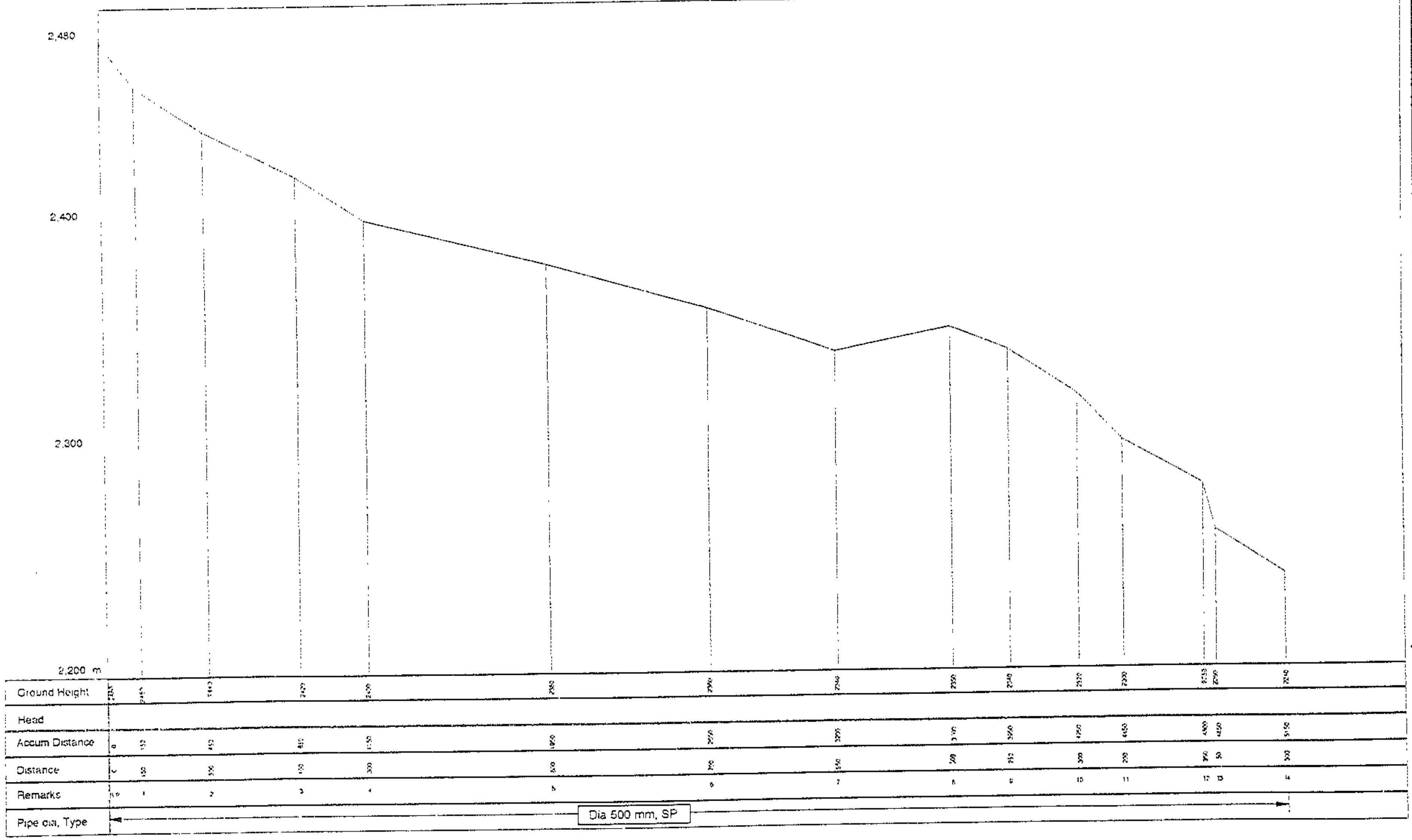
JAPAN INTERNATIONAL COOPERATION AGENCY

Figure 4.1-2

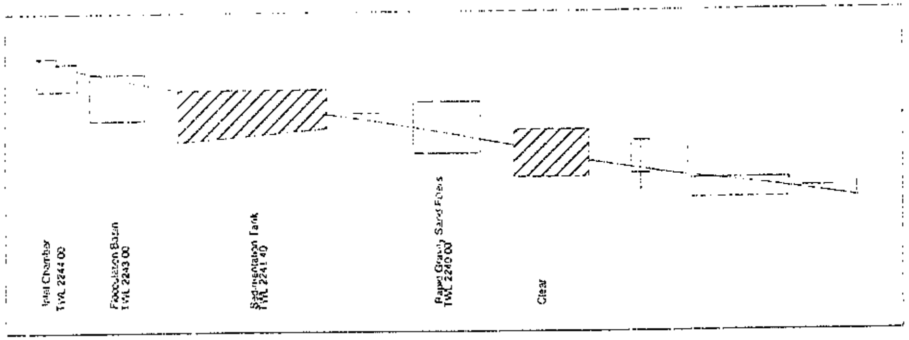
Kathita River Intake



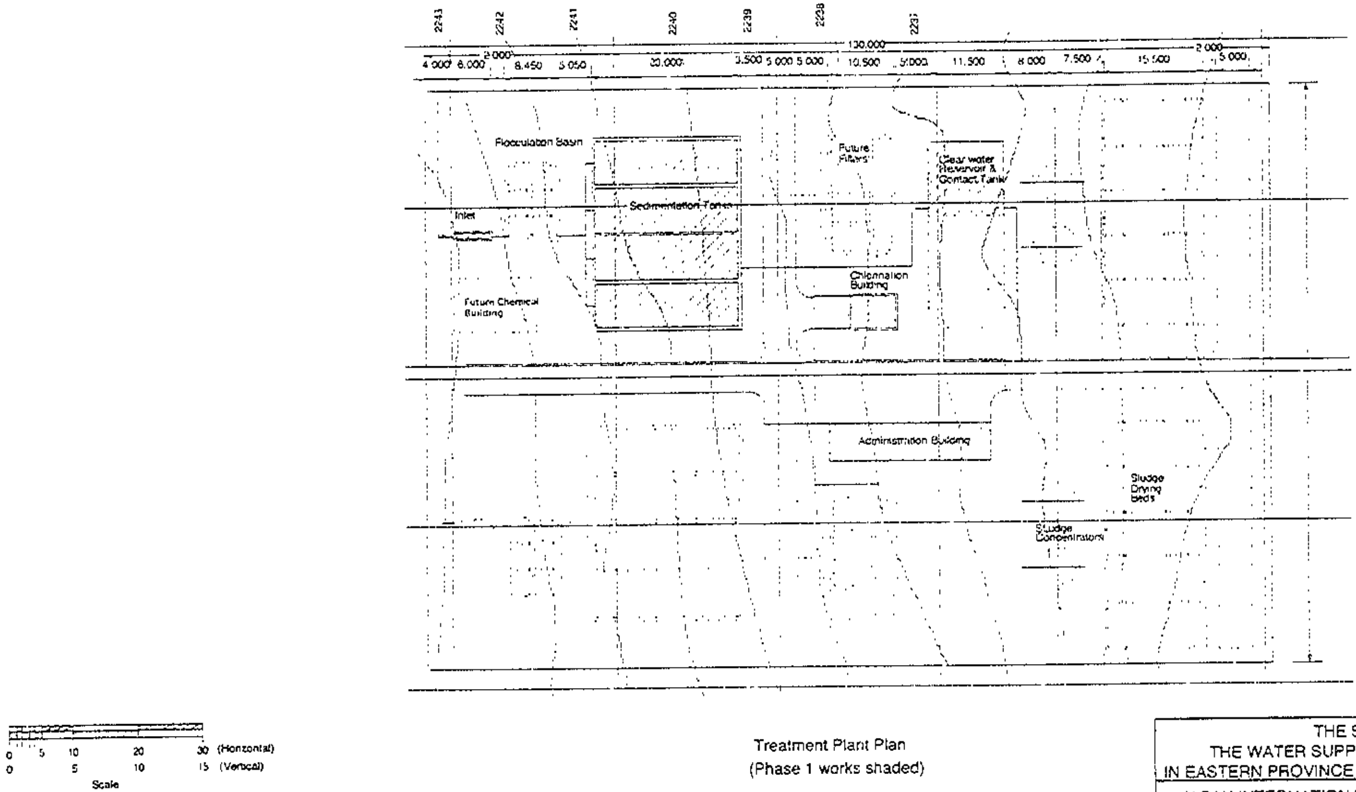
THE STUDY ON THE WATER SUPPLY FOR SEVEN TOWNS IN EASTERN PROVINCE IN THE REPUBLIC OF KENYA	Figure 4.1-3
JAPAN INTERNATIONAL COOPERATION AGENCY	Raw Water Pipeline Route



THE STUDY ON THE WATER SUPPLY FOR SEVEN TOWNS IN EASTERN PROVINCE IN THE REPUBLIC OF KENYA	Figure 4.1-4
JAPAN INTERNATIONAL COOPERATION AGENCY	Raw Water Pipeline Profile

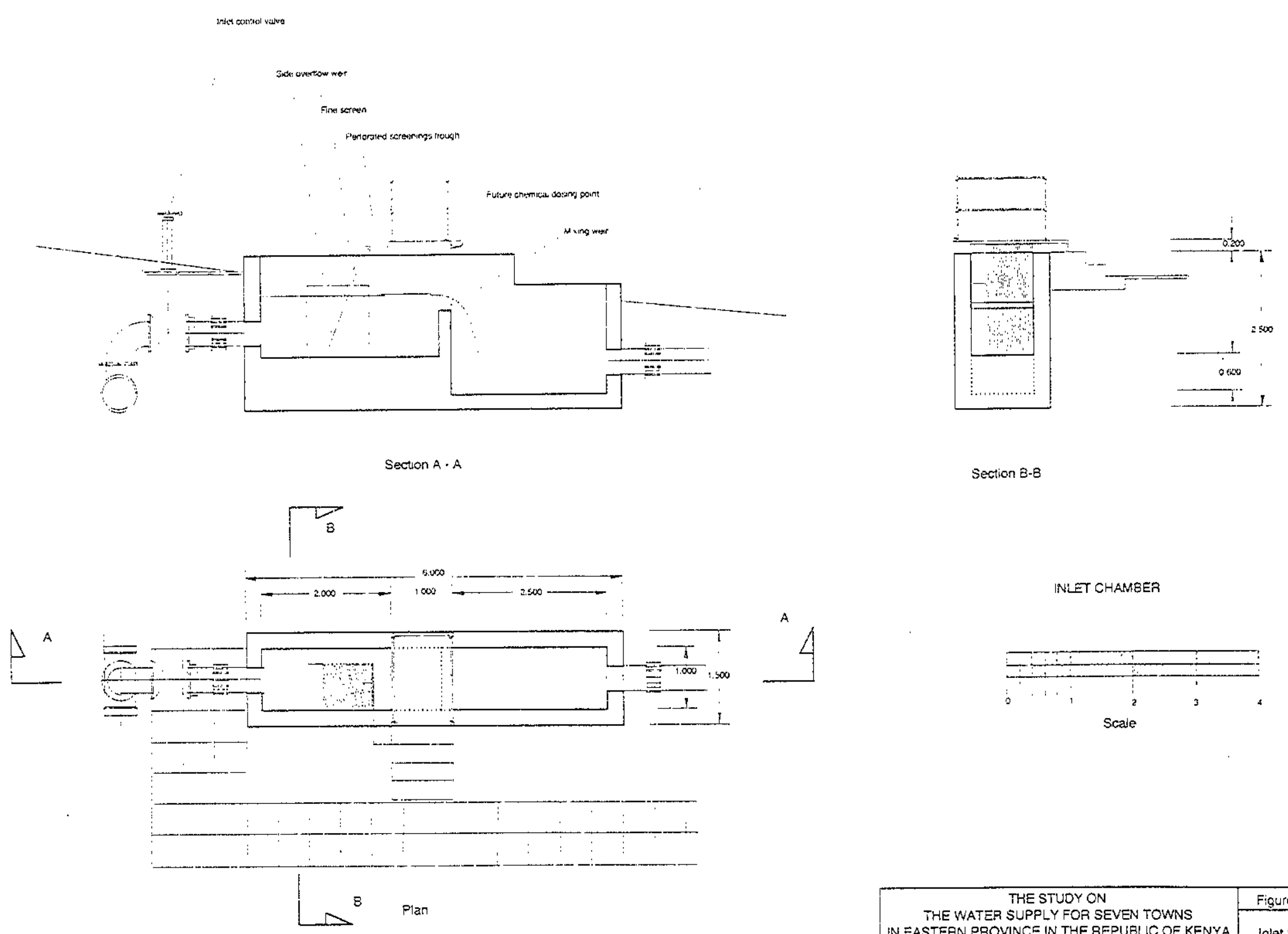


Section Through Treatment Plant
(Vertical Scale Exagarated)



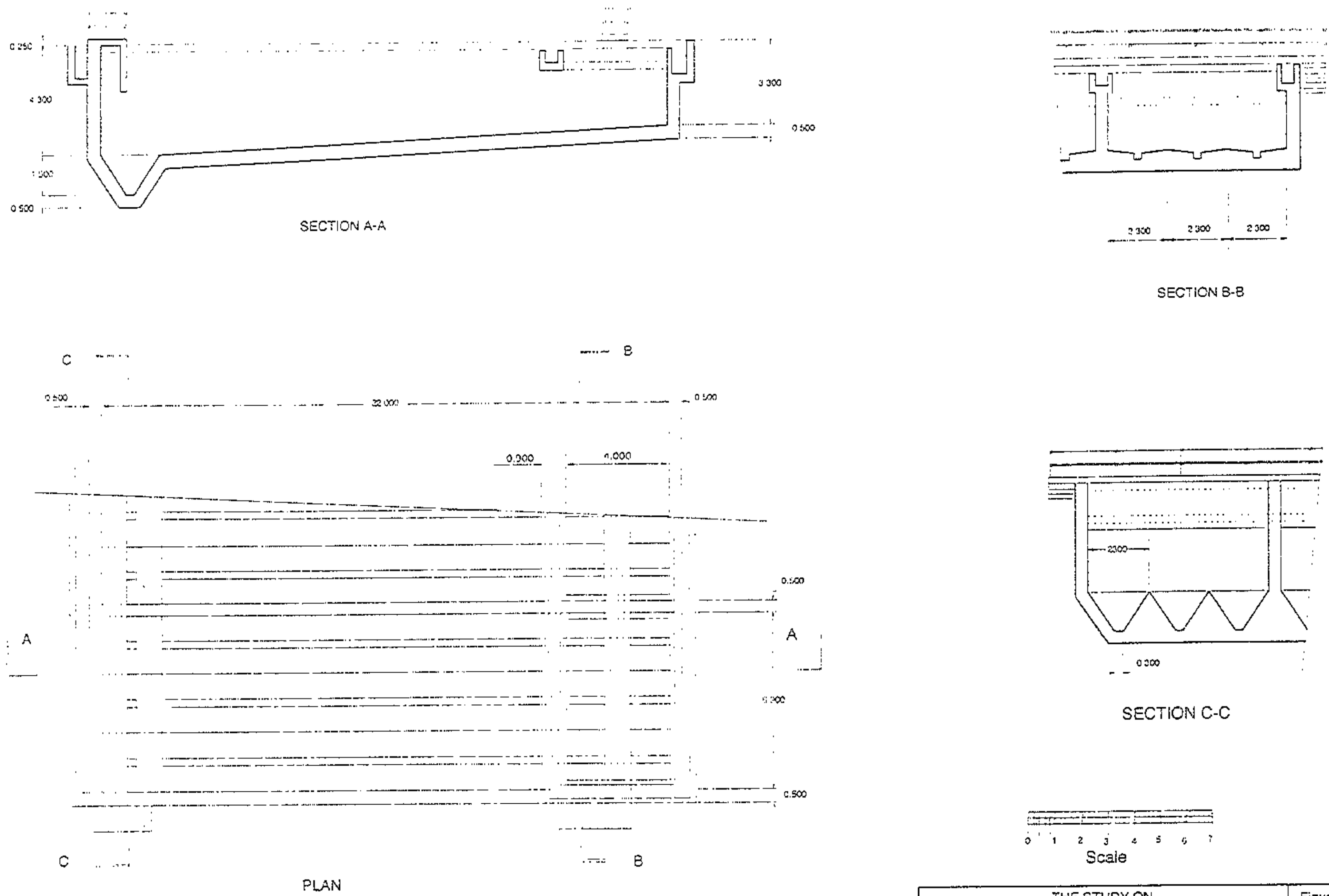
Treatment Plant Plan
(Phase 1 works shaded)

THE STUDY ON THE WATER SUPPLY FOR SEVEN TOWNS IN EASTERN PROVINCE IN THE REPUBLIC OF KENYA	Figure 4.1-5
JAPAN INTERNATIONAL COOPERATION AGENCY	Treatment Plant Layout Plan



THE STUDY ON
THE WATER SUPPLY FOR SEVEN TOWNS
IN EASTERN PROVINCE IN THE REPUBLIC OF KENYA
JAPAN INTERNATIONAL COOPERATION AGENCY

Figure 4.1-6
Inlet Structure

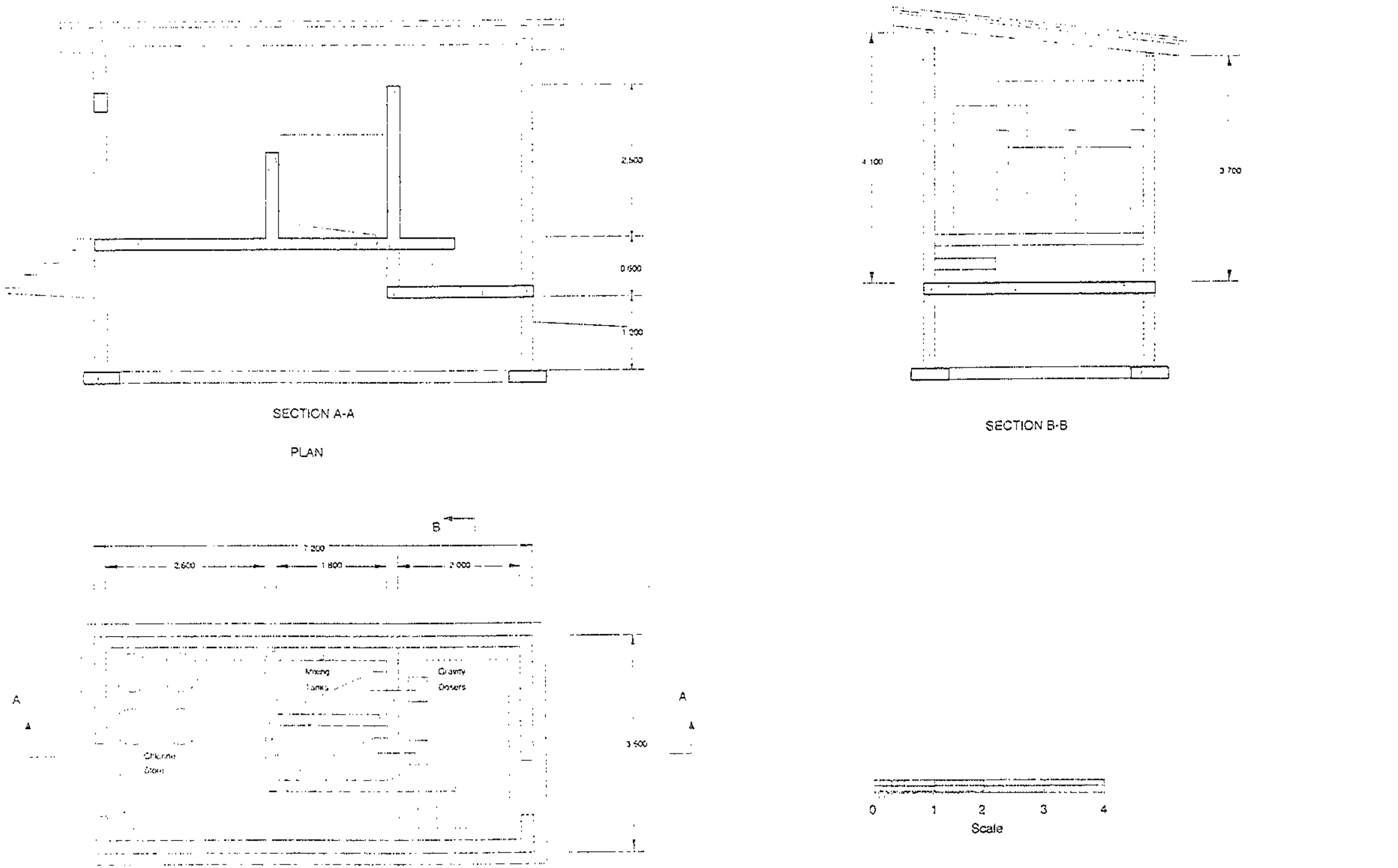


THE STUDY ON
THE WATER SUPPLY FOR SEVEN TOWNS
IN EASTERN PROVINCE IN THE REPUBLIC OF KENYA

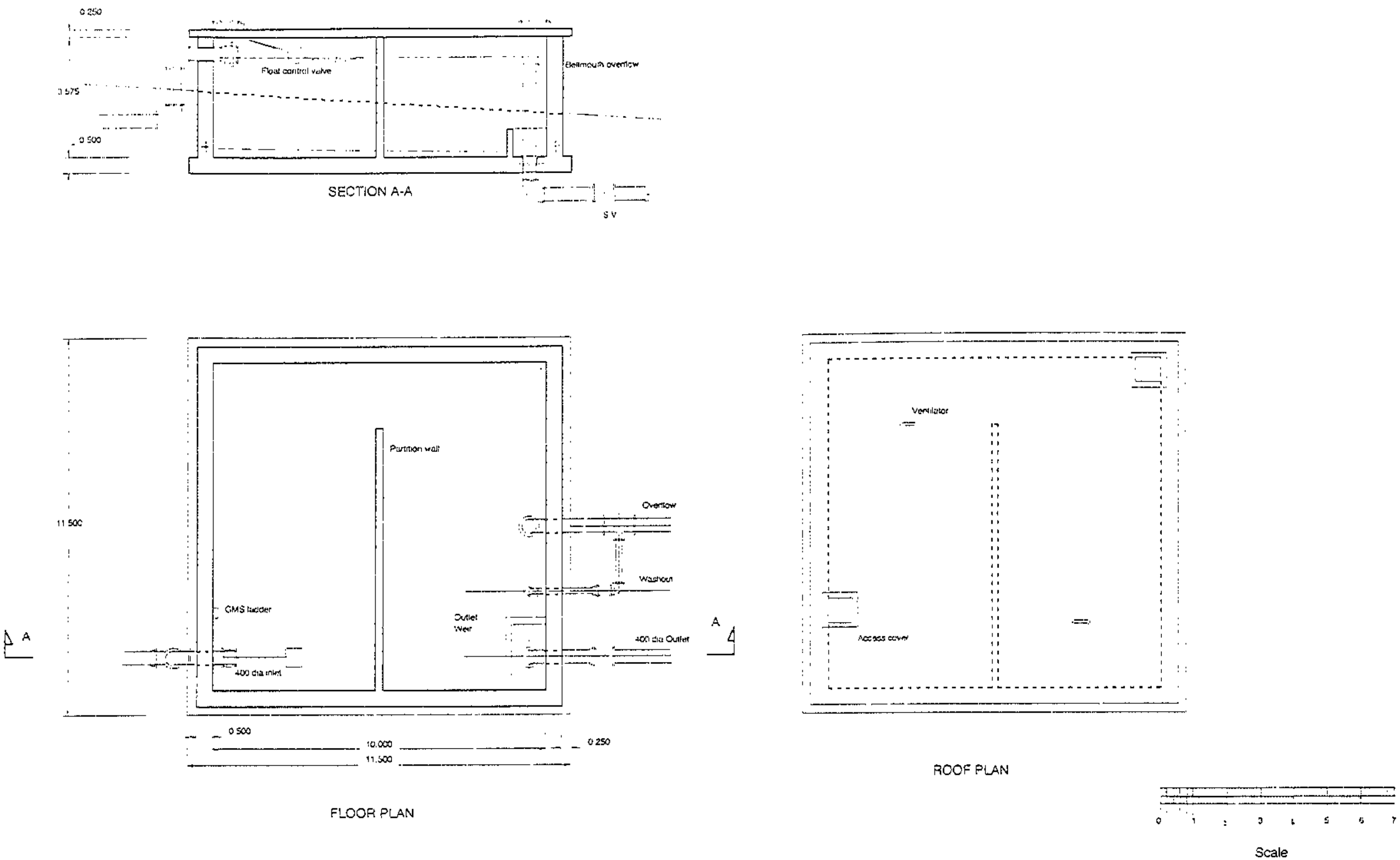
JAPAN INTERNATIONAL COOPERATION AGENCY

Figure 4.1-7

Horizontal Sedimentation Tanks

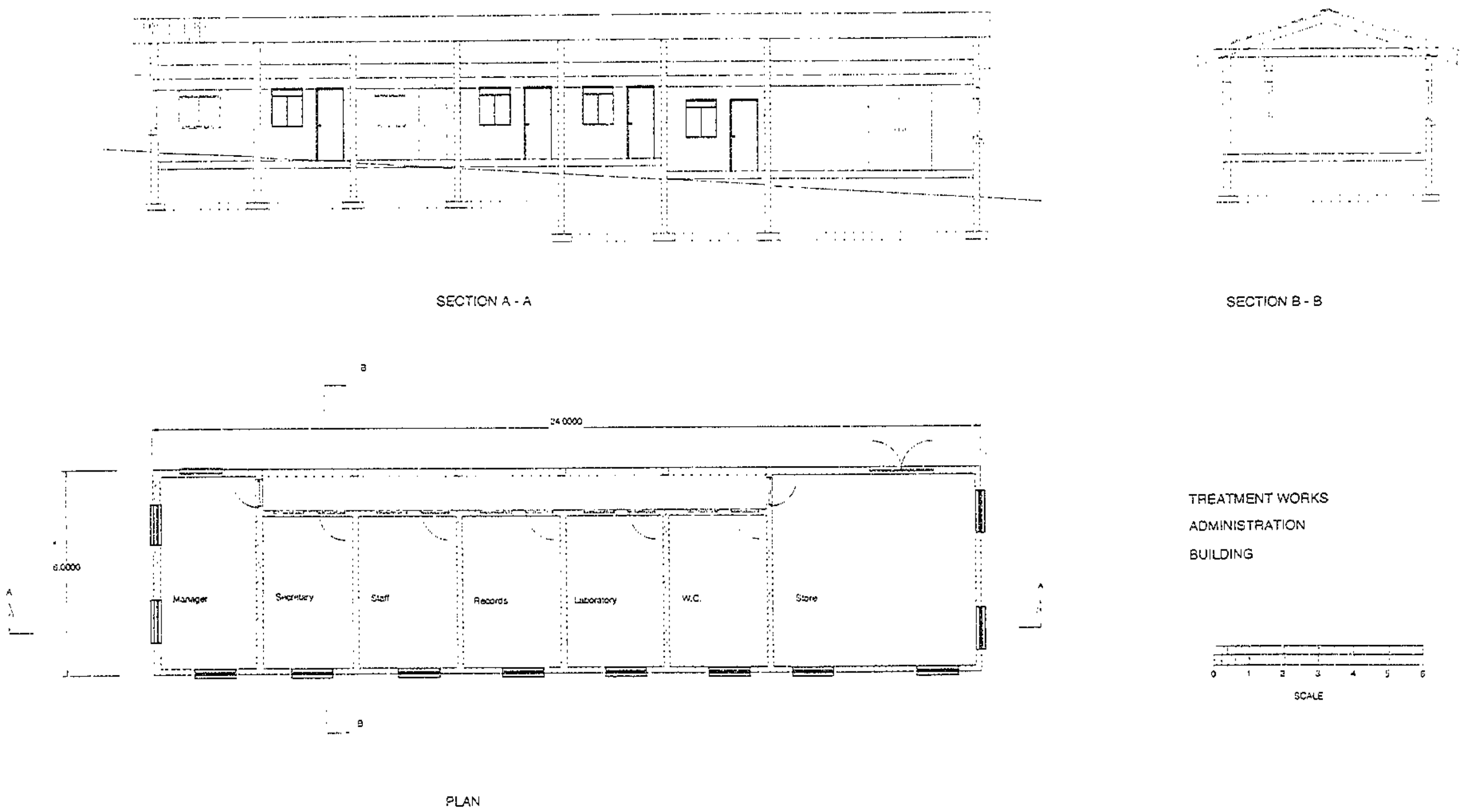


THE STUDY ON THE WATER SUPPLY FOR SEVEN TOWNS IN EASTERN PROVINCE IN THE REPUBLIC OF KENYA	Figure 4.1-8
JAPAN INTERNATIONAL COOPERATION AGENCY	Chlorination Building

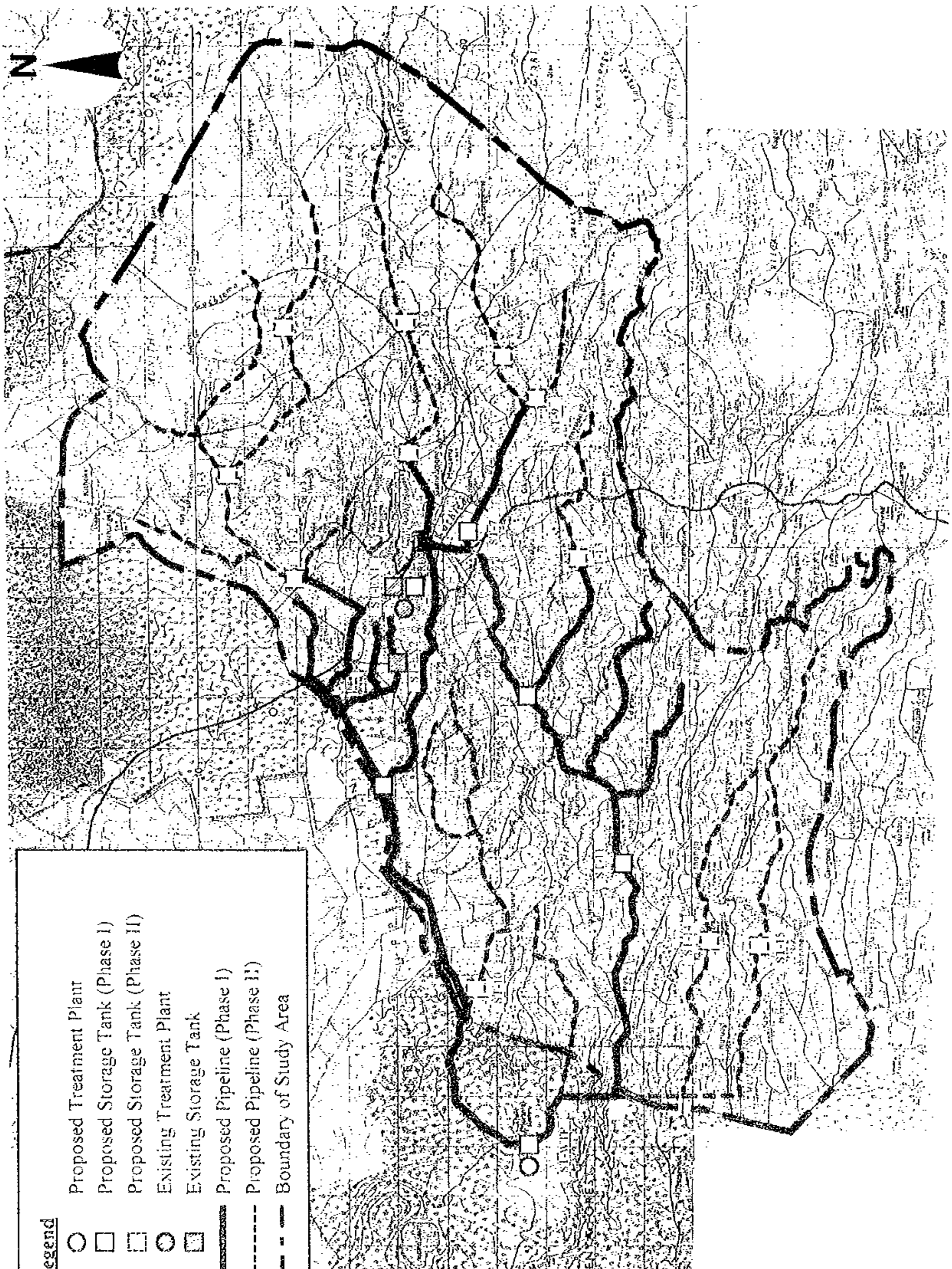


TREATMENT WORKS RESERVOIR
AND CONTACT TANK

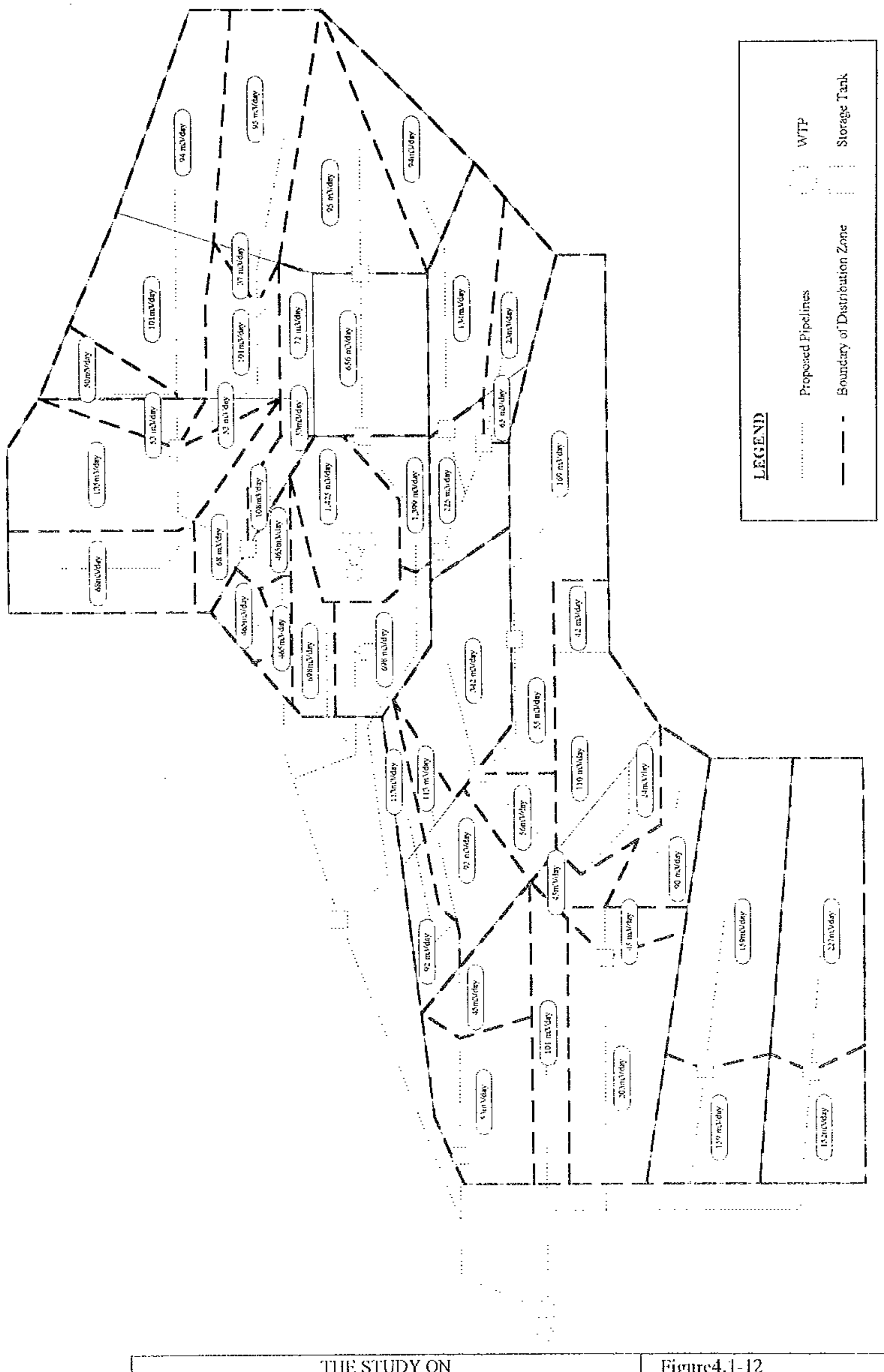
THE STUDY ON THE WATER SUPPLY FOR SEVEN TOWNS IN EASTERN PROVINCE IN THE REPOBLIC OF KENYA	Figure 4.1-9
JAPAN INTERNATIONAL COOPERATON AGENCY	Cearn Water Reservoir



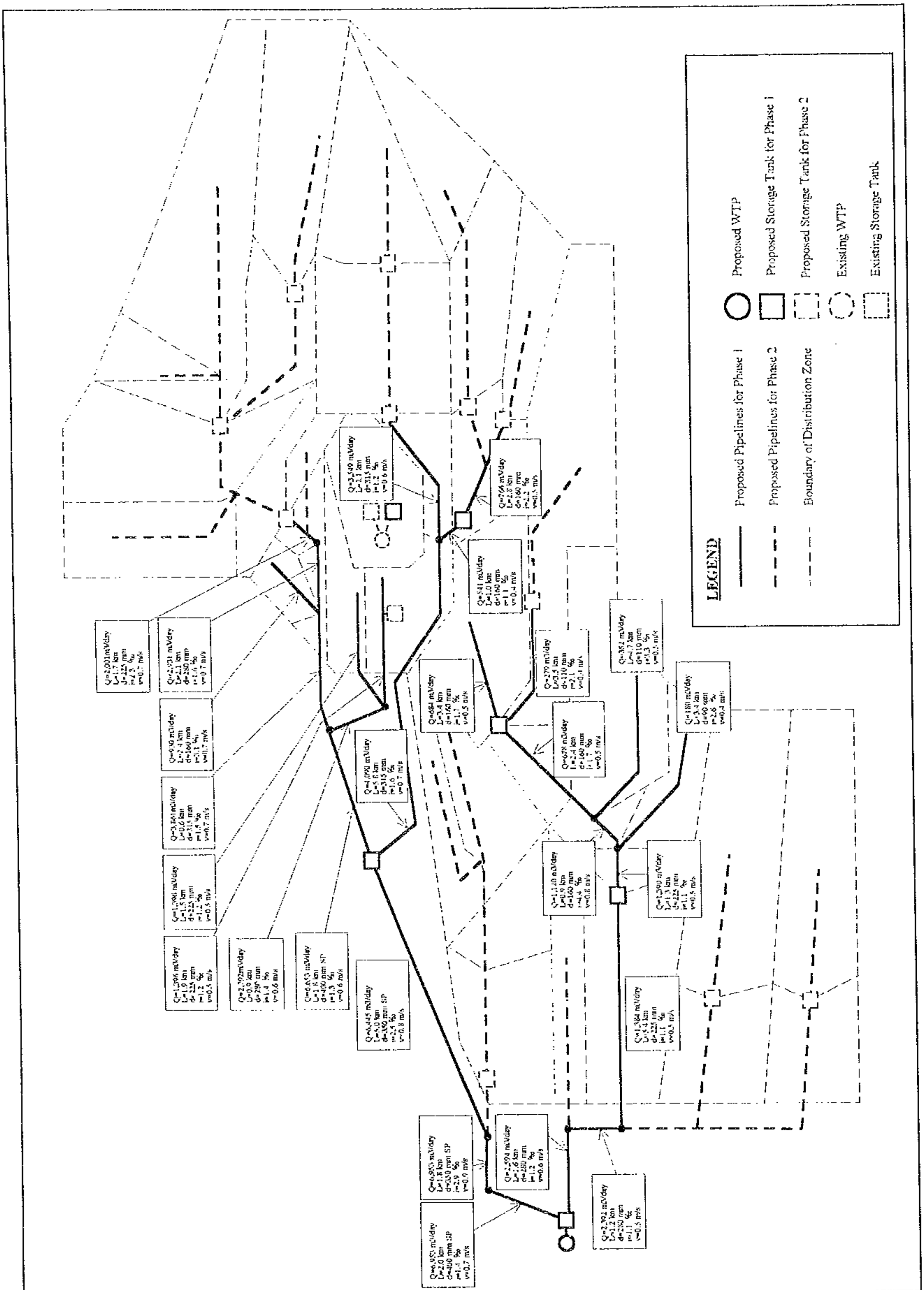
THE STUDY ON THE WATER SUPPLY FOR SEVEN TOWNS IN EASTERN PROVINCE IN THE REPUBLIC OF KENYA	Figure 4.1-10 Administration Building
JAPAN INTERNATIONAL COOPERATION AGENCY	



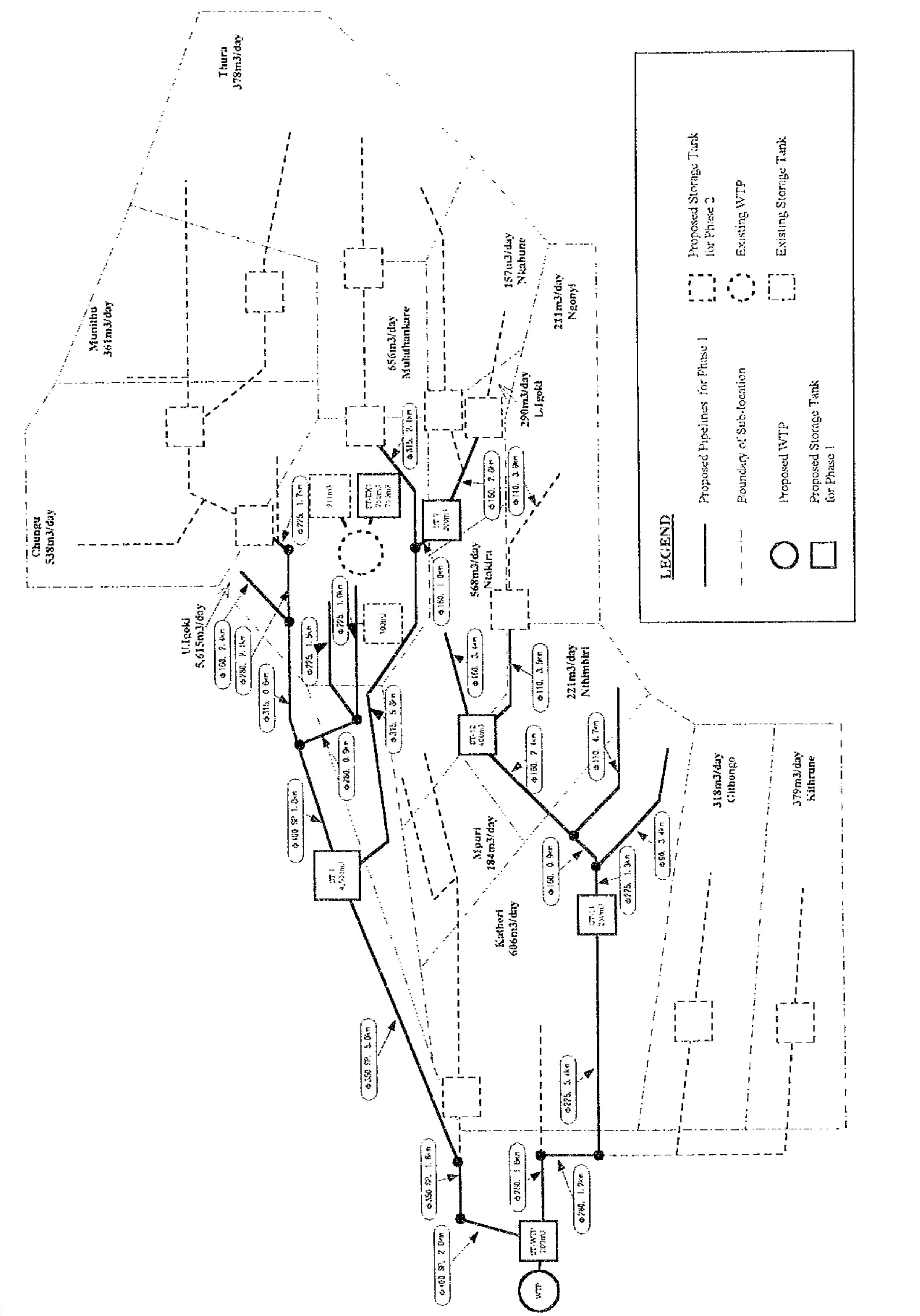
THE STUDY ON THE WATER SUPPLY FOR SEVEN TOWNS IN EASTERN PROVINCE IN THE REPUBLIC OF KENYA	Figure4.1-11
JAPAN INTERNATIONAL COOPERATION AGENCY	General Layout for Phase I in Meru



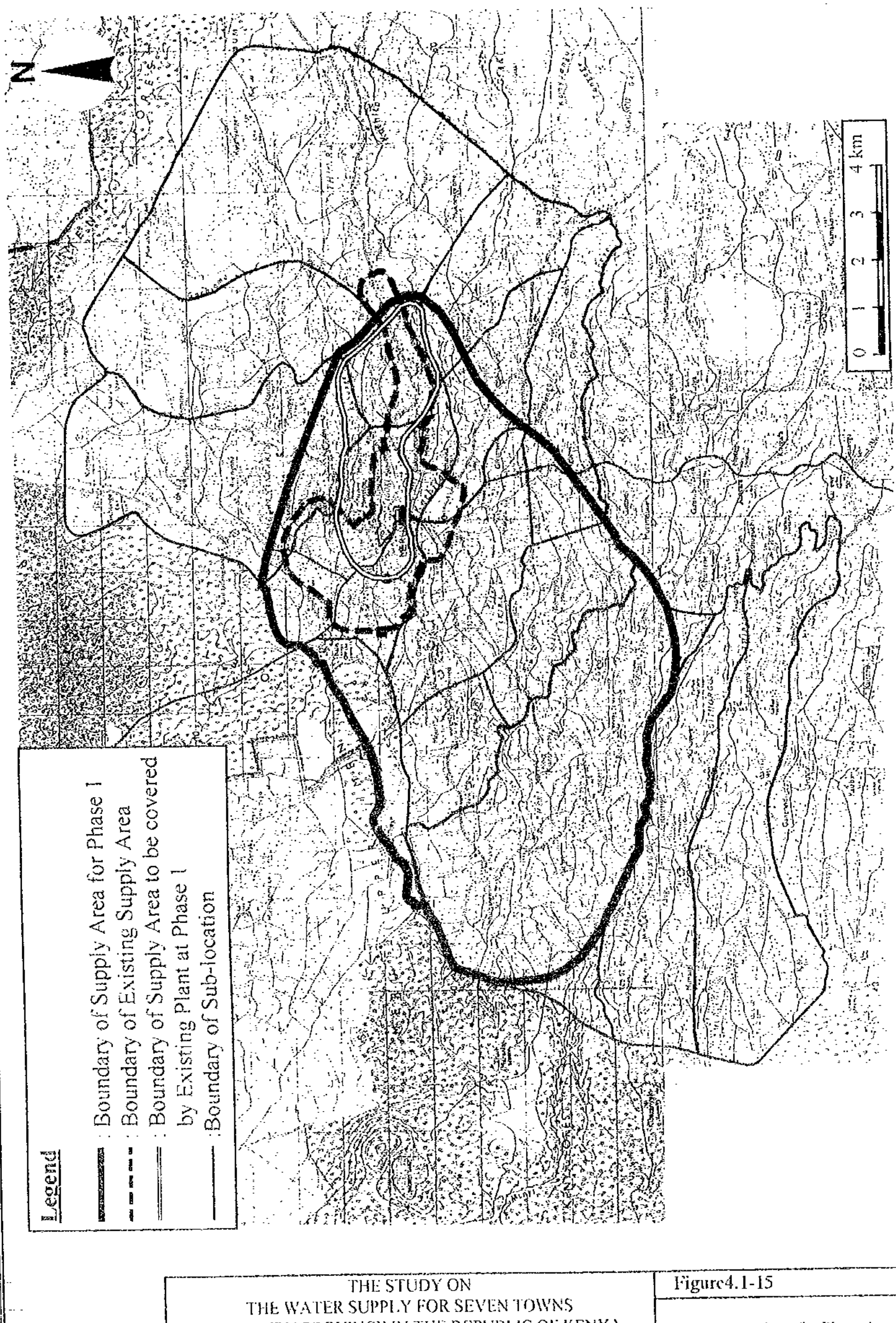
THE STUDY ON THE WATER SUPPLY FOR SEVEN TOWNS IN EASTERN PROVINCE IN THE REPUBLIC OF KENYA	Figure4.1-12
JAPAN INTERNATIONAL COOPERATION AGENCY	Water Demand for Phase 1 by Distribution Zones in Meru



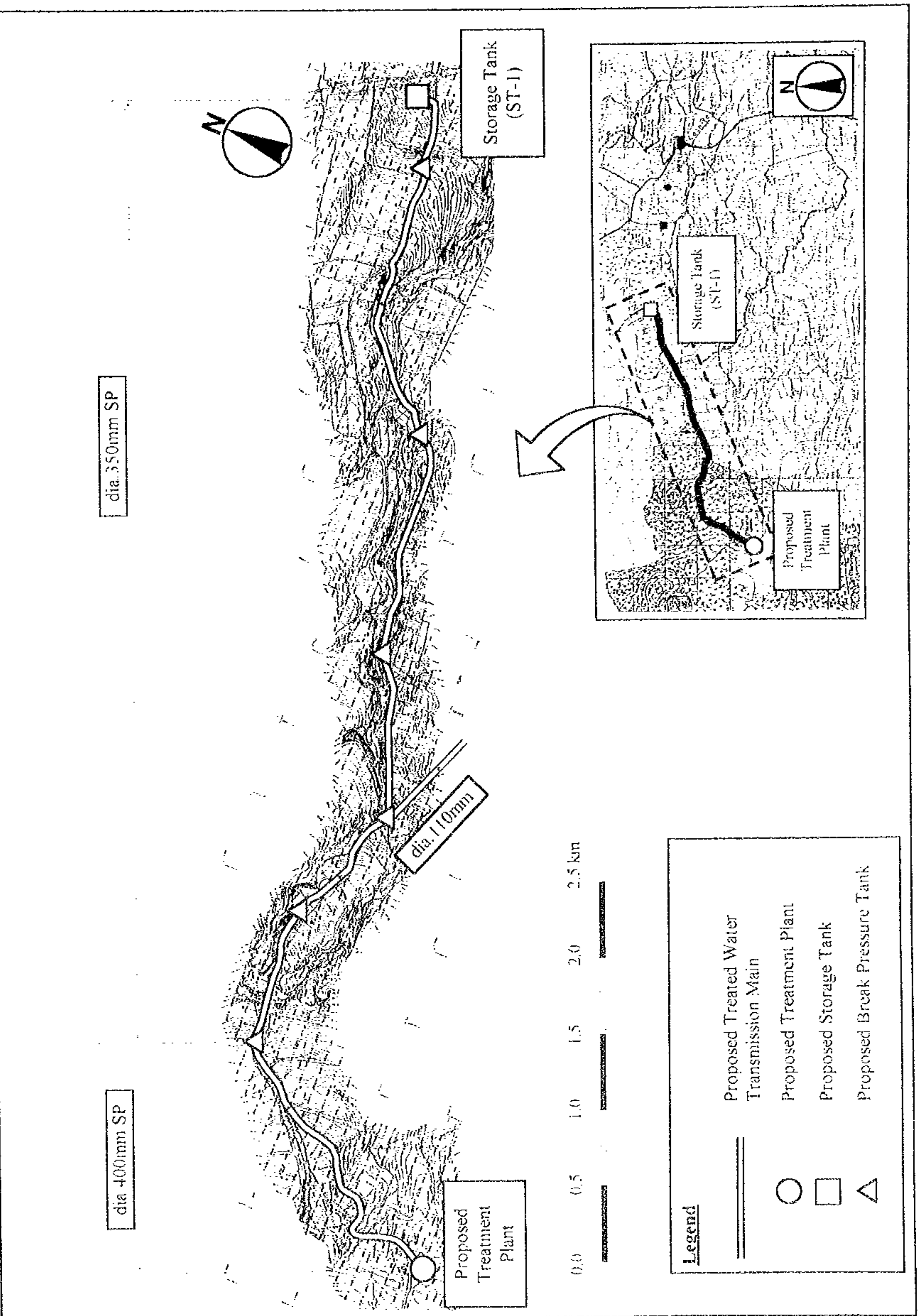
THE STUDY ON THE WATER SUPPLY FOR SEVEN TOWNS IN EASTERN PROVINCE IN THE REPUBLIC OF KENYA	Figure4.1-13
JAPAN INTERNATIONAL COOPERATION AGENCY	Results of Hydraulic Calculation for Phase 1 in Meru



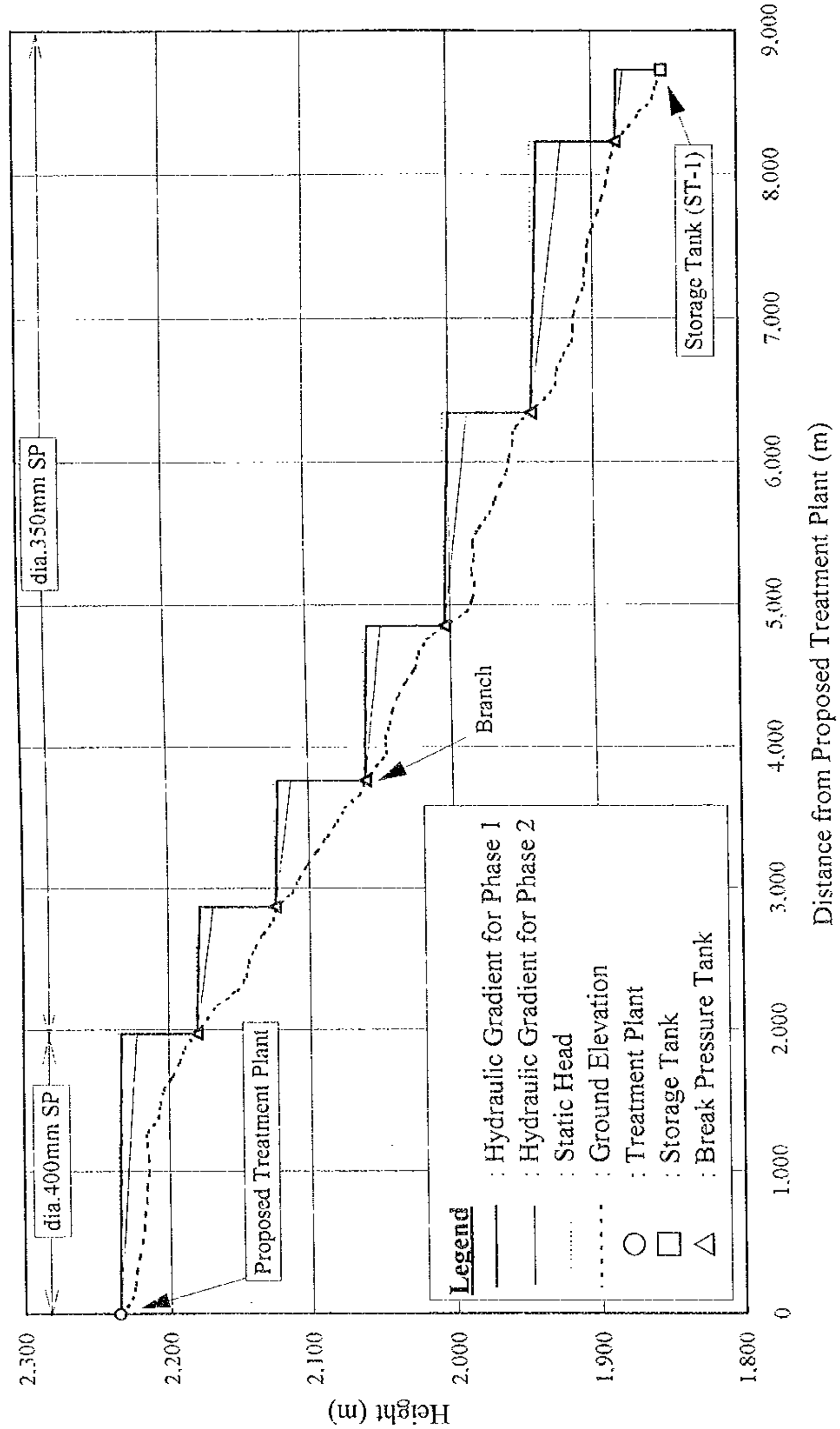
THE STUDY ON THE WATER SUPPLY FOR SEVEN TOWNS IN EASTERN PROVINCE IN THE REPUBLIC OF KENYA	Figure4.1-14
JAPAN INTERNATIONAL COOPERATION AGENCY	Schematic Flow Layout for Phase 1 in Meru



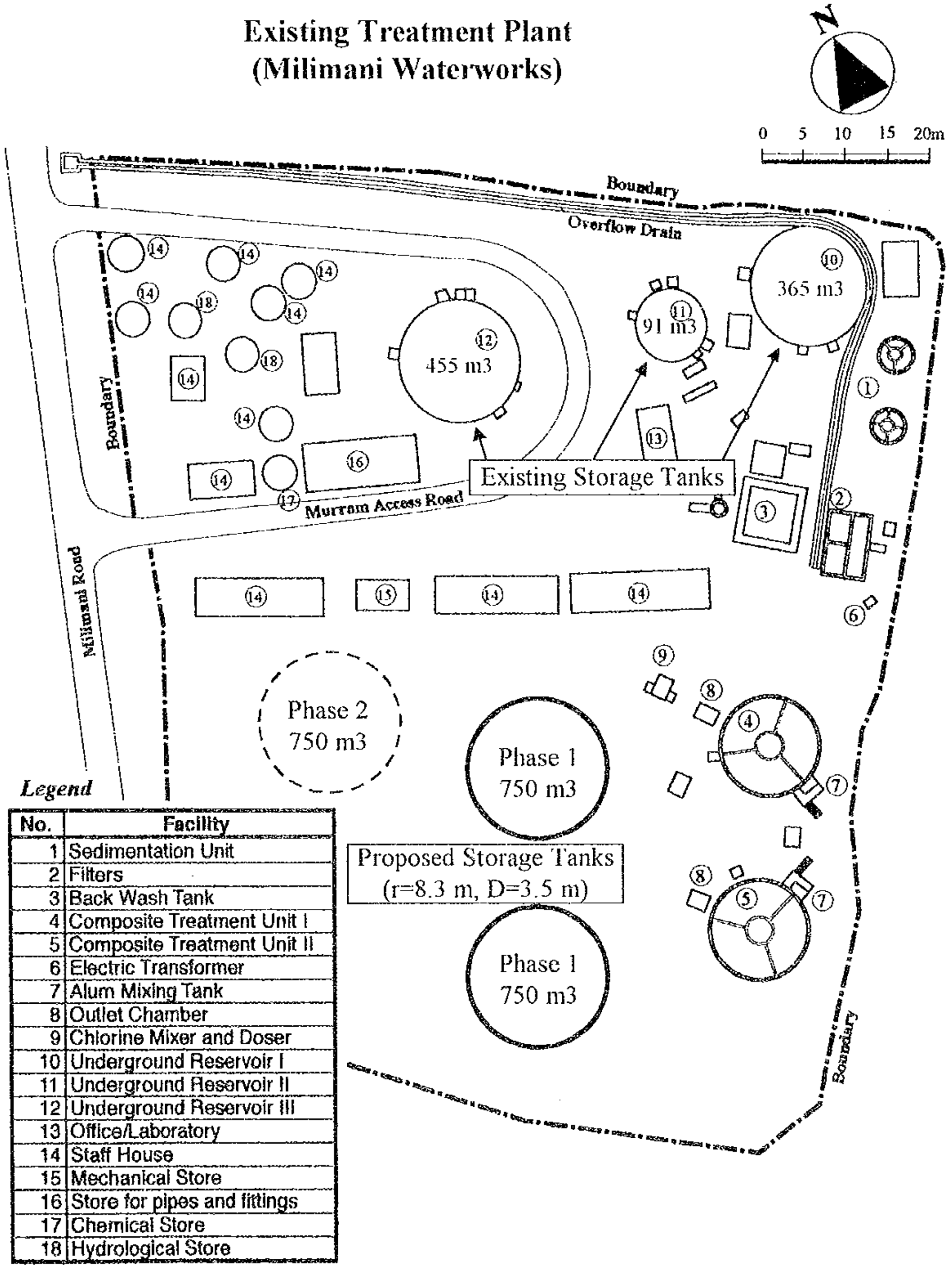
THE STUDY ON THE WATER SUPPLY FOR SEVEN TOWNS IN EASTERN PROVINCE IN THE REPUBLIC OF KENYA	Figure4.1-15
JAPAN INTERNATIONAL COOPERATION AGENCY	Supply Area for Phase 1



THE STUDY ON THE WATER SUPPLY FOR SEVEN TOWNS IN EASTERN PROVINCE IN THE REPUBLIC OF KENYA	Figure4.1-16
JAPAN INTERNATIONAL COOPERATION AGENCY	Route of Proposed Treated Water Transmission Main in Meru



THE STUDY ON THE WATER SUPPLY FOR SEVEN TOWNS IN EASTERN PROVINCE IN THE REPUBLIC OF KENYA	Figure4.1-17
JAPAN INTERNATIONAL COOPERATION AGENCY	Hydraulic Gradient along Transmission Main from Proposed WTP to Storage Tank (ST-1)



Legend

No.	Facility
1	Sedimentation Unit
2	Filters
3	Back Wash Tank
4	Composite Treatment Unit I
5	Composite Treatment Unit II
6	Electric Transformer
7	Alum Mixing Tank
8	Outlet Chamber
9	Chlorine Mixer and Doser
10	Underground Reservoir I
11	Underground Reservoir II
12	Underground Reservoir III
13	Office/Laboratory
14	Staff House
15	Mechanical Store
16	Store for pipes and fittings
17	Chemical Store
18	Hydrological Store

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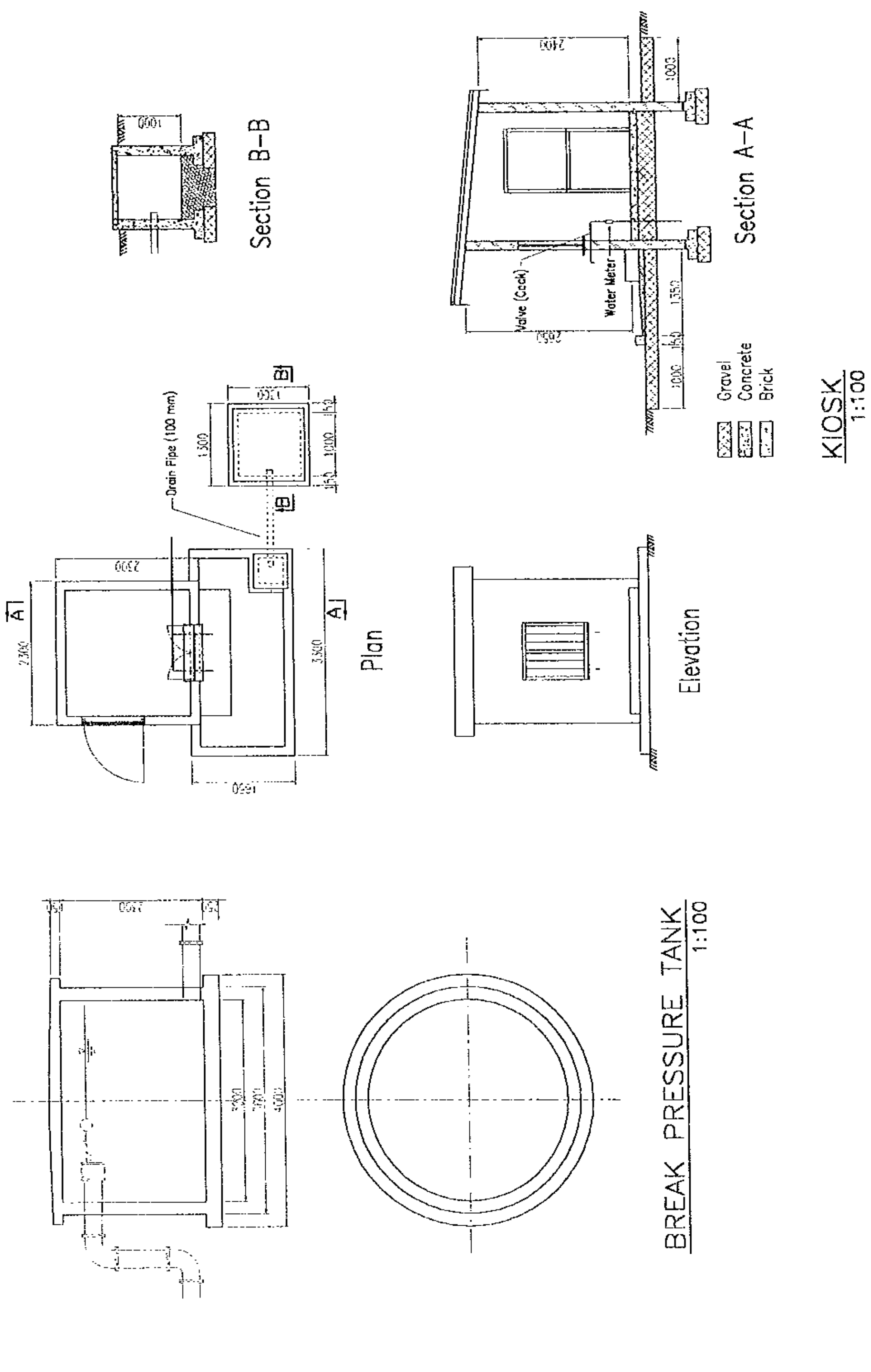
Figure4.1-18

Proposed Storage Tank at Existing Treatment Plant



THE STUDY ON THE WATER SUPPLY FOR SEVEN TOWNS IN EASTERN PROVINCE IN THE REPUBLIC OF KENYA	Figure4.1-19
JAPAN INTERNATIONAL COOPERATION AGENCY	Typical Drawings for Break Pressure Tank and Kiosk

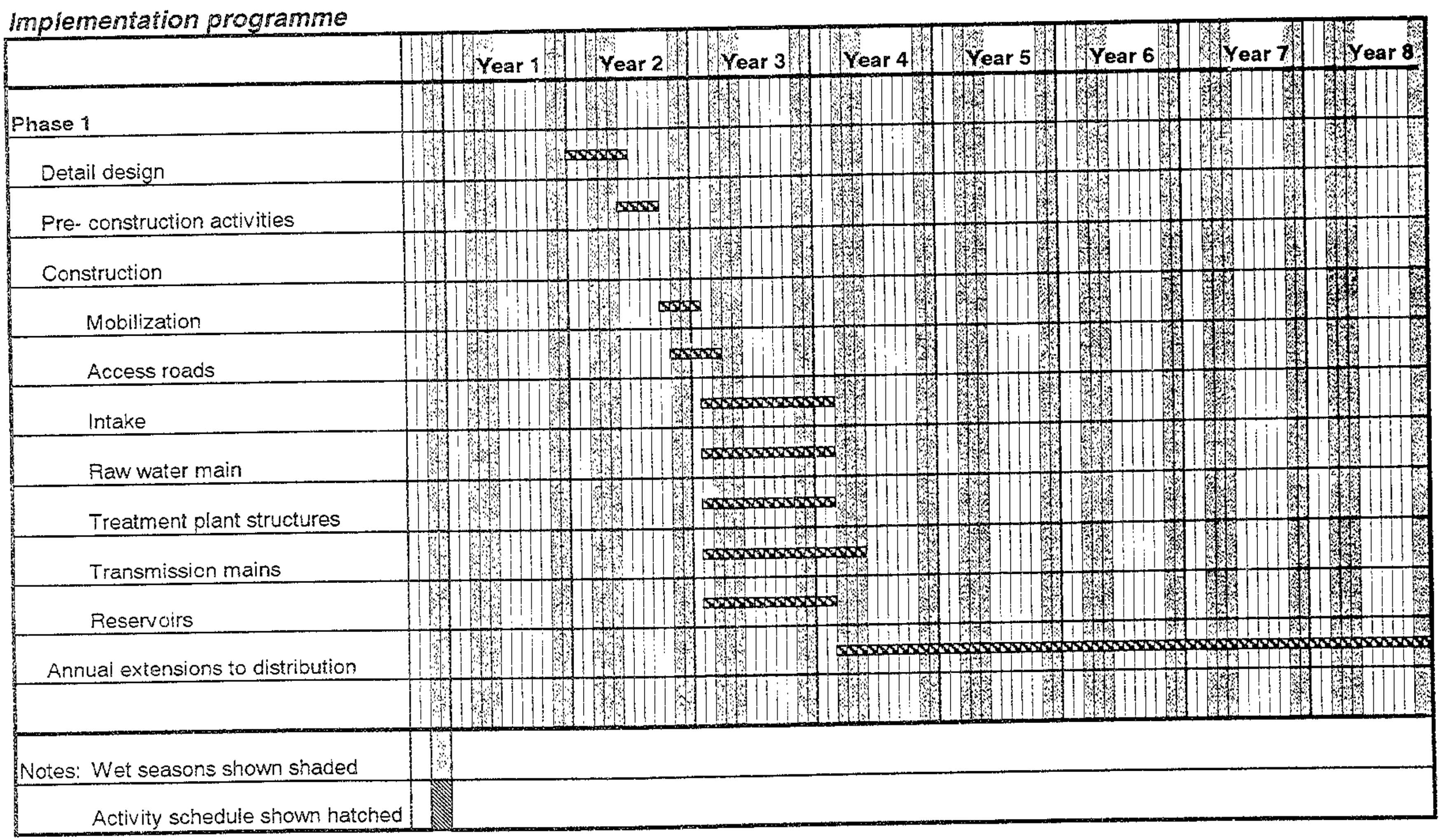


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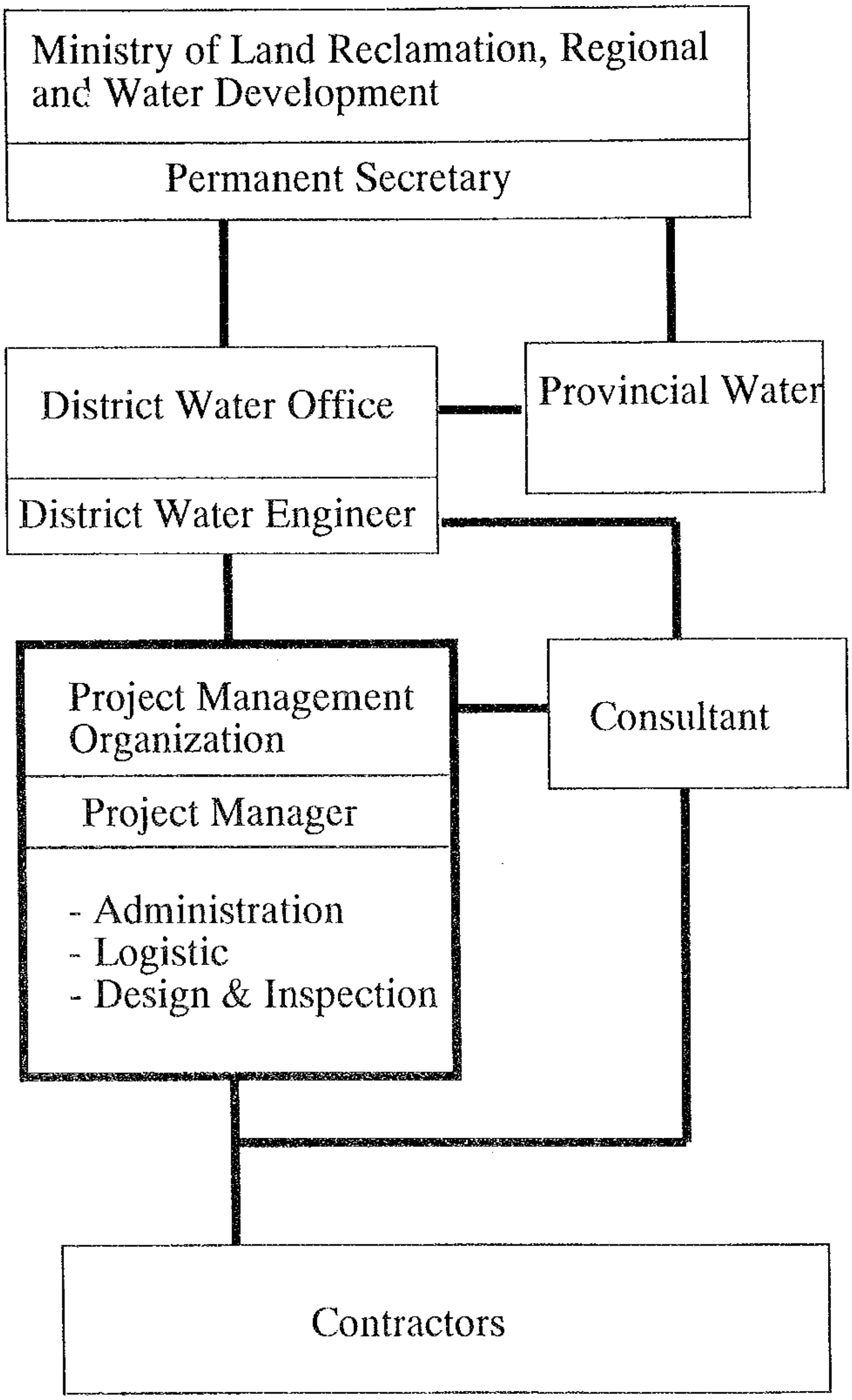
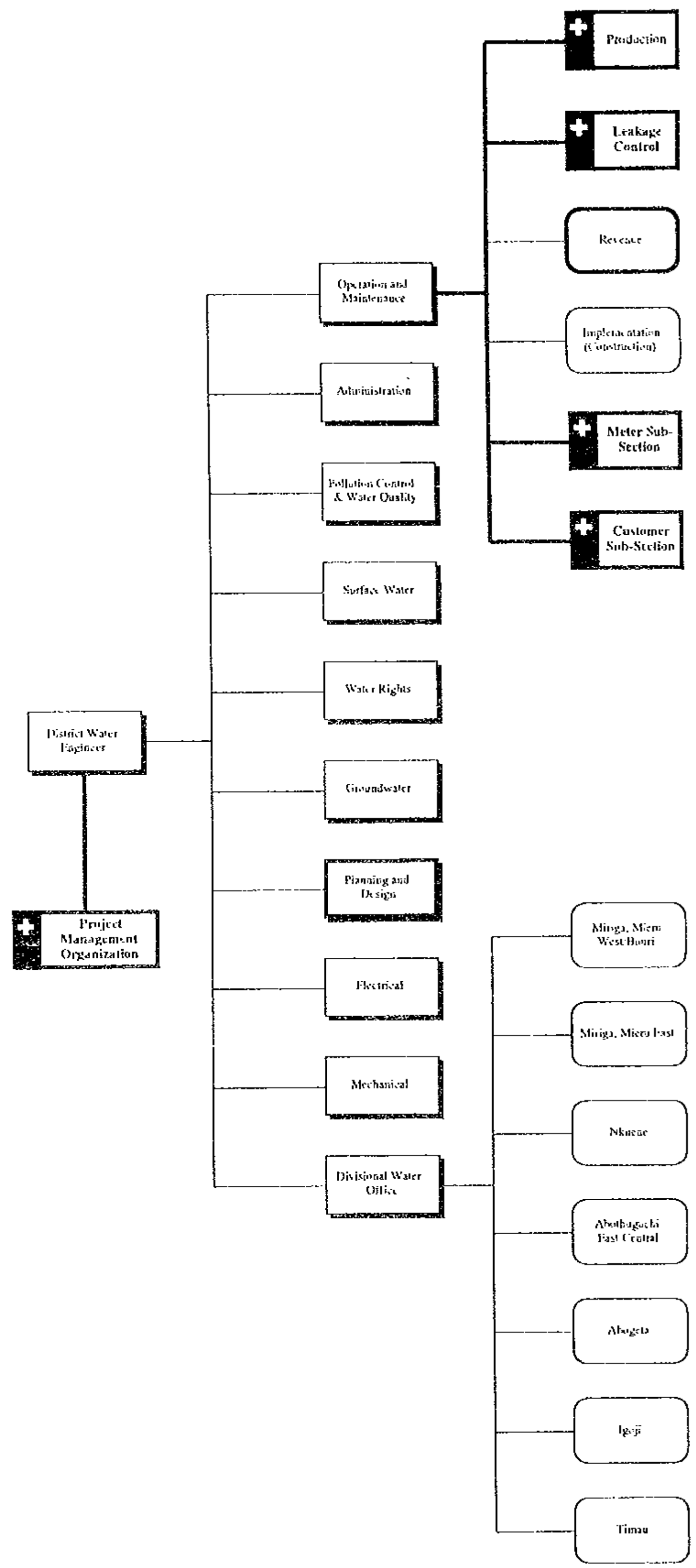
Figure 5.4-1

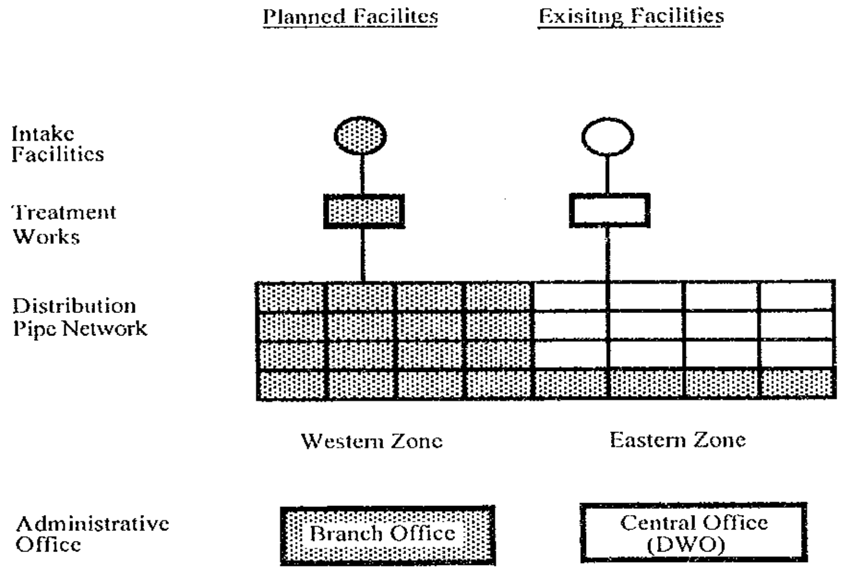
Implementation Program



THE STUDY ON THE WATER SUPPLY FOR SEVEN TOWNS IN EASTERN PROVINCE IN THE REPUBLIC OF KENYA	Figure 6.1-1
JAPAN INTERNATIONAL COOPERATION AGENCY	Organization of Project Implementation Office



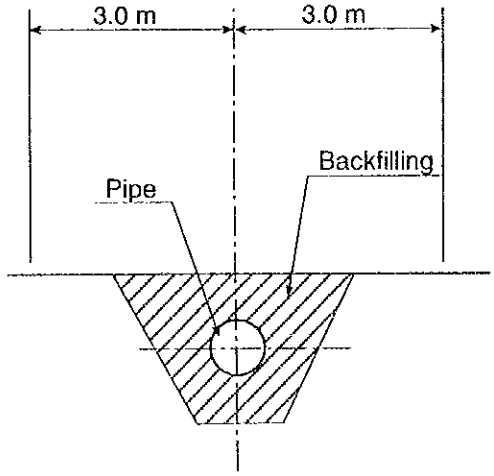
THE STUDY ON THE WATER SUPPLY FOR SEVEN TOWNS IN EASTERN PROVINCE IN THE REPUBLIC OF KENYA	Figure 6.2-1
JAPAN INTERNATIONAL COOPERATION AGENCY	Proposed Organization of DWO



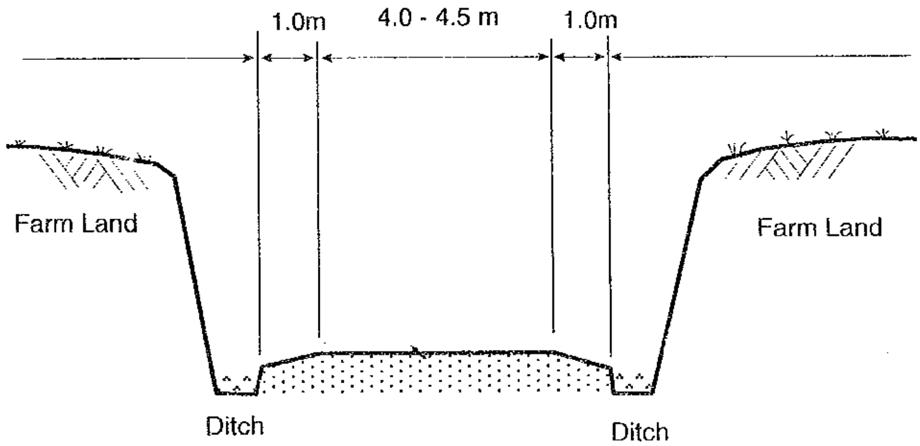
Major works and relationship

Office	Major Works
O & M Section, DWO	Whole area - Public campaign - Leakage control - Inventory control including purchase and stock of chemicals, tools, fuels, piping materials and equipment - Accounting and billing - Update and compilation of all operational records Eastern zone - Flow and pressure control - Record keeping (flow rate, water level at service reservoir, pressure, etc.) - Meter reading - Installation, repair and replacement of customer connections - Monitor and patrol at distribution pipe network - Customer registration
Branch Office	Western zone - Flow and pressure control - Record keeping (flow rate, water level at service reservoir, pressure, etc.) - Meter reading - Installation, repair and replacement of customer connections - Monitor and patrol at distribution pipe network - Customer registration
Milimani Treatment Works	Under normal condition - Operation based on operation manual - Flow and quality control - Inventory control - Record keeping (inflow rate, production, pressure, cosumption of chemicals and fuels, water level, etc.) - Maintenance and repair of all equipment - Monitoring and patrol at raw water intakes, transmission mains In case of emergency - All operation subject to direction by DWE or Section Chief
New Treatment Works	Under normal condition - Operation based on the manual - Flow and quality control - Inventory control - Record keeping (inflow rate, production, pressure, cosumption of chemicals and fuels, water level, etc.) - Maintenance and repair of all equipment - Monitoring and patrol at raw water intakes, transmission mains In case of emergency - All operation subject to direction by DWE or Section Chief

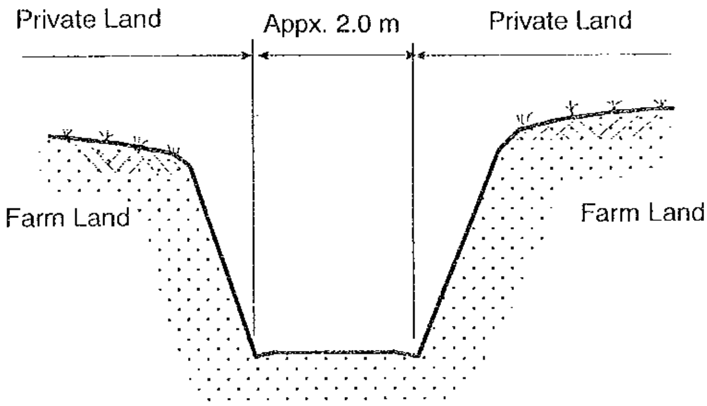
THE STUDY ON THE WATER SUPPLY FOR SEVEN TOWNS IN EASTERN PROVINCE IN THE REPUBLIC OF KENYA	Figure 6.2-2
JAPAN INTERNATIONAL COOPERATION AGENCY	Relationship and Major Work for O&M



Typical Cross Section of Wayleaves

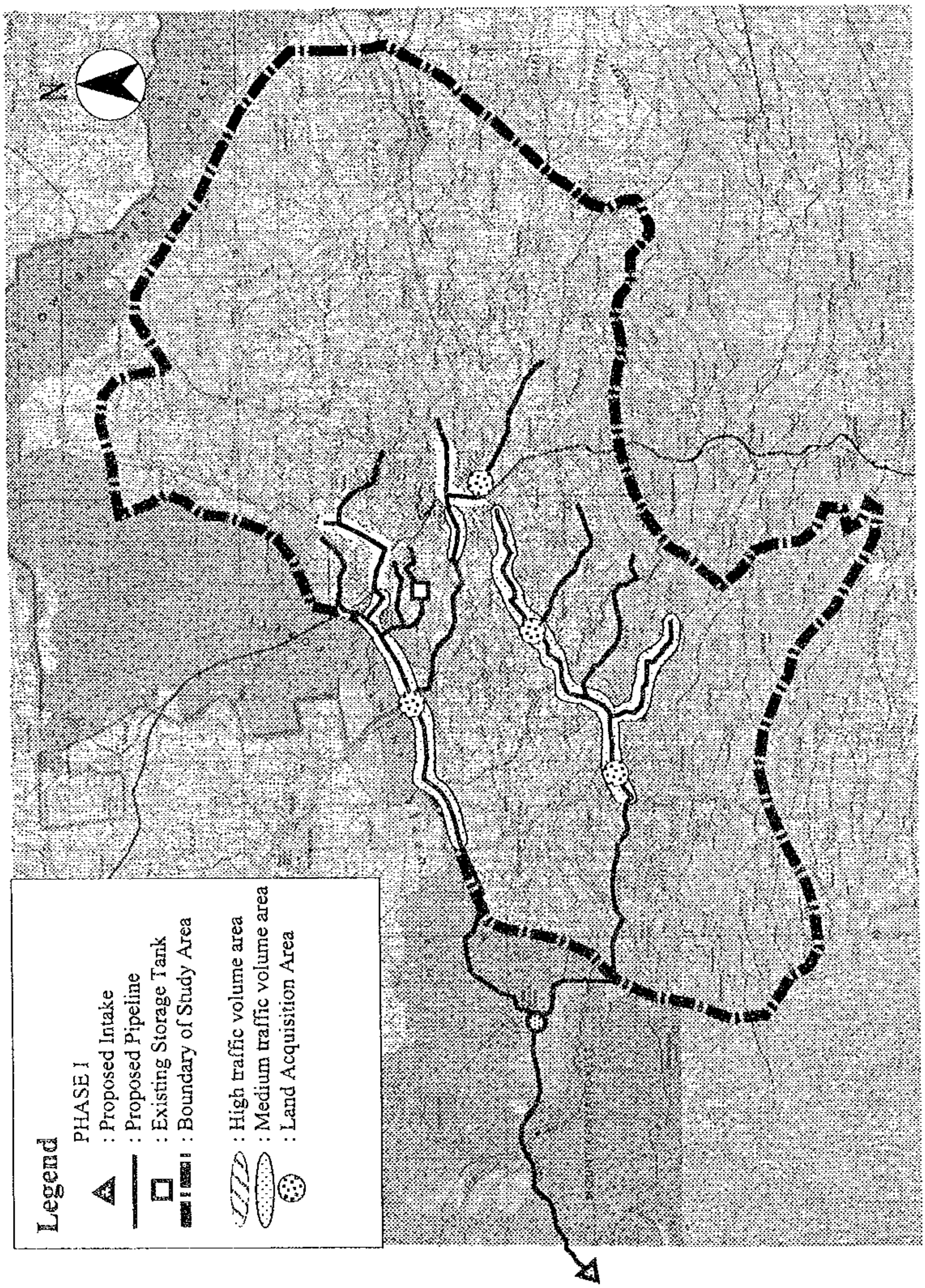


Typical Cross Section of Local Road



Typical Cross Section of Local Track

THE STUDY ON THE WATER SUPPLY FOR SEVEN TOWNS IN EASTERN PROVINCE IN THE REPUBLIC OF KENYA	Figure 7.2-1
JAPAN INTERNATIONAL COOPERATON AGENCY	Typical Cross Section of Wayleaves and Local Roads



THE STUDY ON THE WATER SUPPLY FOR SEVEN TOWNS IN EASTERN PROVINCE IN THE REPUBLIC OF	Figure 7.2-2
JAPAN INTERNATIONAL COORERATION	Social Environmental Consideration Necessity Area

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