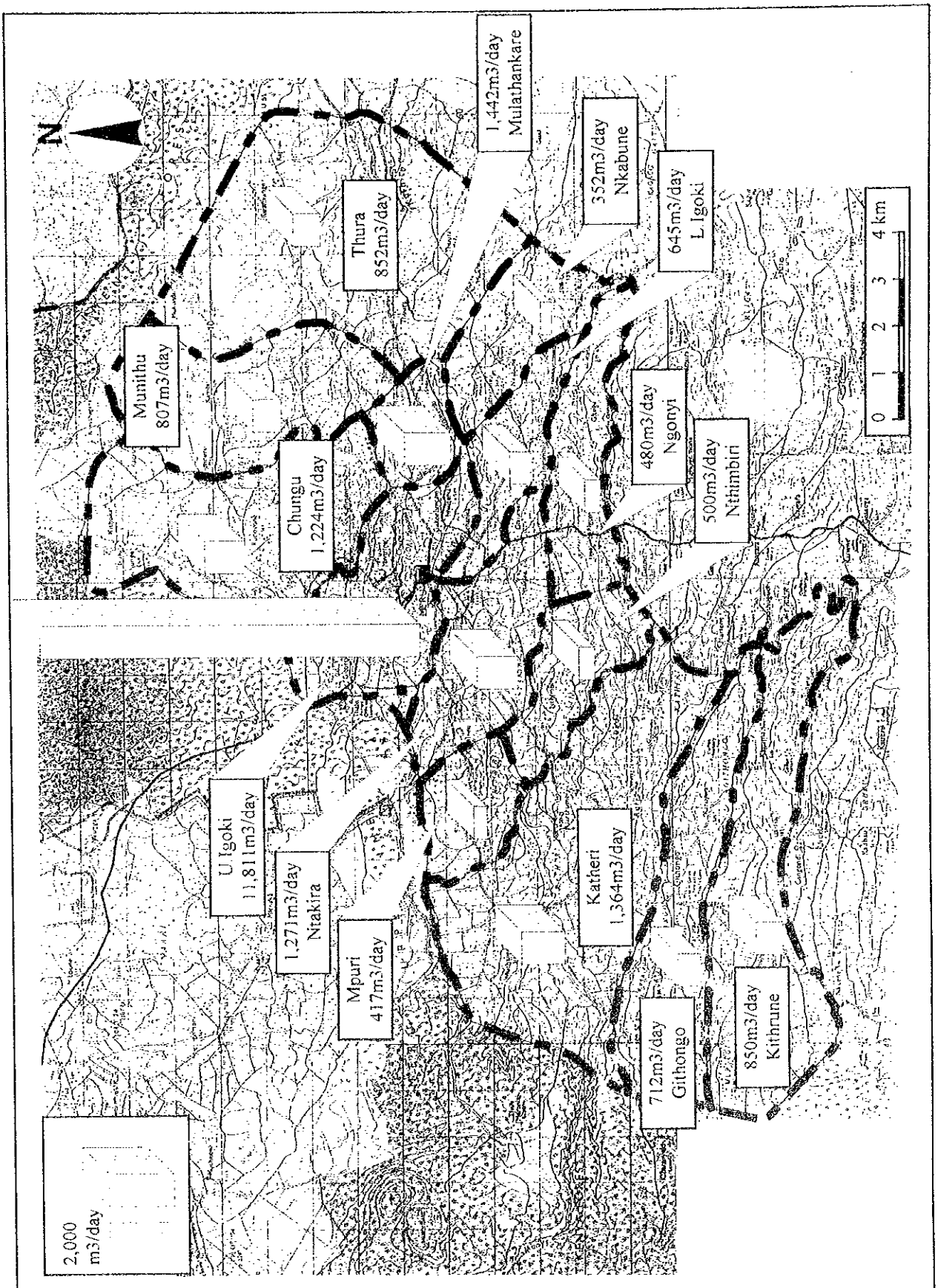
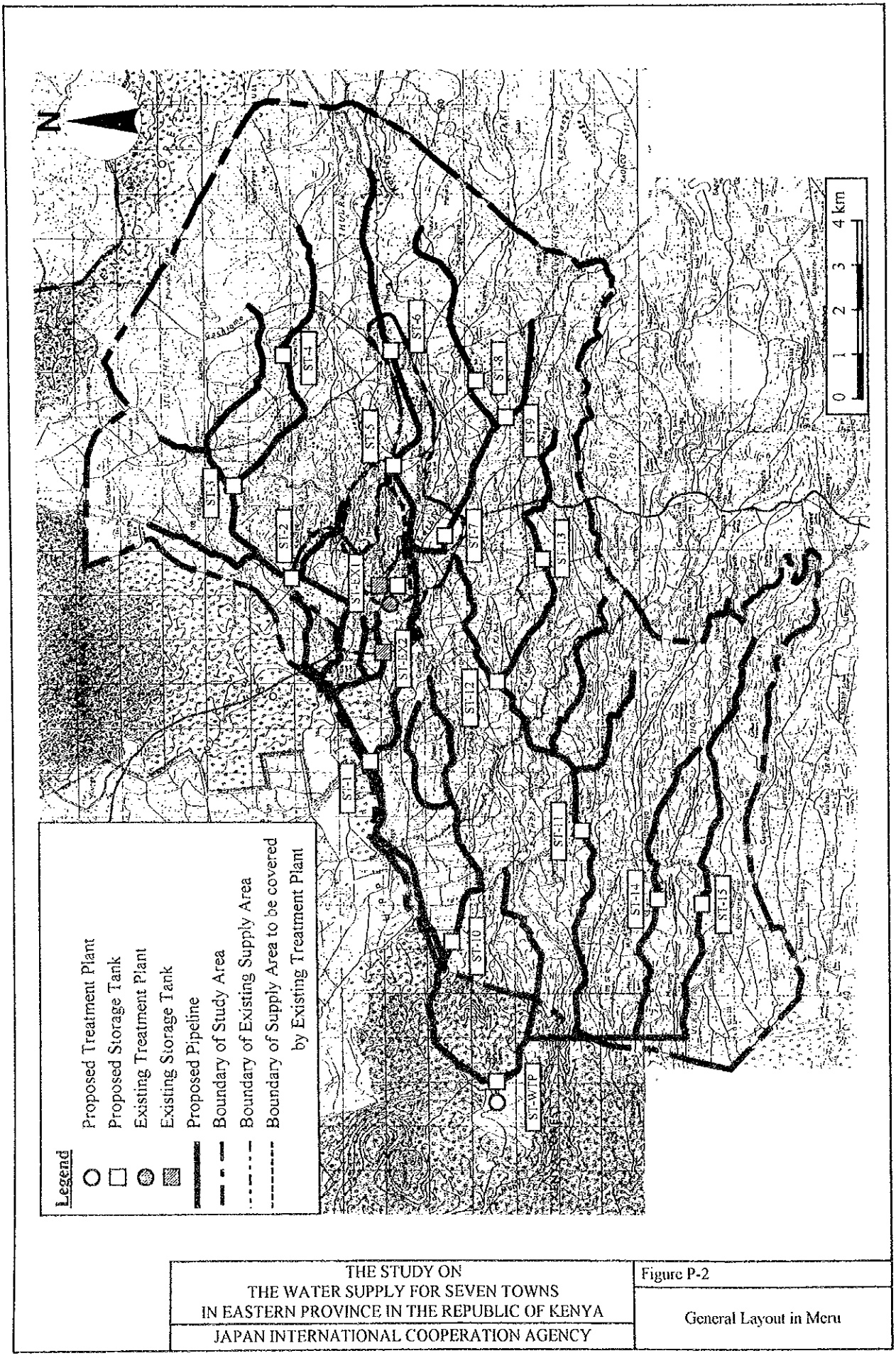
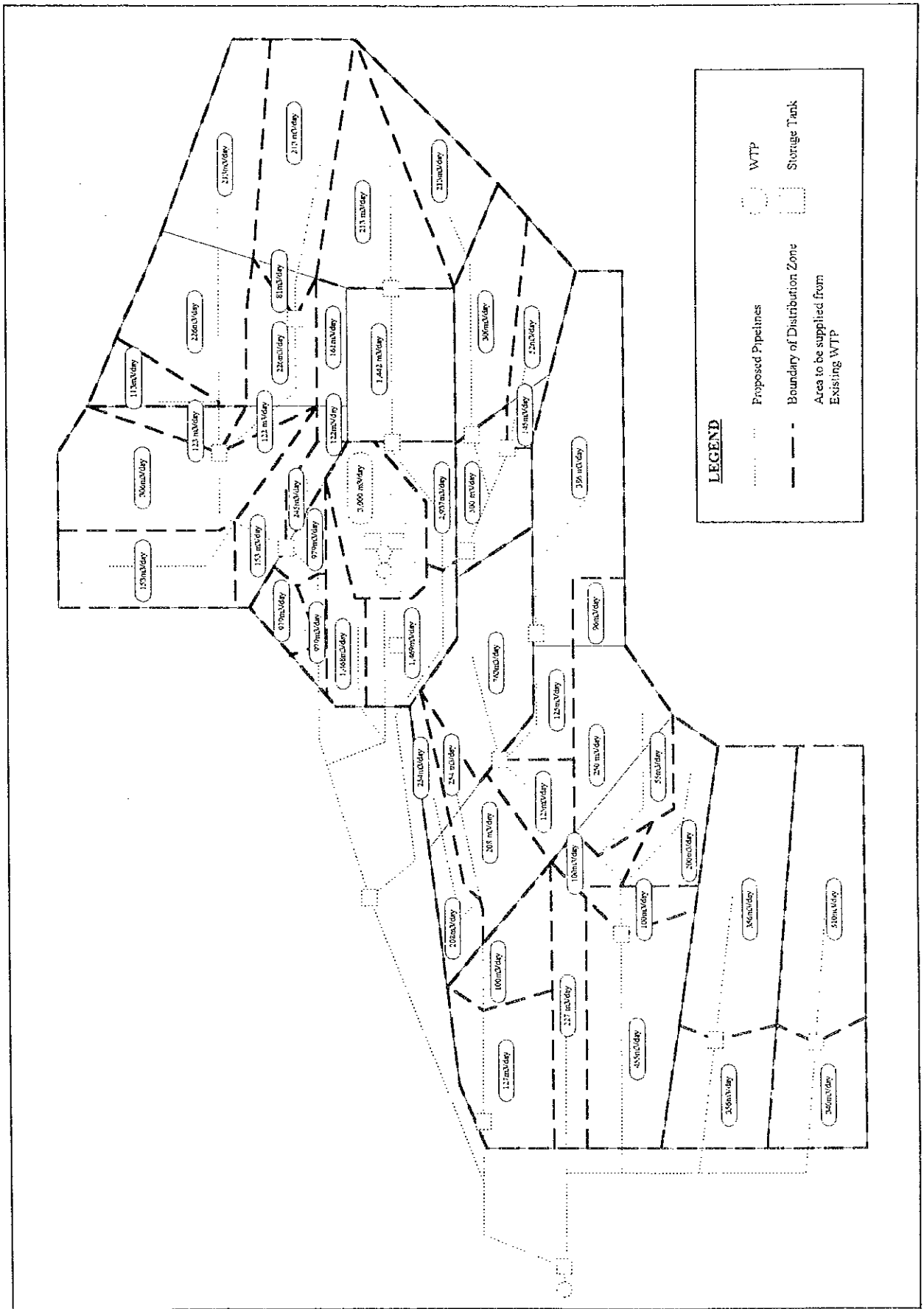
FIGURES



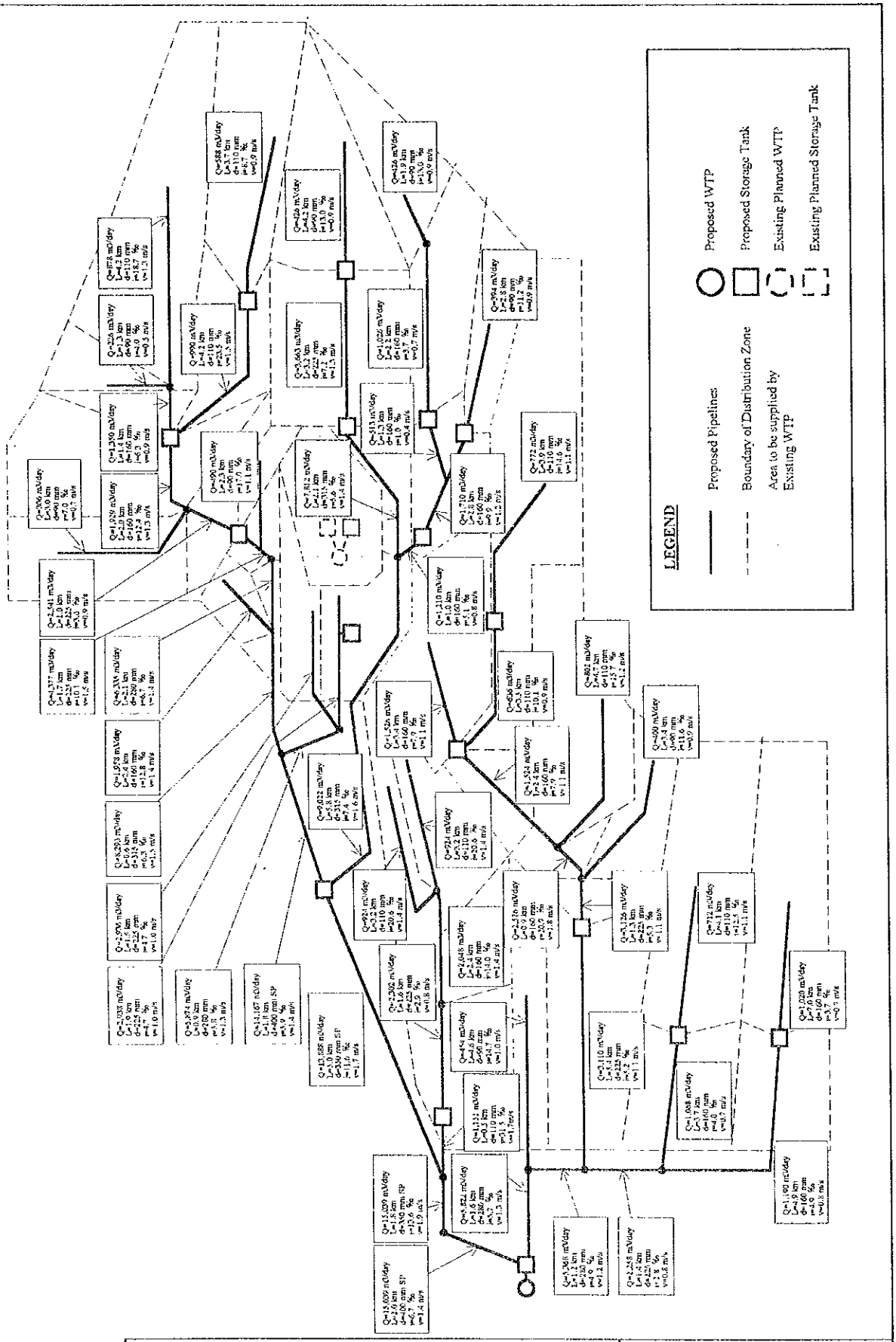
THE STUDY ON THE WATER SUPPLY FOR SEVEN TOWNS IN EASTERN PROVINCE IN THE REPUBLIC OF KENYA JAPAN INTERNATIONAL COOPERATION AGENCY	Figure P-1 Water Demand Distribution by Sub-Location in Meru in 2010



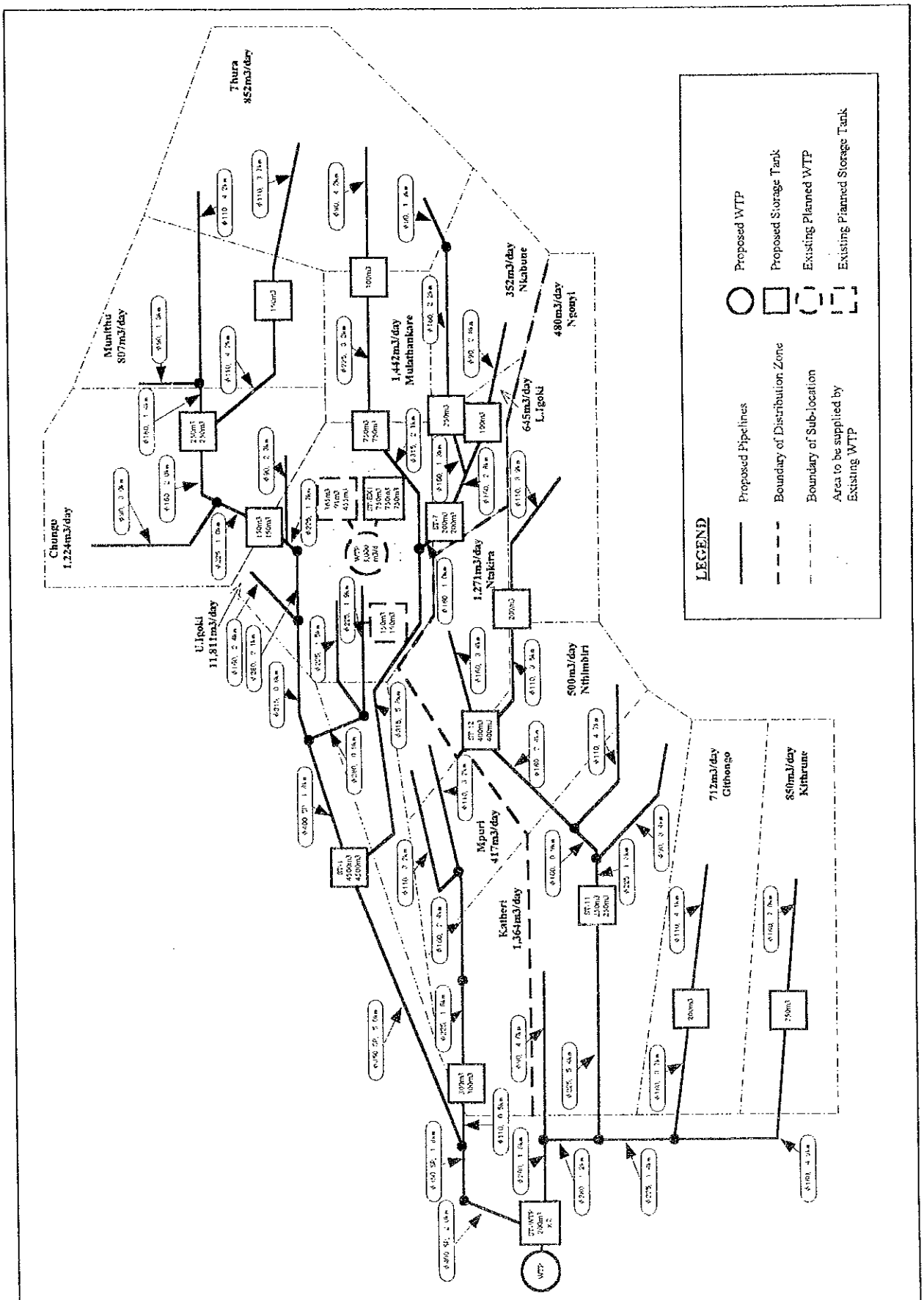
THE STUDY ON THE WATER SUPPLY FOR SEVEN TOWNS IN EASTERN PROVINCE IN THE REPUBLIC OF KENYA	Figure P-2
JAPAN INTERNATIONAL COOPERATION AGENCY	General Layout in Meru



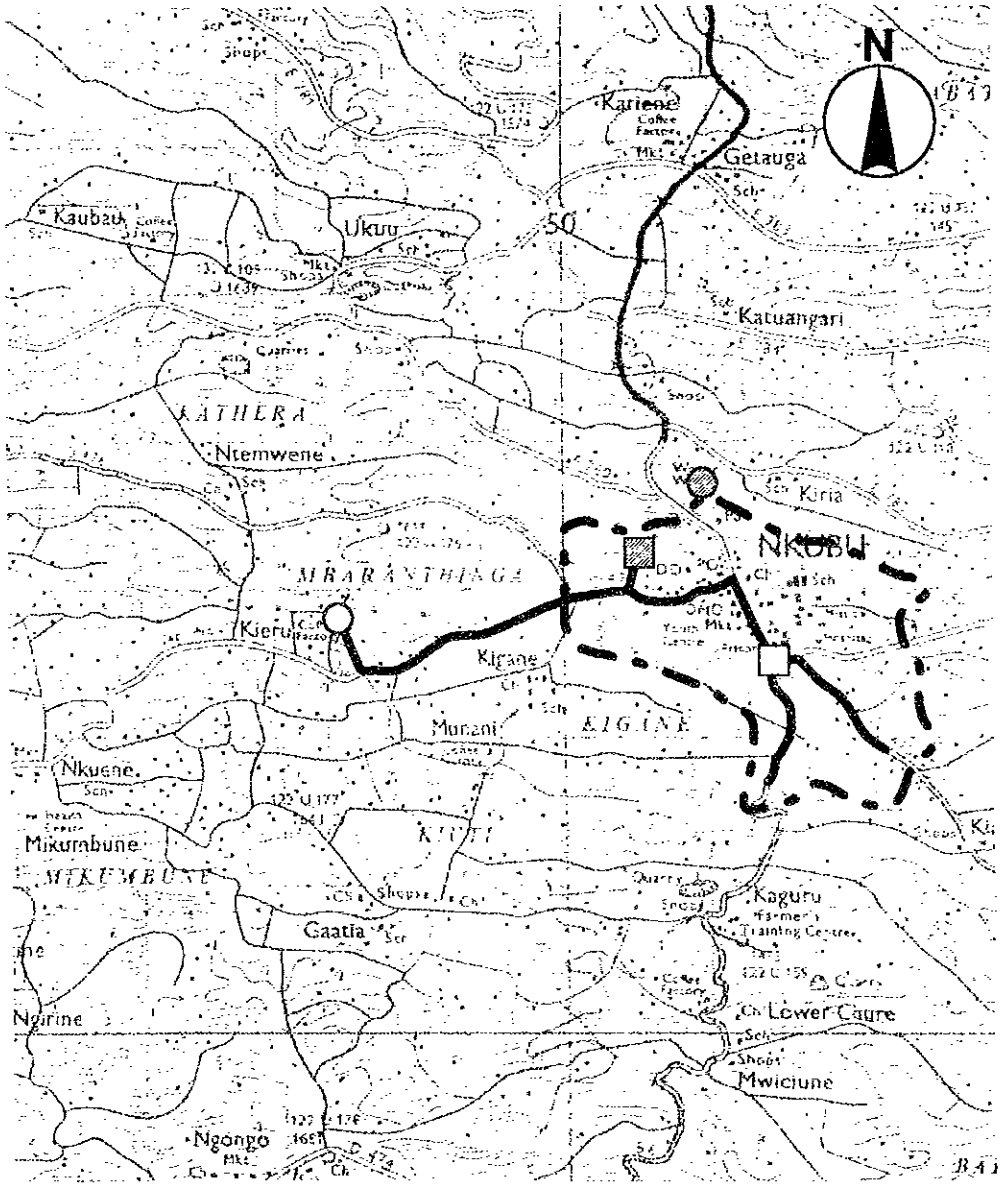
THE STUDY ON THE WATER SUPPLY FOR SEVEN TOWNS IN EASTERN PROVINCE IN THE REPUBLIC OF KENYA	Figure P-3
JAPAN INTERNATIONAL COOPERATION AGENCY	Water Demand by Distribution Zones in Meru



THE STUDY ON THE WATER SUPPLY FOR SEVEN TOWNS IN EASTERN PROVINCE IN THE REPUBLIC OF KENYA JAPAN INTERNATIONAL COOPERATION AGENCY	Figure P-4 Results of Hydraulic Calculation in Meru



THE STUDY ON THE WATER SUPPLY FOR SEVEN TOWNS IN EASTERN PROVINCE IN THE REPUBLIC OF KENYA JAPAN INTERNATIONAL COOPERATION AGENCY	Figure P-5 Schematic Flow Layout in Meru

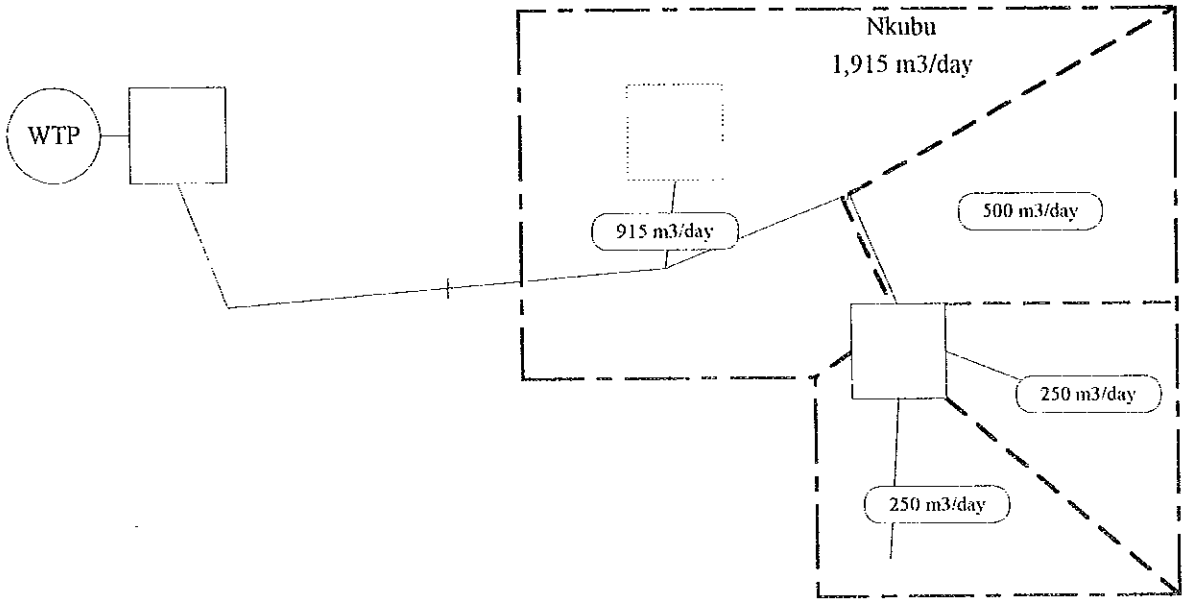


Scale 1:50,000

Legend

- Proposed Treatment Plant
- Proposed Storage Tank
- Existing Treatment Plant
- Existing Storage Tank
- Proposed Pipeline
- Boundary of Study Area

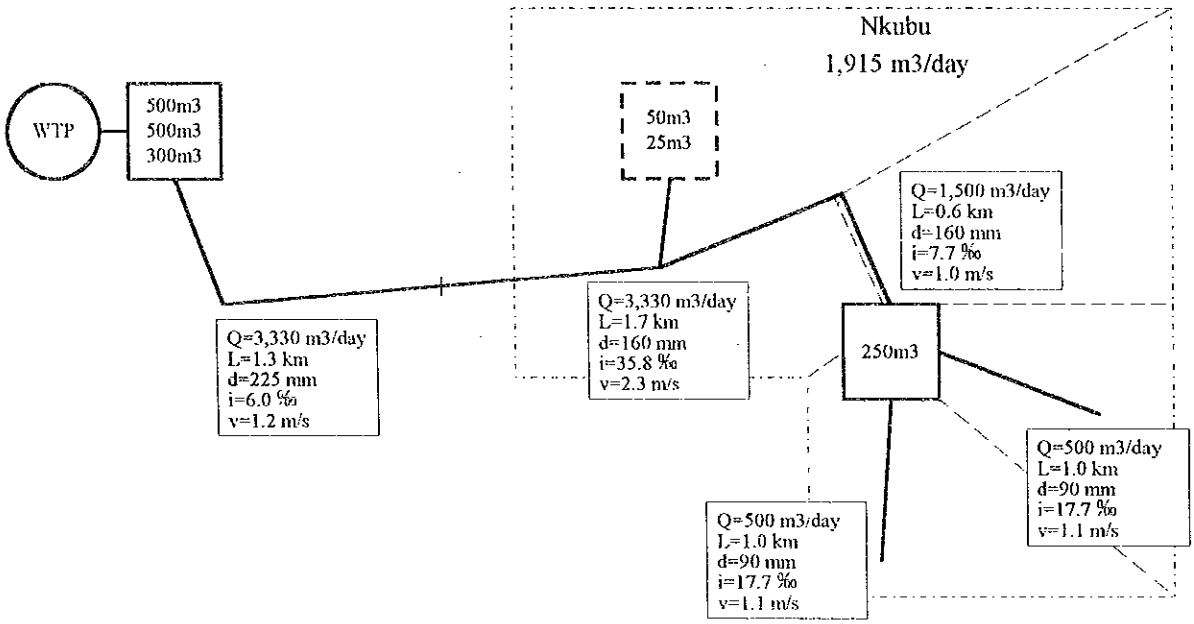
THE STUDY ON THE WATER SUPPLY FOR SEVEN TOWNS IN EASTERN PROVINCE IN THE REPUBLIC OF KENYA JAPAN INTERNATIONAL COOPERATION AGENCY	Figure P-6 General Layout in Nkubu



LEGEND

Proposed Pipelines	Proposed Treatment Plant
Boundary of Study Area	Proposed Storage Tank
Boundary of Distribution Zone	Existing Storage Tank

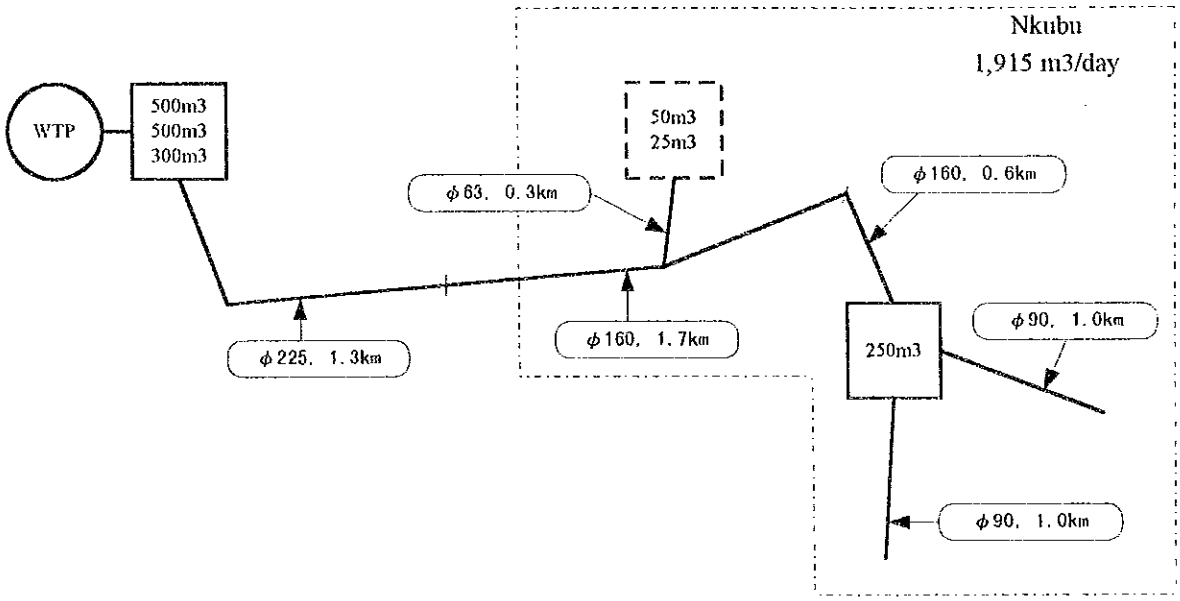
THE STUDY ON THE WATER SUPPLY FOR SEVEN TOWNS IN EASTERN PROVINCE IN THE REPUBLIC OF KENYA	Figure P-7
JAPAN INTERNATIONAL COOPERATION AGENCY	Water Demand by Distribution Zones in Nkubu



LEGEND

- Proposed Pipelines
- Boundary of Study Area
- Boundary of Distribution Zone
- Proposed Treatment Plant
- Proposed Storage Tank (with capacity)
- Existing Storage Tank (with capacity)

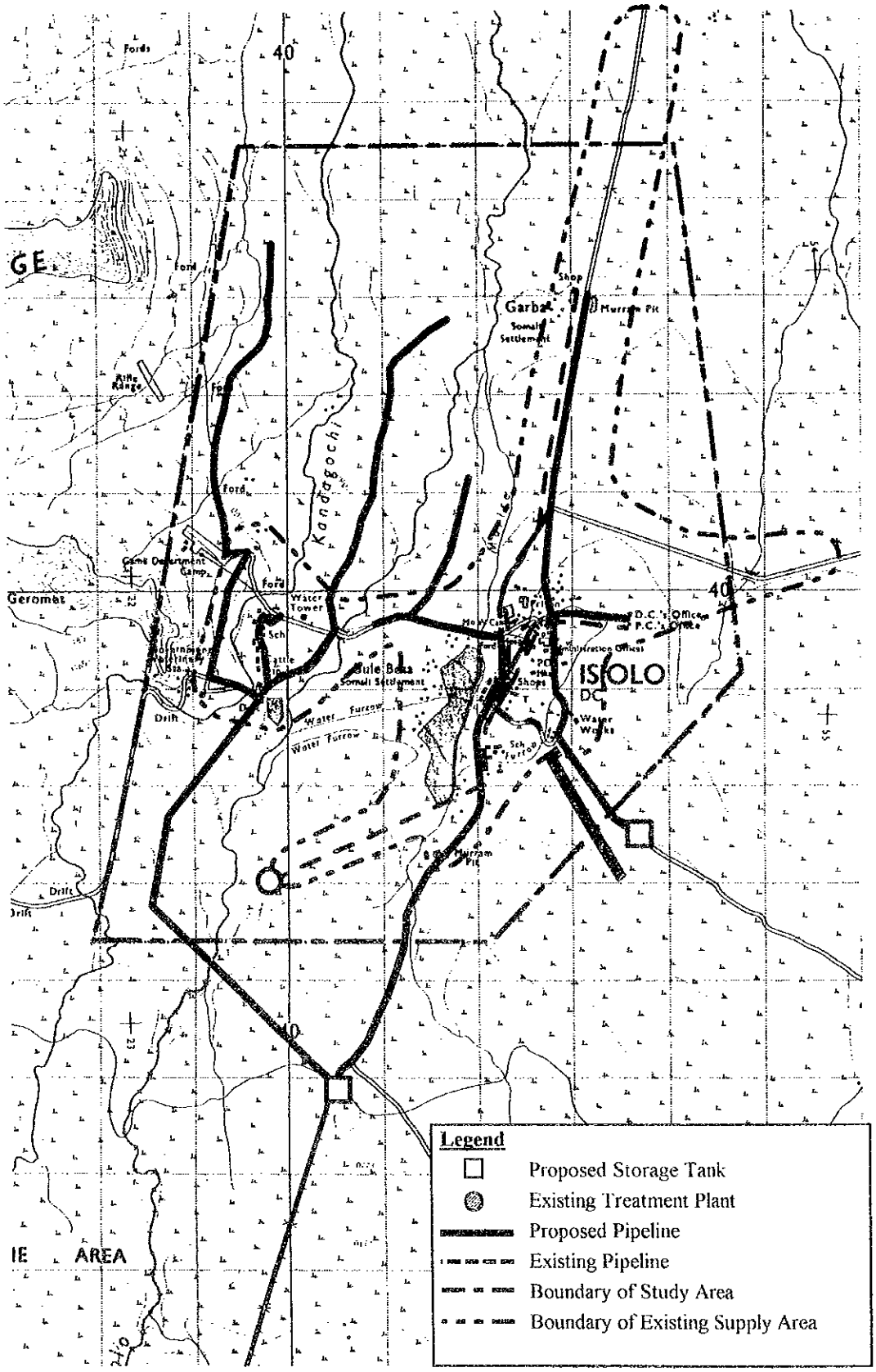
THE STUDY ON THE WATER SUPPLY FOR SEVEN TOWNS IN EASTERN PROVINCE IN THE REPUBLIC OF KENYA JAPAN INTERNATIONAL COOPERATION AGENCY	Figure P-8 Results of Hydraulic Calculation in Nkubu



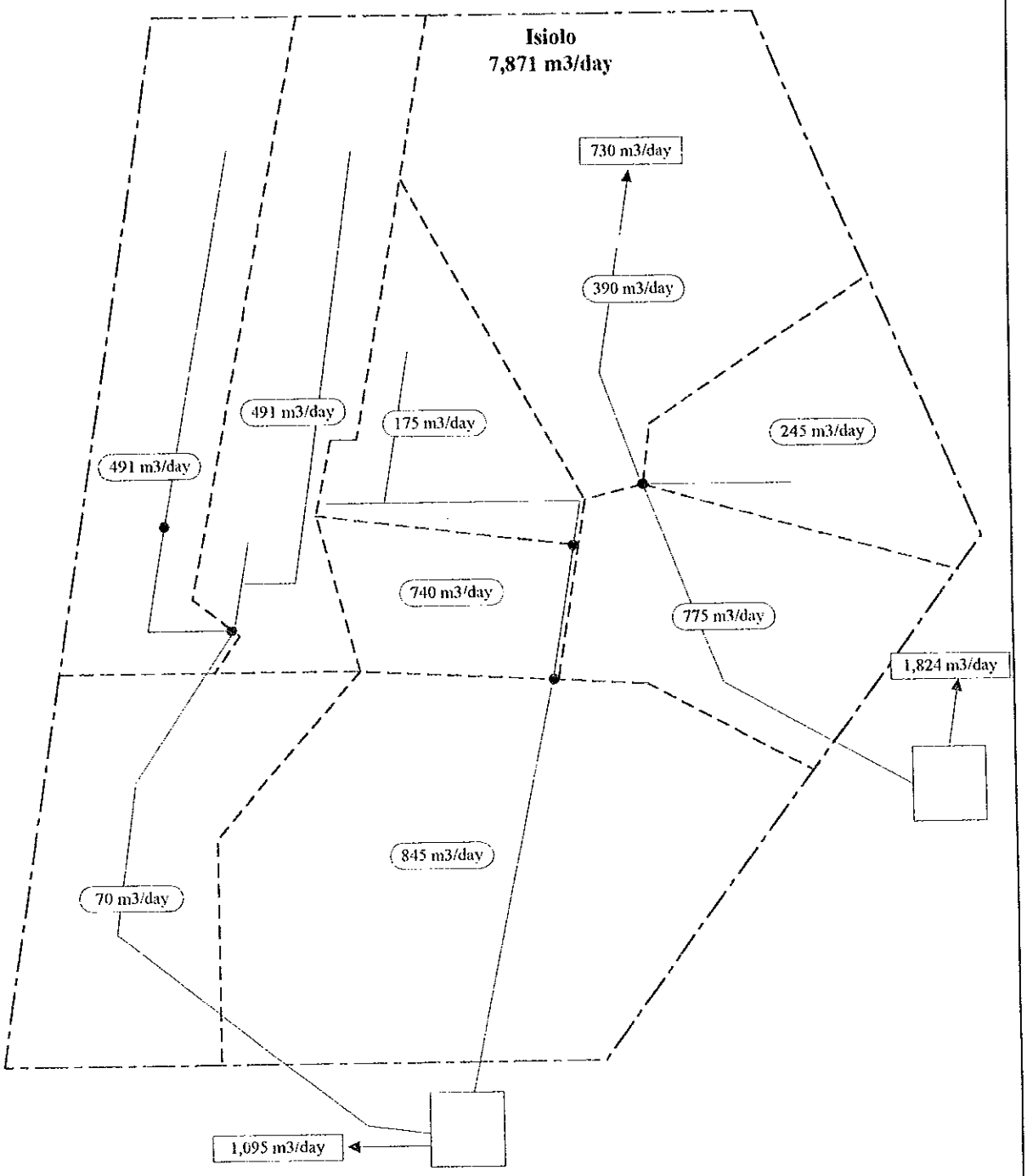
LEGEND

- Proposed Pipelines
- Boundary of Study Area
- Proposed Treatment Plant
- Proposed Storage Tank (with capacity)
- Existing Storage Tank (with capacity)

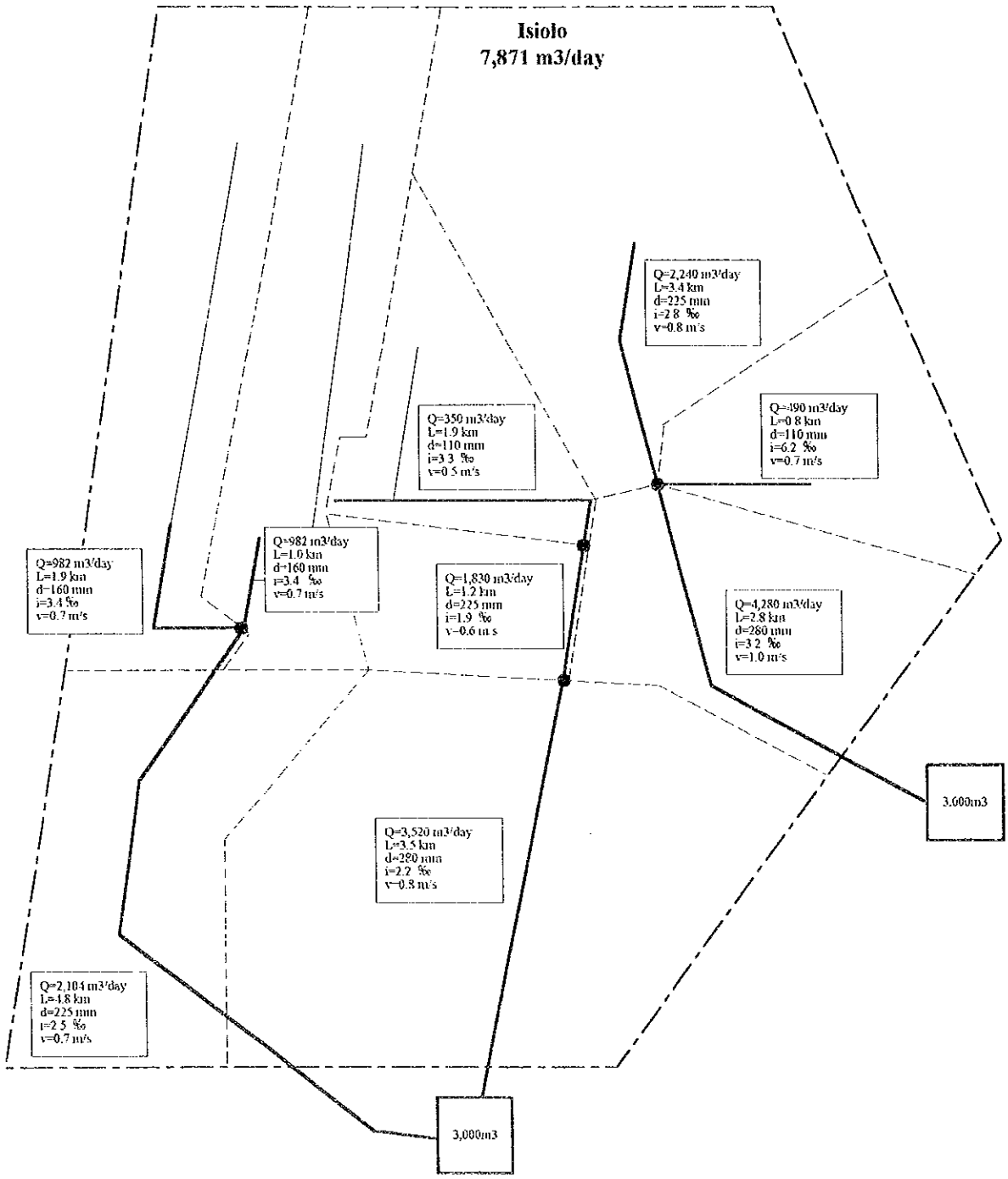
THE STUDY ON THE WATER SUPPLY FOR SEVEN TOWNS IN EASTERN PROVINCE IN THE REPUBLIC OF KENYA JAPAN INTERNATIONAL COOPERATION AGENCY	Figure P-9 Schematic Flow Layout in Nkubu



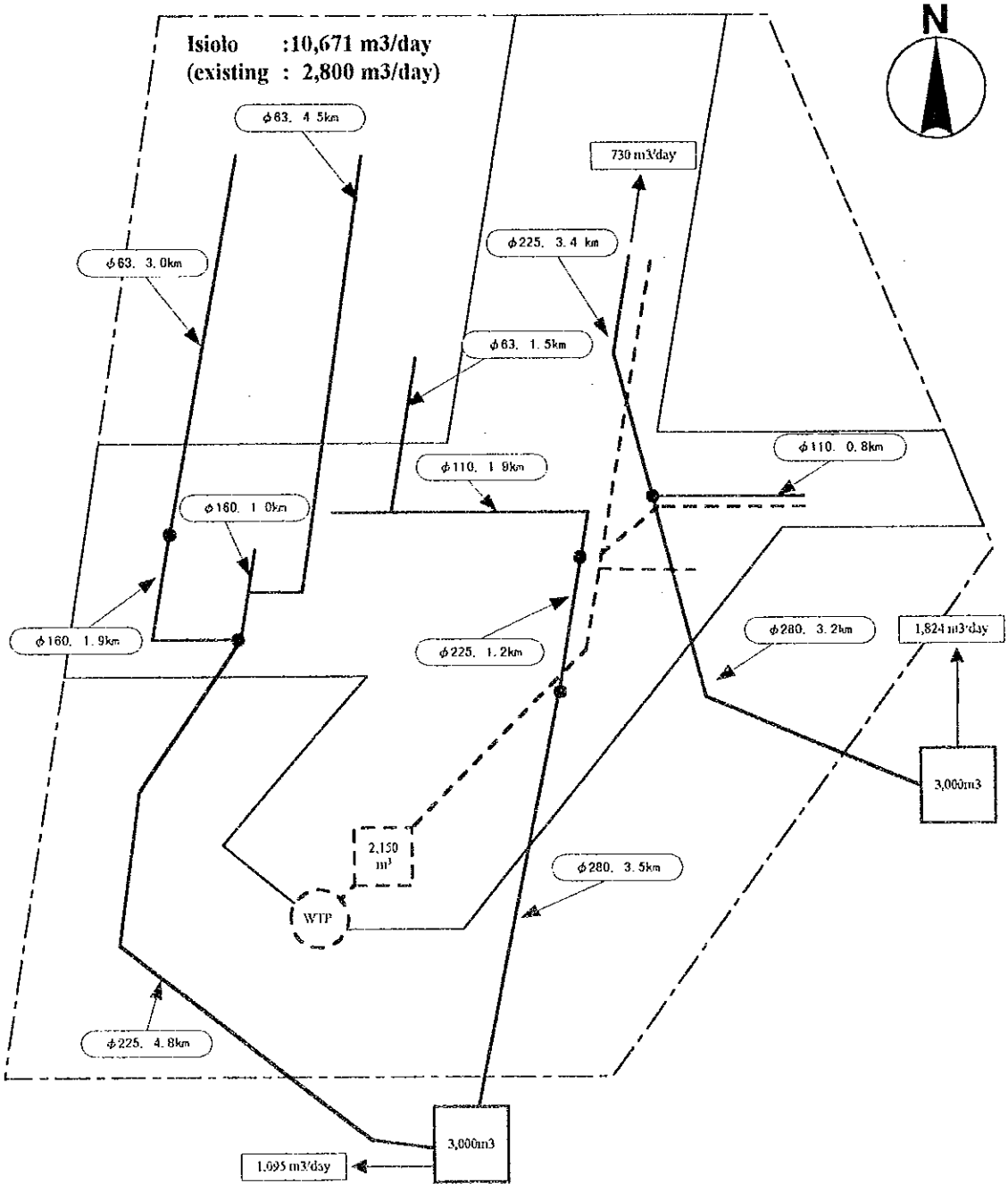
THE STUDY ON THE WATER SUPPLY FOR SEVEN TOWNS IN EASTERN PROVINCE IN THE REPUBLIC OF KENYA JAPAN INTERNATIONAL COOPERATION AGENCY	Figure P-10 General Layout in Isiolo



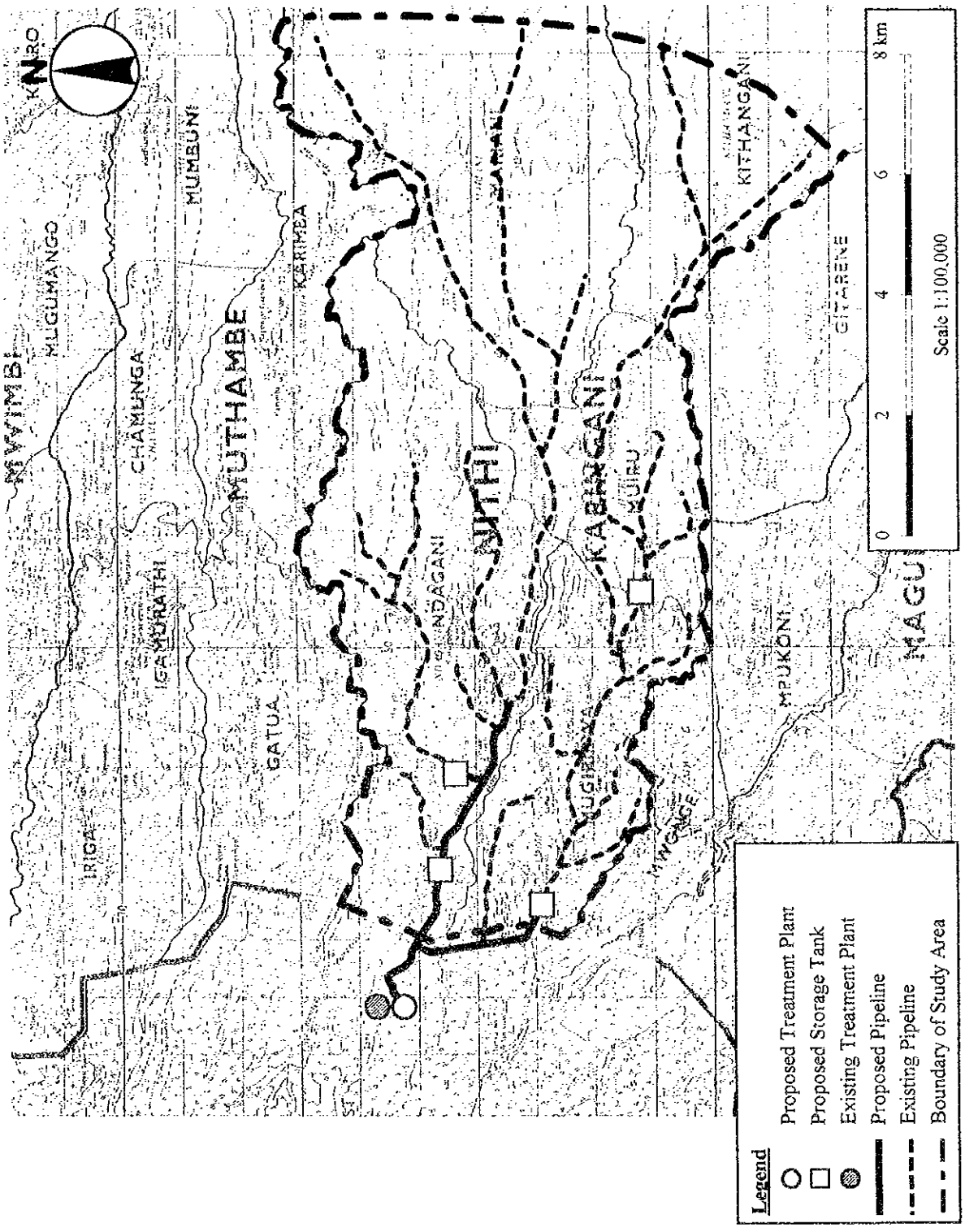
THE STUDY ON THE WATER SUPPLY FOR SEVEN TOWNS IN EASTERN PROVINCE IN THE REPUBLIC OF KENYA JAPAN INTERNATIONAL COOPERATION AGENCY	Figure P-11 Water Demand by Distribution Zones in Isiolo



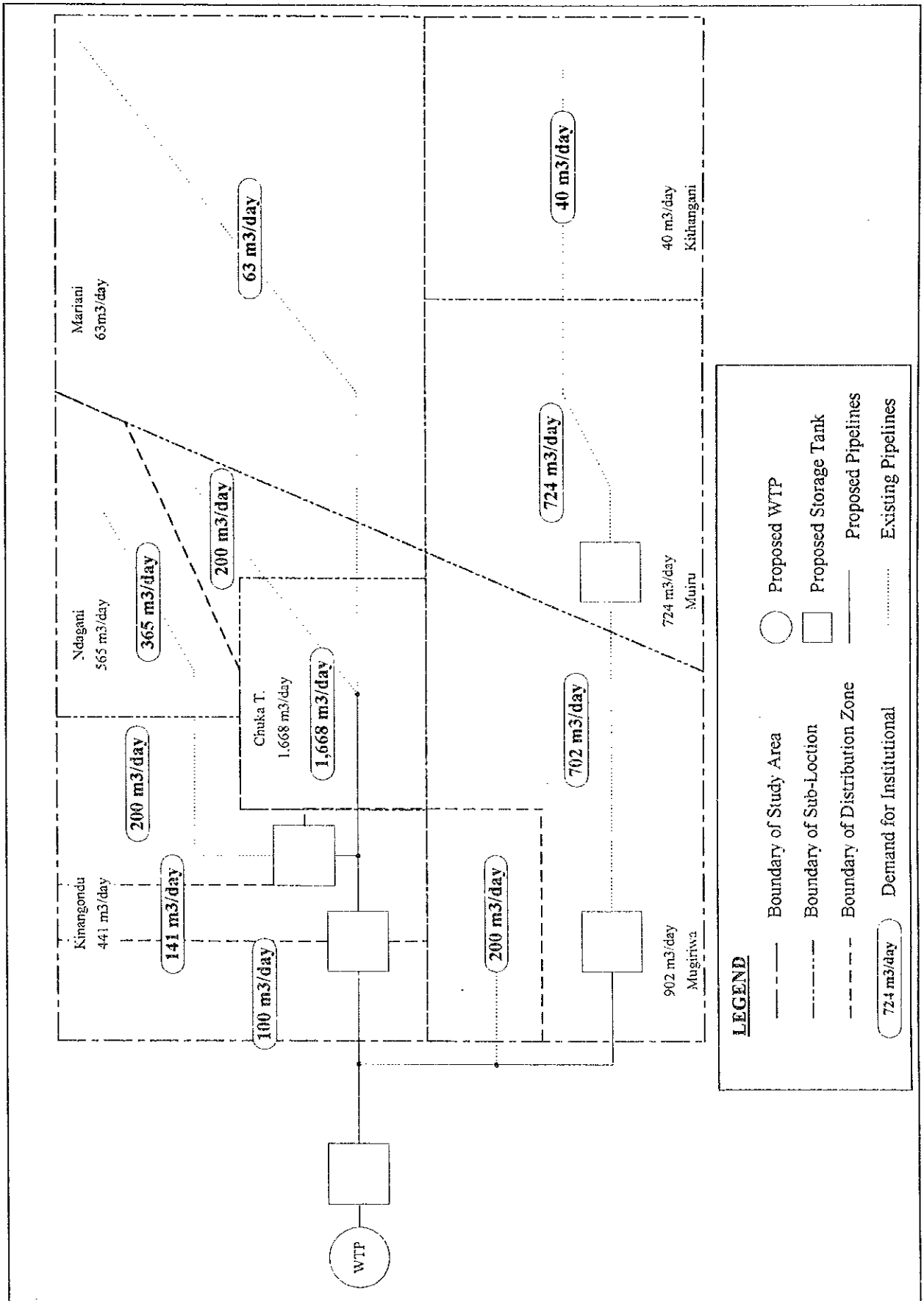
THE STUDY ON THE WATER SUPPLY FOR SEVEN TOWNS IN EASTERN PROVINCE IN THE REPUBLIC OF KENYA JAPAN INTERNATIONAL COOPERATION AGENCY	Figure P-12 Results of Hydraulic Calculation in Isiolo



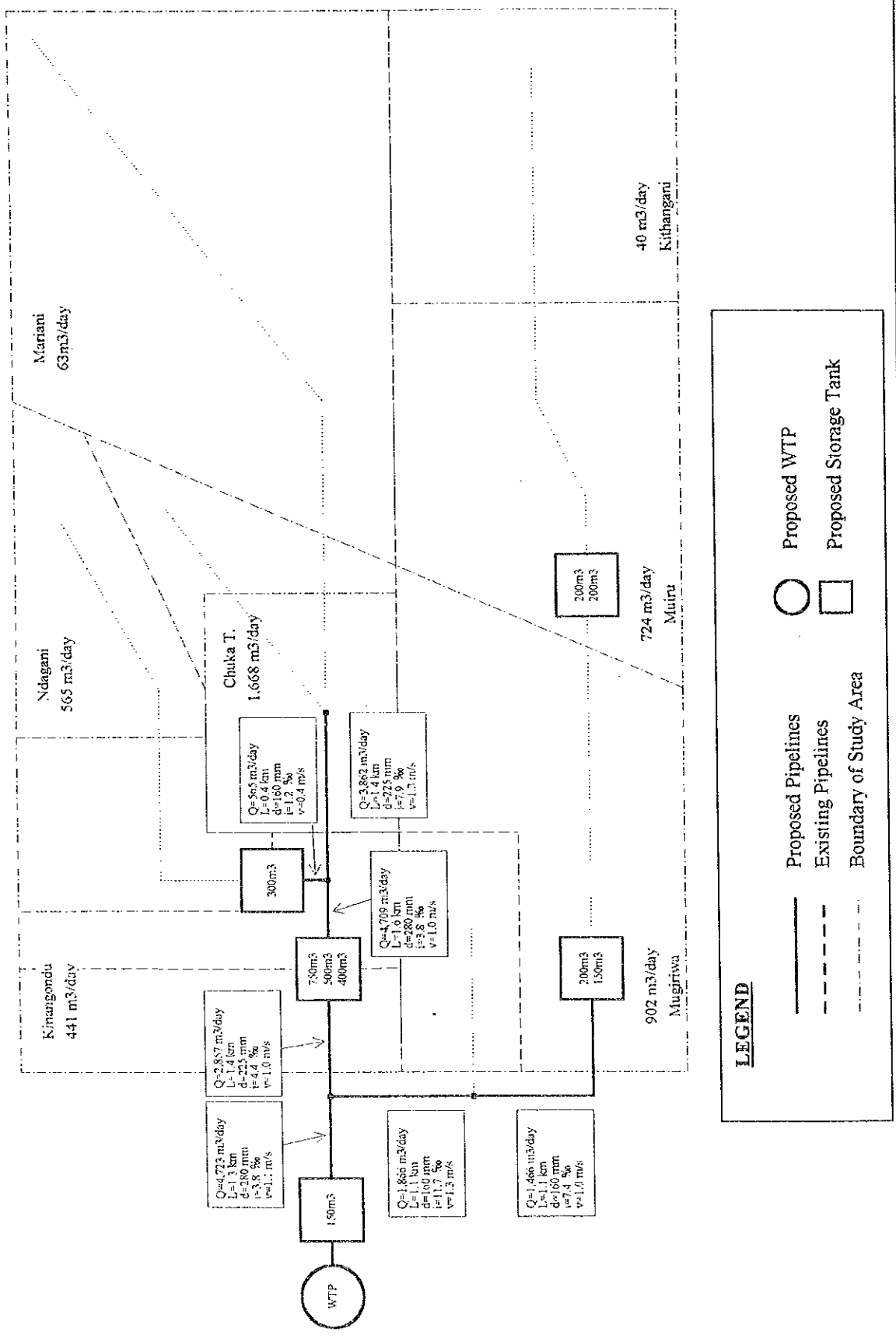
THE STUDY ON THE WATER SUPPLY FOR SEVEN TOWNS IN EASTERN PROVINCE IN THE REPUBLIC OF KENYA	Figure P-13
JAPAN INTERNATIONAL COOPERATION AGENCY	Schematic Flow Layout in Isiolo



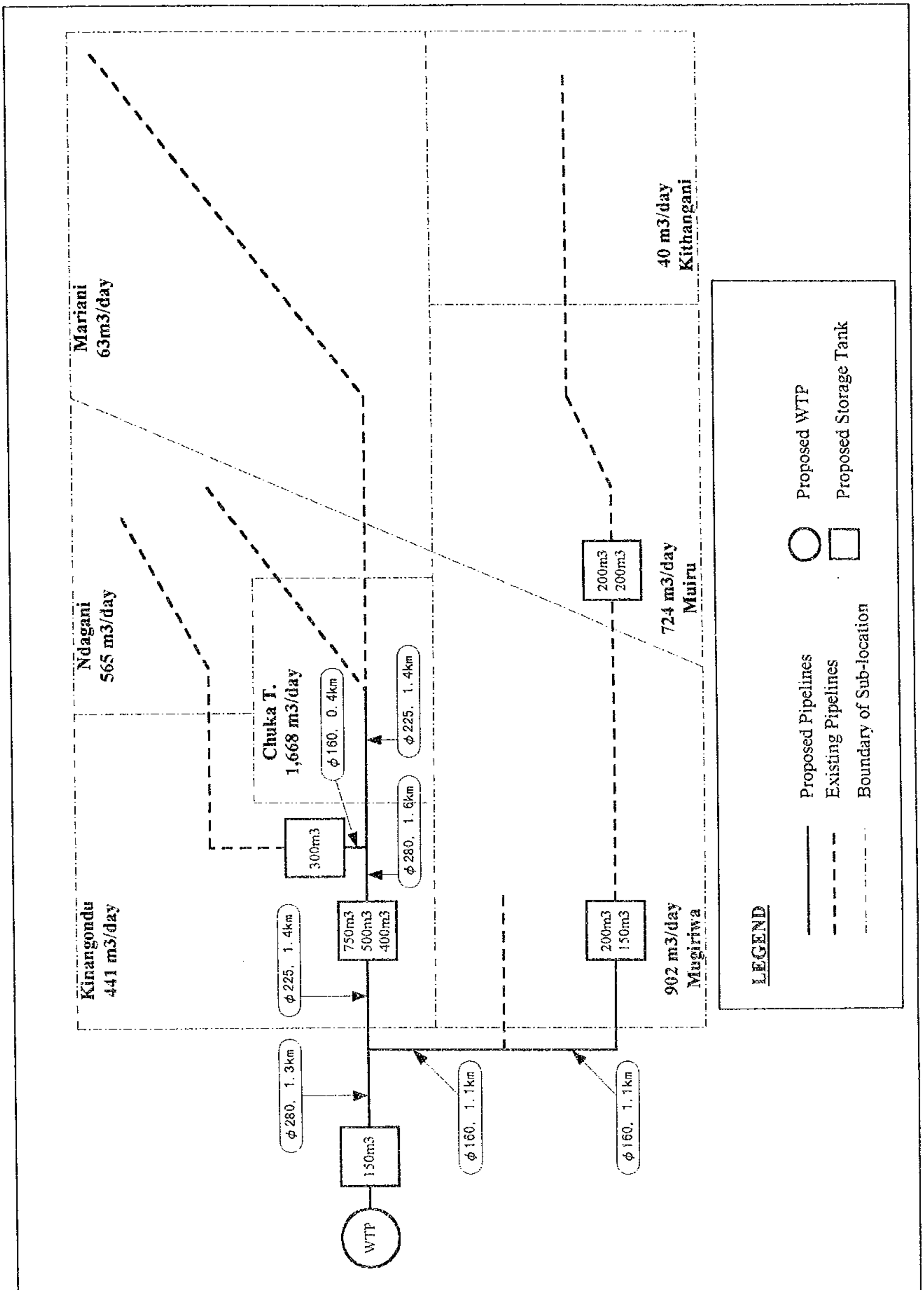
THE STUDY ON THE WATER SUPPLY FOR SEVEN TOWNS IN EASTERN PROVINCE IN THE REPUBLIC OF KENYA	Figure P-14
JAPAN INTERNATIONAL COOPERATION AGENCY	General Layout in Chuka



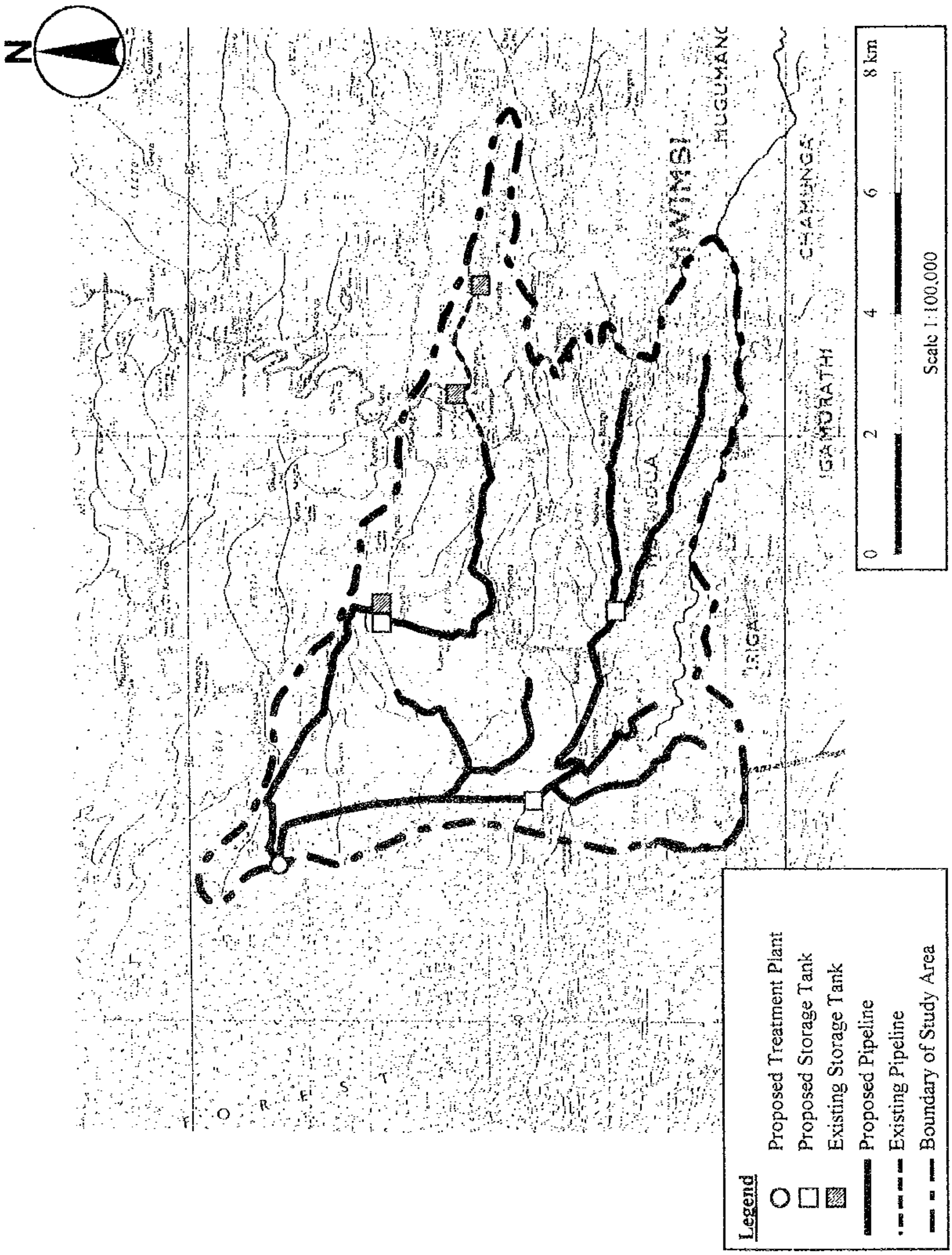
THE STUDY ON THE WATER SUPPLY FOR SEVEN TOWNS IN EASTERN PROVINCE IN THE REPUBLIC OF KENYA JAPAN INTERNATIONAL COOPERATION AGENCY	Figure P-15 Water Demand by Distribution Zones in Chuka



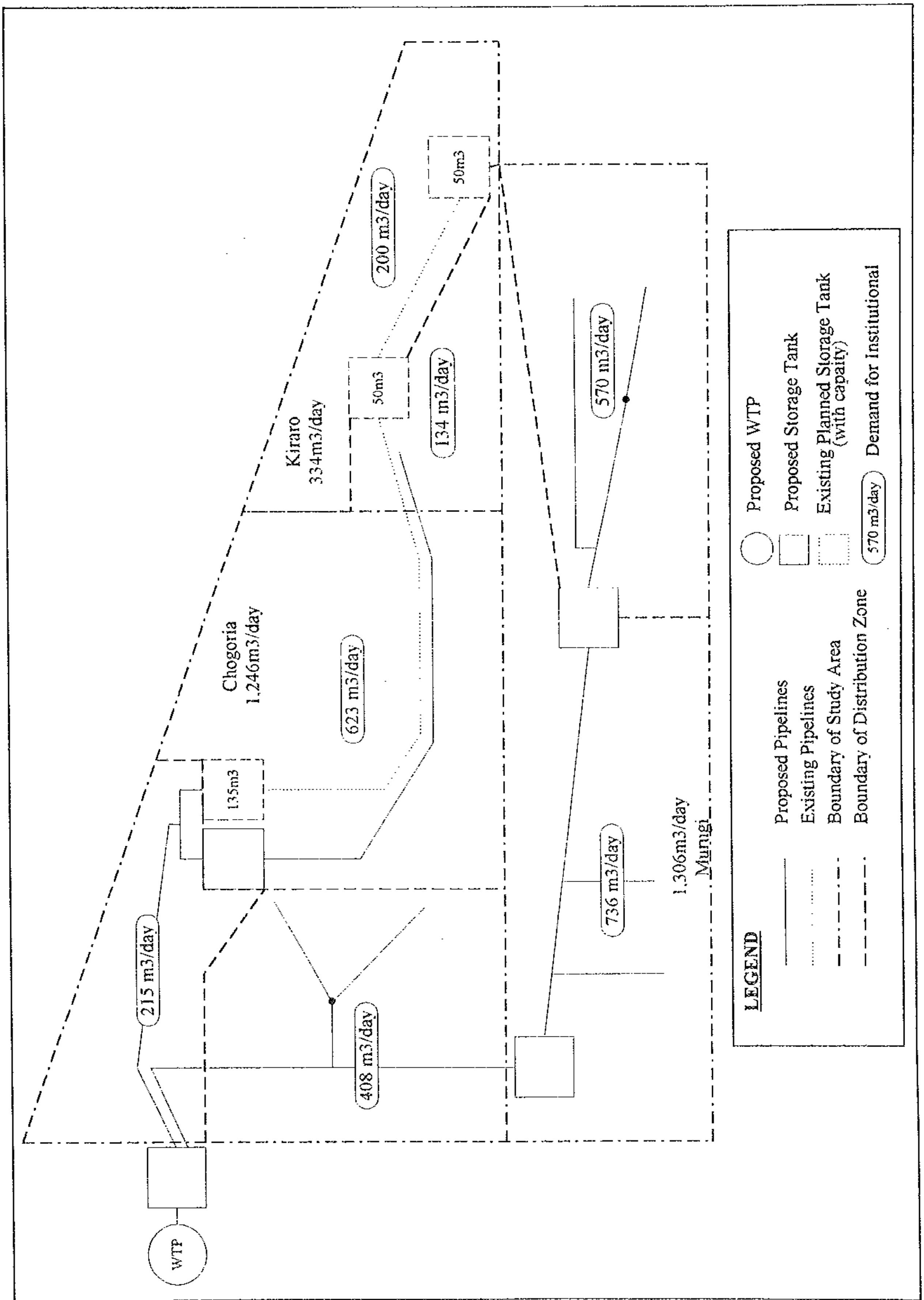
THE STUDY ON THE WATER SUPPLY FOR SEVEN TOWNS IN EASTERN PROVINCE IN THE REPUBLIC OF KENYA	Figure P-16
JAPAN INTERNATIONAL COOPERATION AGENCY	Results of Hydraulic Calculation in Chuka



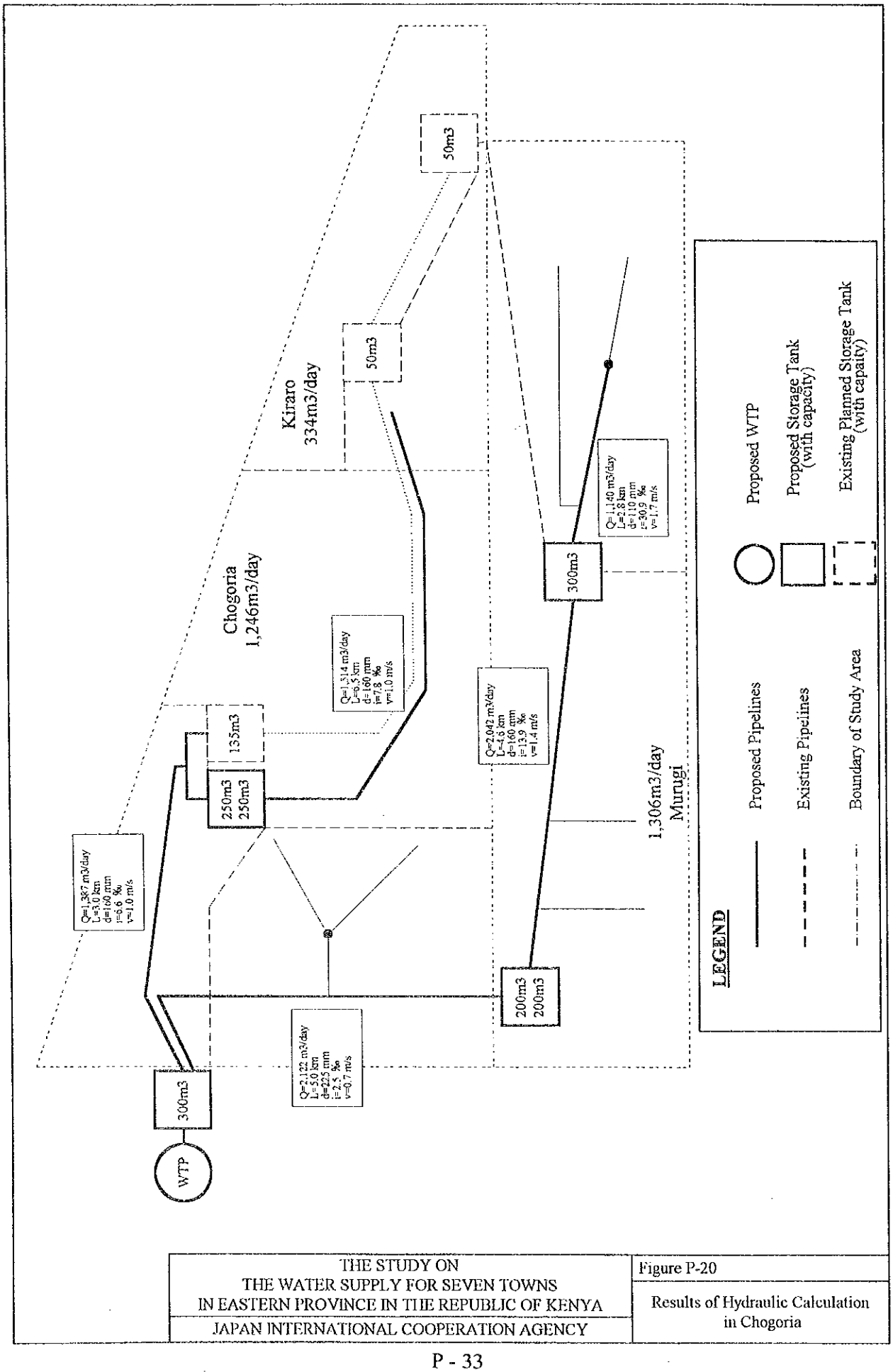
THE STUDY ON THE WATER SUPPLY FOR SEVEN TOWNS IN EASTERN PROVINCE IN THE REPUBLIC OF KENYA	Figure P-17
JAPAN INTERNATIONAL COOPERATION AGENCY	Schematic Flow Layout in Chuka



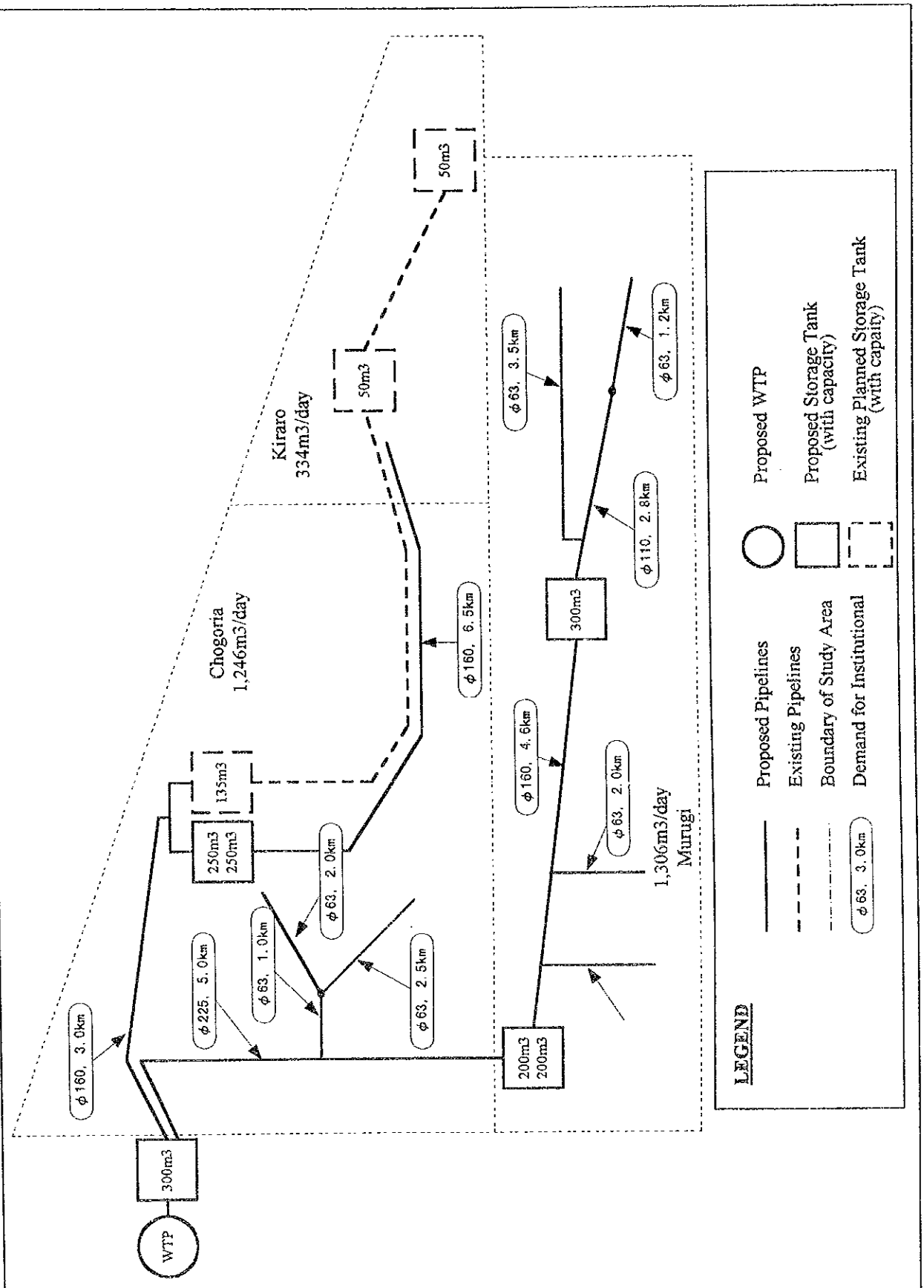
THE STUDY ON THE WATER SUPPLY FOR SEVEN TOWNS IN EASTERN PROVINCE IN THE REPUBLIC OF KENYA	Figure P-18
JAPAN INTERNATIONAL COOPERATION AGENCY	General Layout in Chogoria



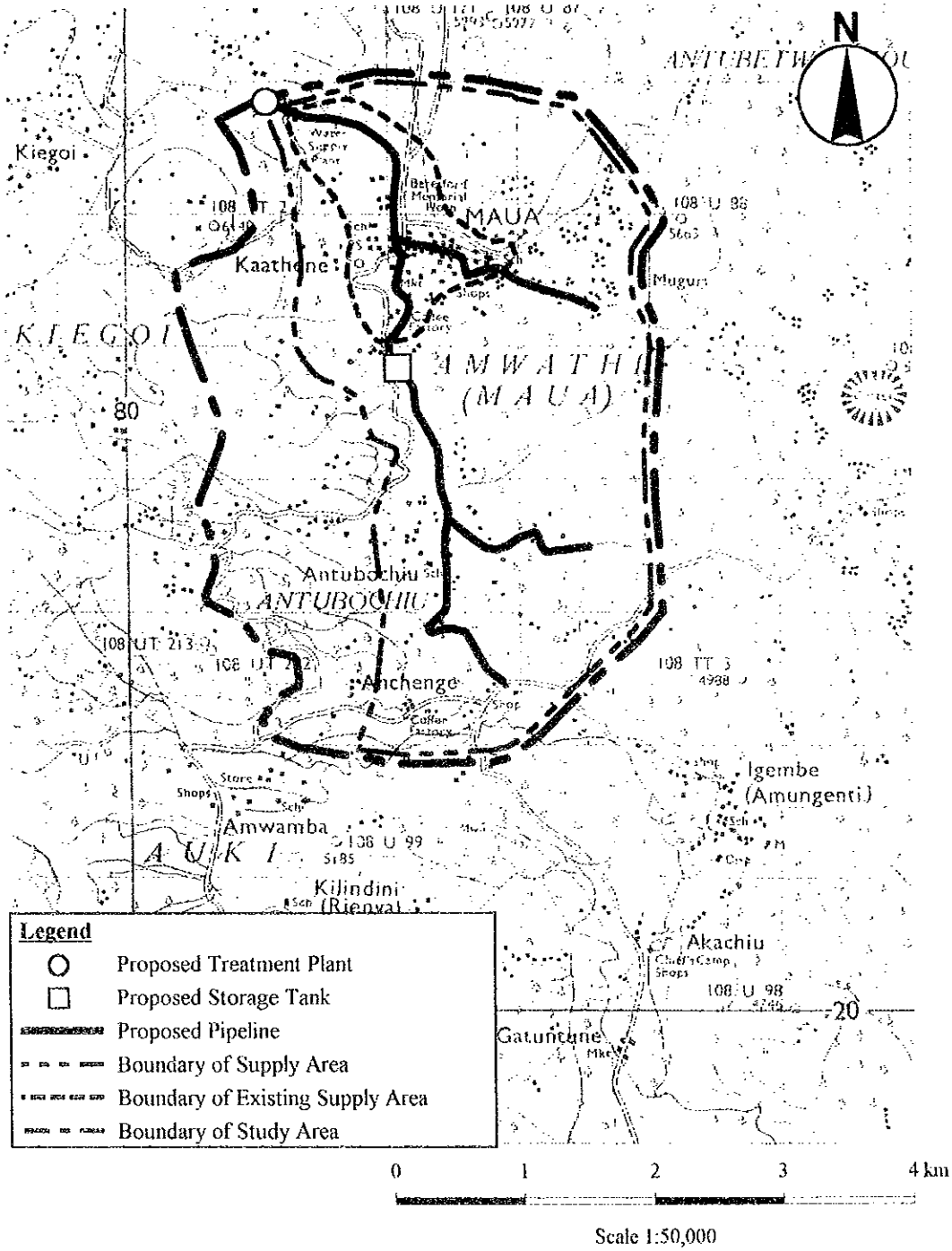
THE STUDY ON THE WATER SUPPLY FOR SEVEN TOWNS IN EASTERN PROVINCE IN THE REPUBLIC OF KENYA	Figure P-19
JAPAN INTERNATIONAL COOPERATION AGENCY	Water Demand by Distribution Zones in Chogoria



THE STUDY ON THE WATER SUPPLY FOR SEVEN TOWNS IN EASTERN PROVINCE IN THE REPUBLIC OF KENYA JAPAN INTERNATIONAL COOPERATION AGENCY	Figure P-20 Results of Hydraulic Calculation in Chogoria

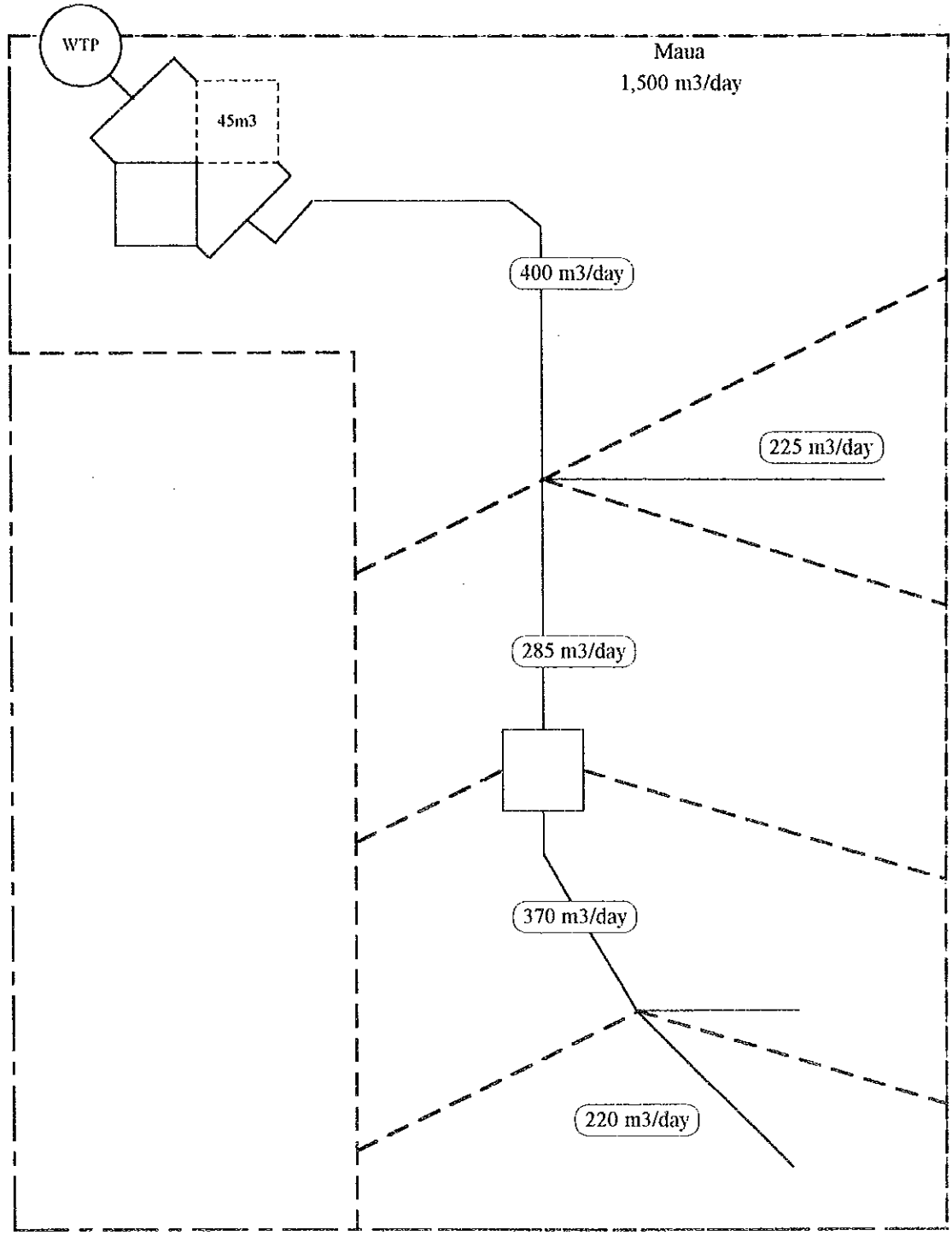


THE STUDY ON THE WATER SUPPLY FOR SEVEN TOWNS IN EASTERN PROVINCE IN THE REPUBLIC OF KENYA	Figure P-21
JAPAN INTERNATIONAL COOPERATION AGENCY	Schematic Flow Layout in Chogoria



Scale 1:50,000

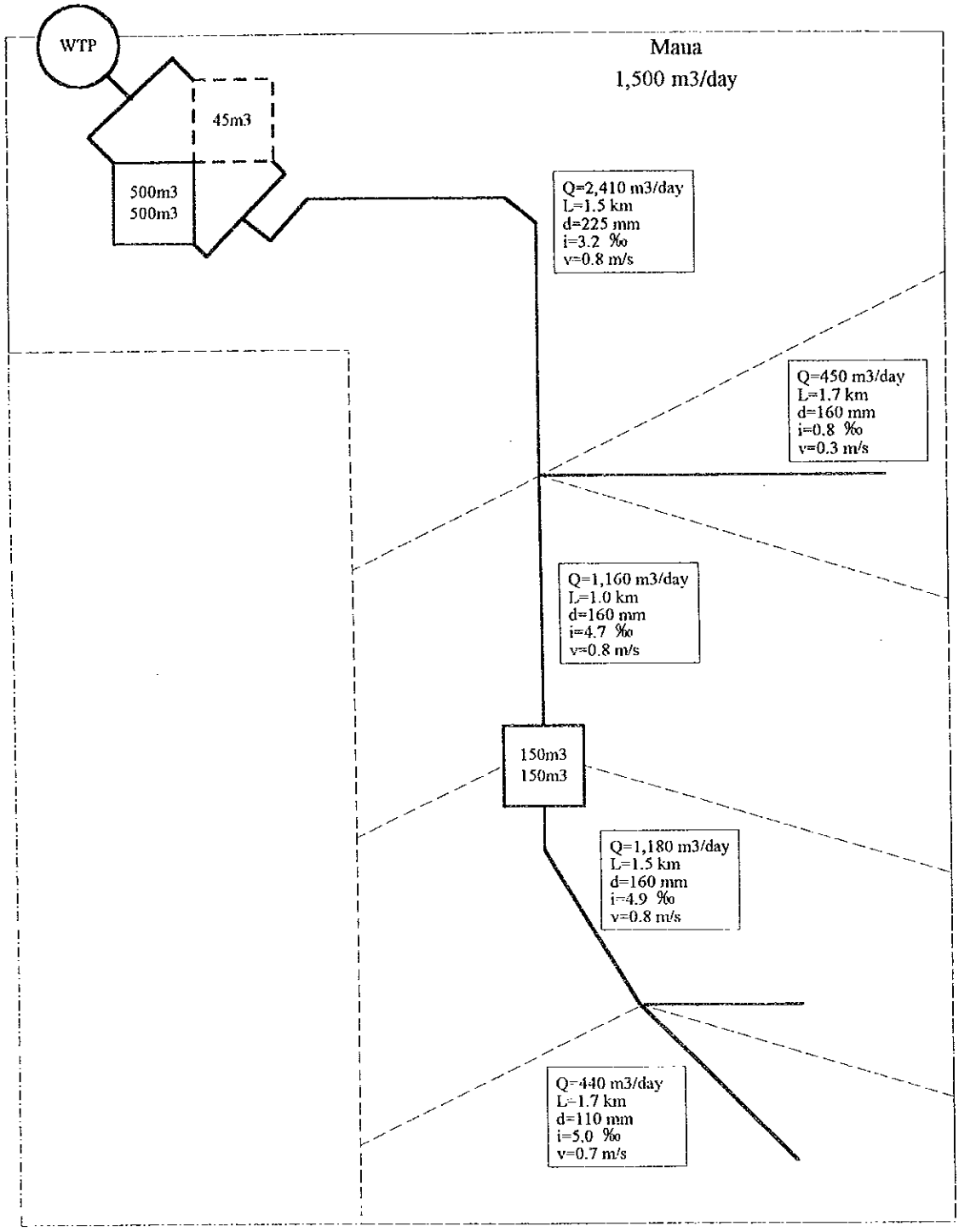
THE STUDY ON THE WATER SUPPLY FOR SEVEN TOWNS IN EASTERN PROVINCE IN THE REPUBLIC OF KENYA JAPAN INTERNATIONAL COOPERATION AGENCY	Figure P-22 General Layout in Maua



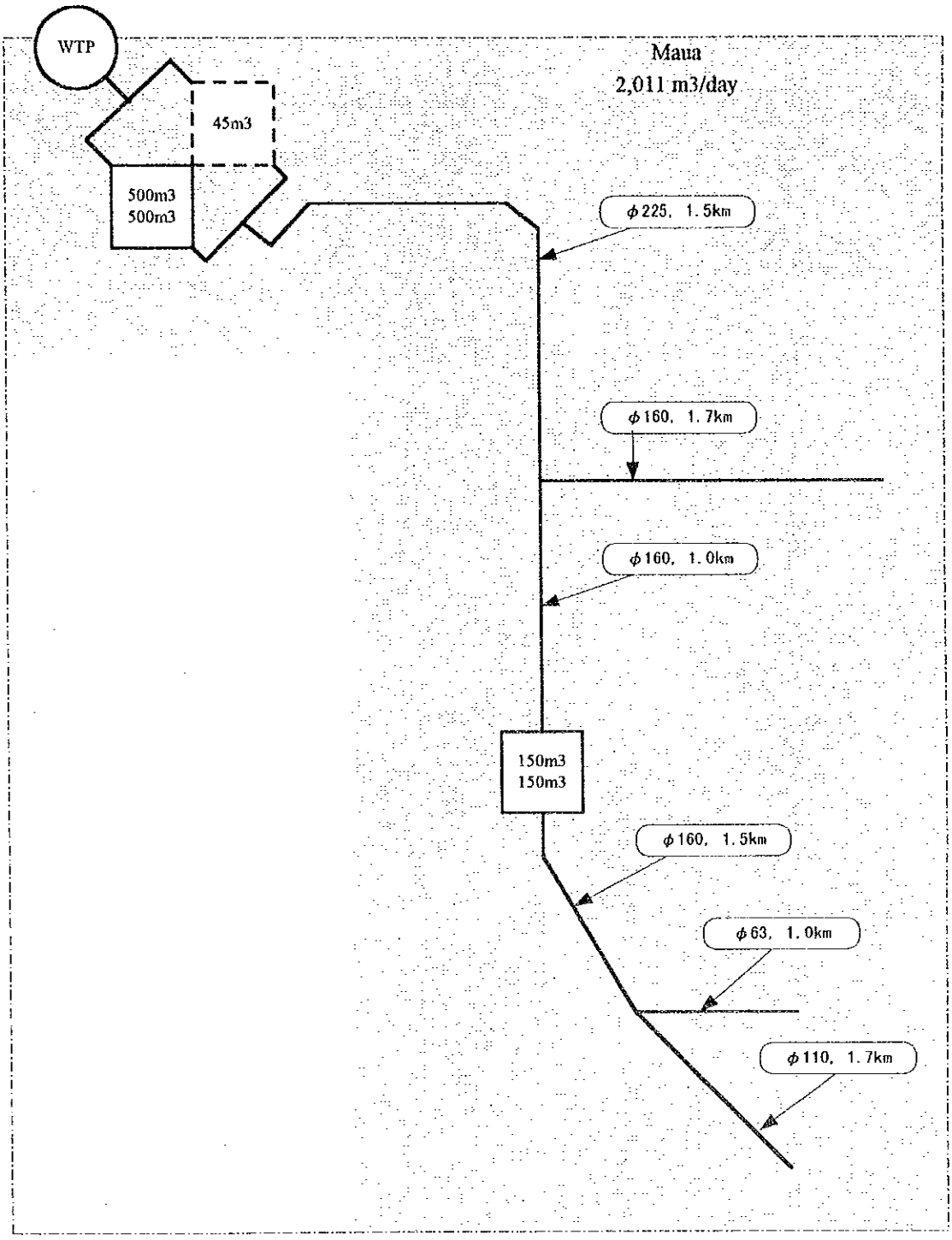
LEGEND

- Proposed Pipelines
- Boundary of Study Area
- Boundary of Distribution Zone
- φ63, 3.0km — Demand for Institutional
- Proposed WTP
- Proposed Storage Tank (with capacity)
- Existing Planned Storage Tank (with capaity)

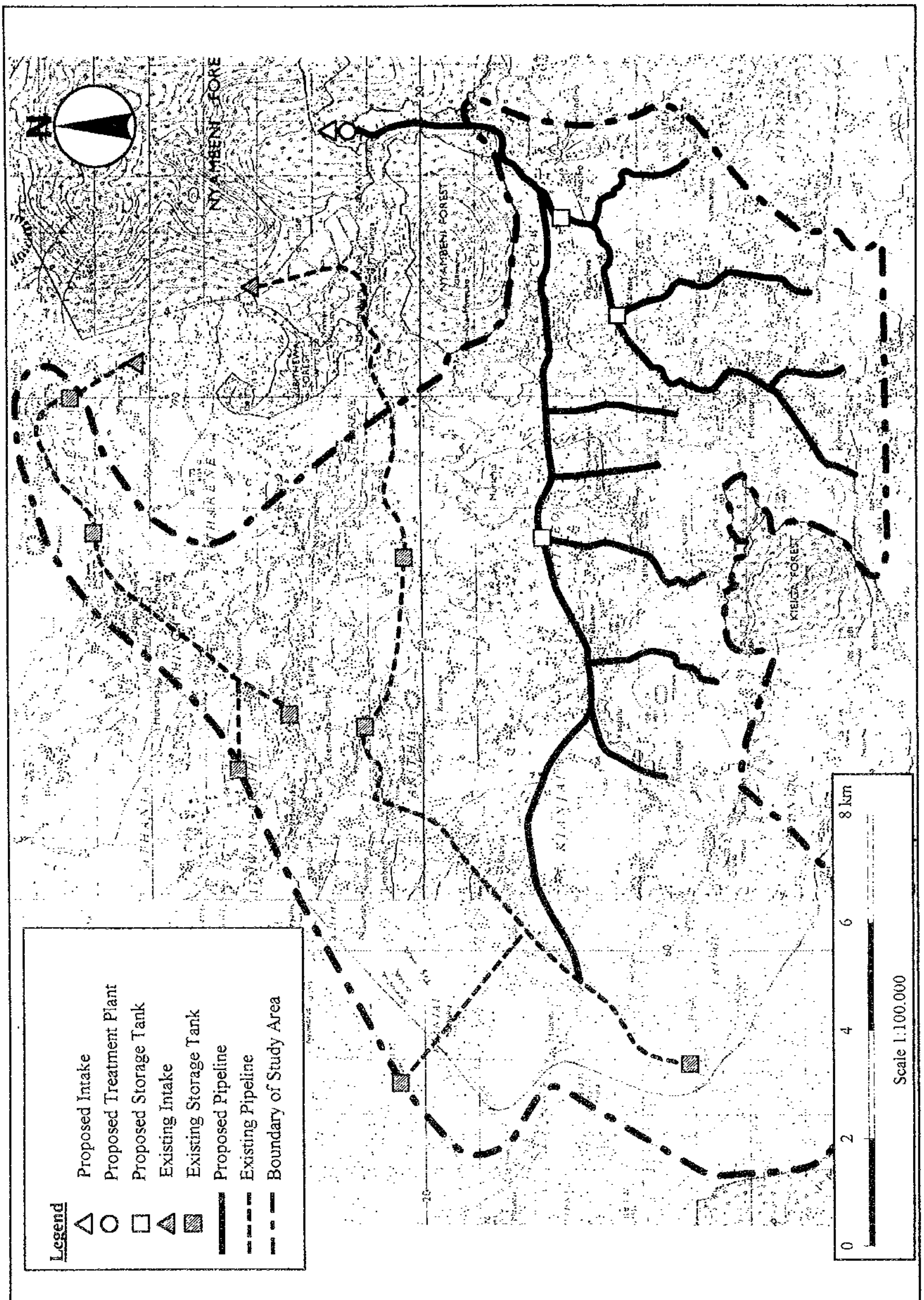
THE STUDY ON THE WATER SUPPLY FOR SEVEN TOWNS IN EASTERN PROVINCE IN THE REPUBLIC OF KENYA	Figure P-23
JAPAN INTERNATIONAL COOPERATION AGENCY	Water Demand by Distribution Zones in Maua



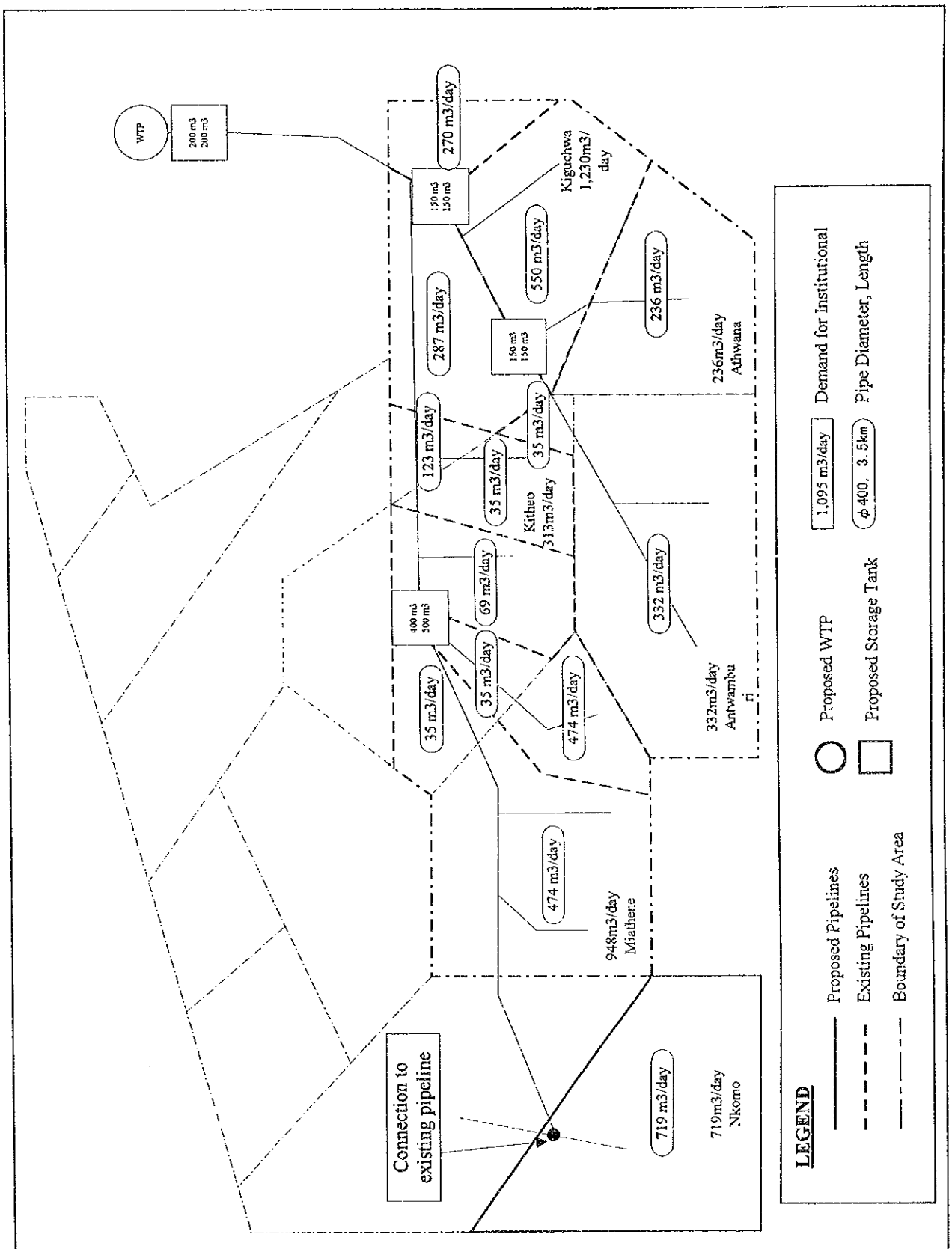
THE STUDY ON THE WATER SUPPLY FOR SEVEN TOWNS IN EASTERN PROVINCE IN THE REPUBLIC OF KENYA JAPAN INTERNATIONAL COOPERATION AGENCY	Figure P-24 Results of Hydraulic Calculation in Maua



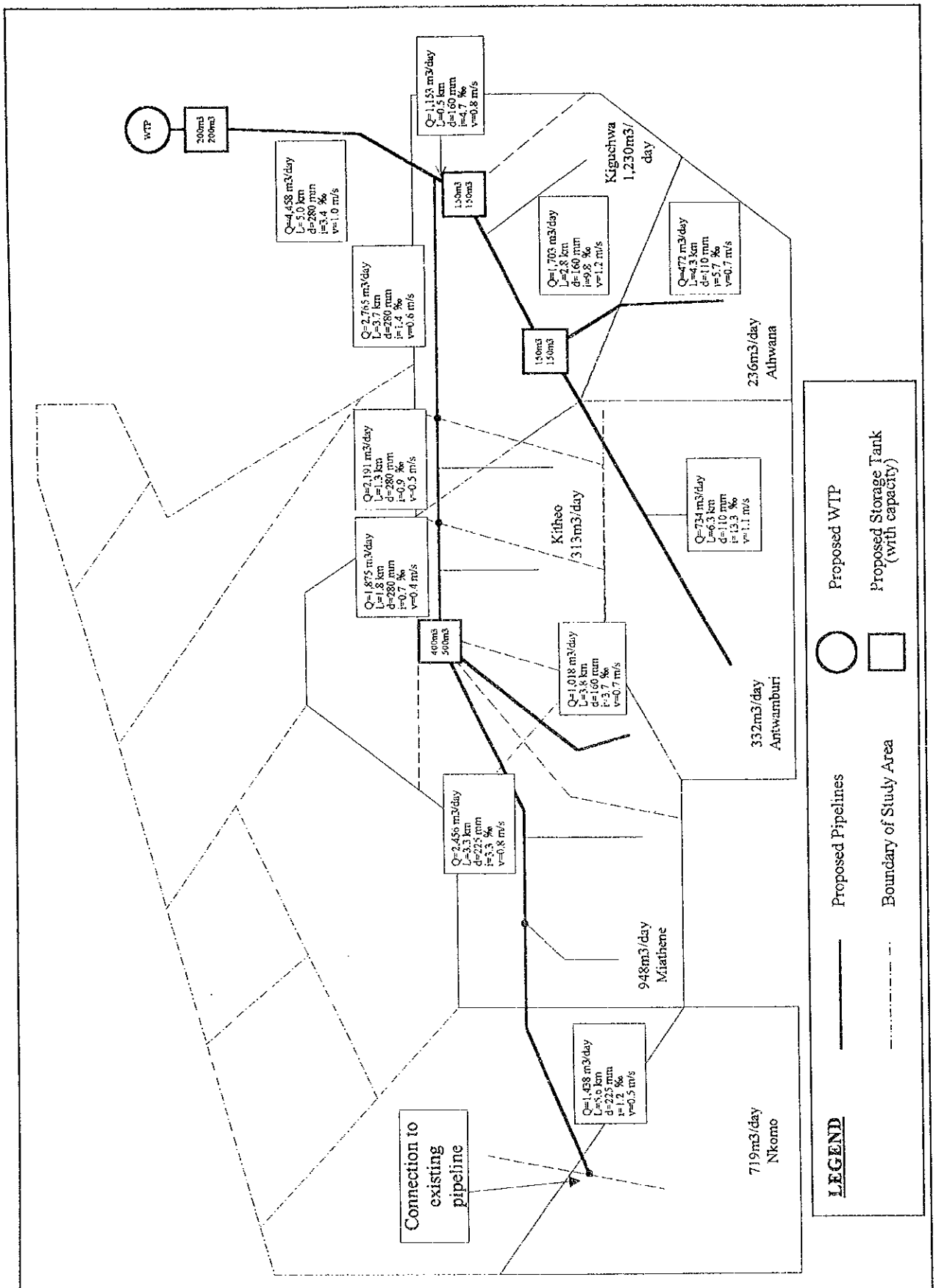
THE STUDY ON THE WATER SUPPLY FOR SEVEN TOWNS IN EASTERN PROVINCE IN THE REPUBLIC OF KENYA JAPAN INTERNATIONAL COOPERATION AGENCY	Figure P-25 Schematic Flow Layout in Maua



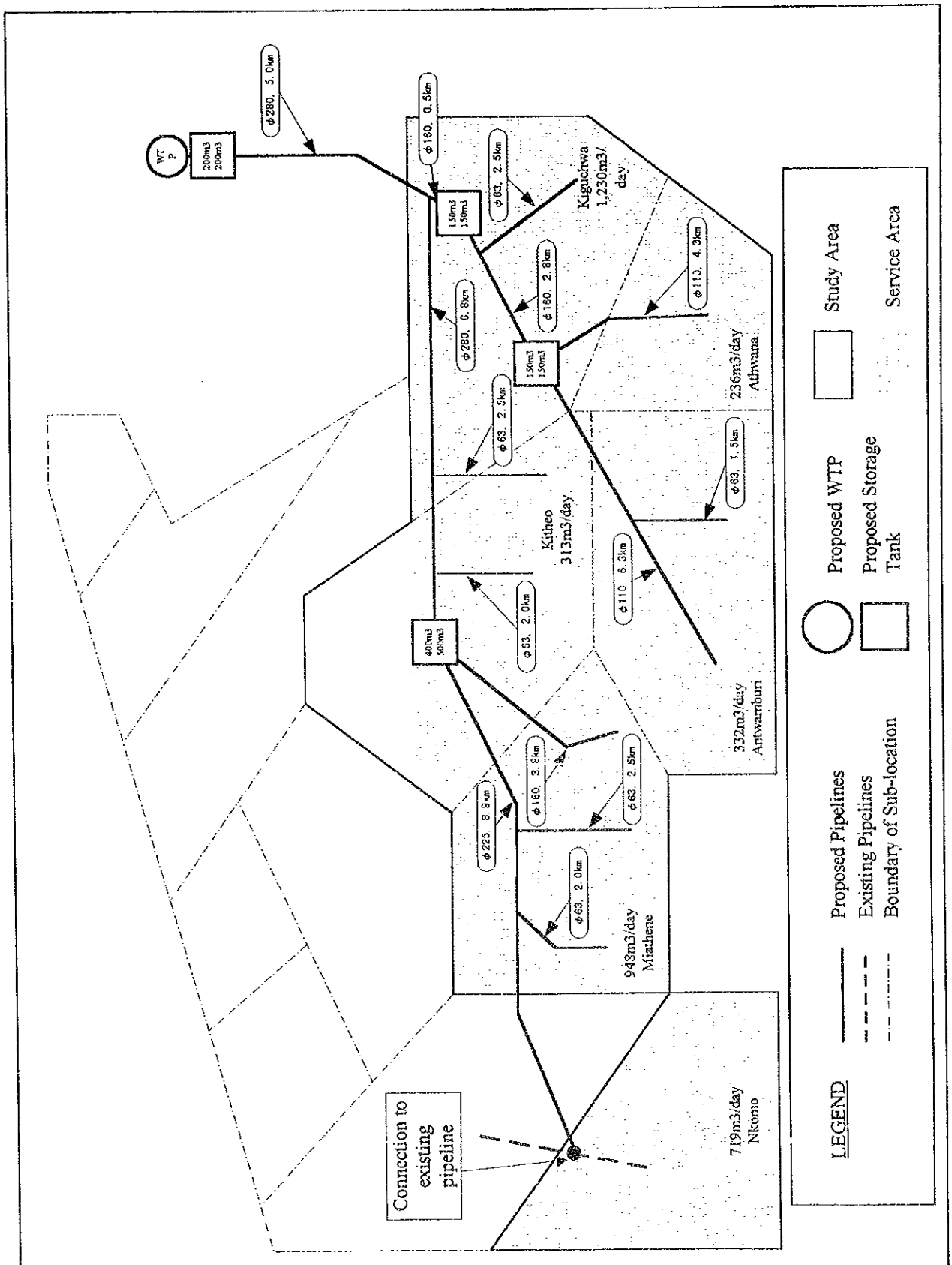
THE STUDY ON THE WATER SUPPLY FOR SEVEN TOWNS IN EASTERN PROVINCE IN THE REPUBLIC OF KENYA	Figure P-26
JAPAN INTERNATIONAL COOPERATION AGENCY	General Layout in Tigania



THE STUDY ON THE WATER SUPPLY FOR SEVEN TOWNS IN EASTERN PROVINCE IN THE REPUBLIC OF KENYA JAPAN INTERNATIONAL COOPERATION AGENCY	Figure P-27 Water Demand by Distribution Zones in Tigania



THE STUDY ON THE WATER SUPPLY FOR SEVEN TOWNS IN EASTERN PROVINCE IN THE REPUBLIC OF KENYA	Figure P-28
JAPAN INTERNATIONAL COOPERATION AGENCY	Results of Hydraulic Calculation in Tigania



THE STUDY ON THE WATER SUPPLY FOR SEVEN TOWNS IN EASTERN PROVINCE IN THE REPUBLIC OF KENYA JAPAN INTERNATIONAL COOPERATION AGENCY	Figure P-29 Schematic Flow Layout in Tigania

ATTACHMENT

Attachment

Hydraulic Calculation Sheet for each Pipeline by Colebrook White Formula (K=0.1 mm)

(Maximum wall thickness of KS 06-149 Standard for each diameter is applied.)

(1) Meru

Nominal Diameter	Flow m3/d	Length m	Diameter m	Flow l/sec	Flow m3/h	Losses m/km	Velocity m/s
90 mm	226	1000	0.0816	2.62	9.42	3.952	0.50
	306	1000	0.0816	3.54	12.75	6.968	0.68
	394	1000	0.0816	4.56	16.42	11.231	0.87
	400	1000	0.0816	4.63	16.67	11.558	0.89
	426	1000	0.0816	4.93	17.75	13.026	0.94
	454	1000	0.0816	5.25	18.92	14.704	1.00
	490	1000	0.0816	5.67	20.42	17.007	1.08
110 mm	588	1000	0.0998	6.81	24.50	8.694	0.87
	636	1000	0.0998	7.36	26.50	10.092	0.94
	712	1000	0.0998	8.24	29.67	12.513	1.05
	772	1000	0.0998	8.94	32.17	14.604	1.14
	802	1000	0.0998	9.28	33.42	15.710	1.19
	878	1000	0.0998	10.16	36.58	18.688	1.30
	924	1000	0.0998	10.69	38.50	20.614	1.37
	990	1000	0.0998	11.46	41.25	23.541	1.46
	1,151	1000	0.0998	13.32	47.96	31.485	1.70
160 mm	513	1000	0.1456	5.94	21.38	1.024	0.36
	1,020	1000	0.1456	11.81	42.50	3.693	0.71
	1,026	1000	0.1456	11.88	42.75	3.734	0.71
	1,068	1000	0.1456	12.36	44.50	4.028	0.74
	1,190	1000	0.1456	13.77	49.58	4.943	0.83
	1,210	1000	0.1456	14.00	50.42	5.102	0.84
	1,350	1000	0.1456	15.63	56.25	6.282	0.94
	1,524	1000	0.1456	17.64	63.50	7.916	1.06
	1,526	1000	0.1456	17.66	63.58	7.935	1.06
	1,710	1000	0.1456	19.79	71.25	9.867	1.19
	1,929	1000	0.1456	22.33	80.38	12.434	1.34
	1,958	1000	0.1456	22.66	81.58	12.796	1.36
	2,048	1000	0.1456	23.70	85.33	13.952	1.42
	2.526	1000	0.1456	29.24	105.25	20.919	1.76
225 mm	2,258	1000	0.207	26.13	94.08	2.843	0.78
	2,302	1000	0.207	26.64	95.92	2.949	0.79
	2,541	1000	0.207	29.41	105.88	3.557	0.87
	2,936	1000	0.207	33.98	122.33	4.684	1.01
	2,938	1000	0.207	34.00	122.42	4.690	1.01
	3.110	1000	0.207	36.00	129.58	5.228	1.07
	3,126	1000	0.207	36.18	130.25	5.280	1.08
	3,663	1000	0.207	42.40	152.63	7.154	1.26
	4,377	1000	0.207	50.66	182.38	10.079	1.51
280 mm	5,368	1000	0.2578	62.13	223.67	4.905	1.19
	5,822	1000	0.2578	67.38	242.58	5.733	1.29
	5,874	1000	0.2578	67.99	244.75	5.832	1.30
	6,335	1000	0.2578	73.32	263.96	6.745	1.40
315 mm	7,812	1000	0.2898	90.42	325.50	5.579	1.37
	8,293	1000	0.2898	95.98	345.54	6.260	1.46
	9,022	1000	0.2898	104.42	375.92	7.366	1.58
350 mm SP	13,888	1000	0.344	160.74	578.67	11.601	1.73
(K=1 mm)	15,039	1000	0.344	174.06	626.63	13.594	1.87
400 mm SP	14,167	1000	0.394	163.97	590.29	5.914	1.34
(K=1 mm)	15,039	1000	0.394	174.06	626.63	6.660	1.43

(2) Nkubu

Nominal Diameter	Flow m3/d	Length m	Diameter m	Flow l/sec	Flow m3/h	Losses m/km	Velocity m/s
90 mm	500	1000	0.0816	5.79	20.83	17.676	1.11
160 mm	1,500	1000	0.1456	17.36	62.50	7.679	1.04
160 mm	3,330	1000	0.1456	38.54	138.75	35.773	2.31
225 mm	3,330	1000	0.207	38.54	138.75	5.959	1.15

(3) Ishiolo

Nominal Diameter	Flow m3/d	Length m	Diameter m	Flow l/sec	Flow m3/h	Losses m/km	Velocity m/s
110 mm	460	1000	0.0998	5.32	19.17	5.467	0.68
160 mm	560	1000	0.1456	6.48	23.33	1.204	0.39
160 mm	720	1000	0.1456	8.33	30.00	1.921	0.50
160 mm	772	1000	0.1456	8.94	32.17	2.188	0.54
225 mm	1,160	1000	0.207	13.43	48.33	0.815	0.40
225 mm	1,180	1000	0.207	13.66	49.17	0.841	0.41
225 mm	1,864	1000	0.207	21.57	77.67	1.979	0.64
280 mm	4,560	1000	0.2578	52.78	190.00	3.590	1.01
280 mm	5,280	1000	0.2578	61.11	220.00	4.752	1.17

(4) Chuka

Nominal Diameter	Flow m3/d	Length m	Diameter m	Flow l/sec	Flow m3/h	Losses m/km	Velocity m/s
160 mm	565	1000	0.1456	6.54	23.54	1.224	0.39
160 mm	1,466	1000	0.1456	16.97	61.08	7.350	1.02
160 mm	1,866	1000	0.1456	21.60	77.75	11.666	1.30
225 mm	2,857	1000	0.207	33.07	119.04	4.446	0.98
225 mm	3,862	1000	0.207	44.70	160.92	7.920	1.33
280 mm	4,709	1000	0.2578	54.50	196.21	3.817	1.04
280 mm	4,723	1000	0.2578	54.66	196.79	3.839	1.05

5) Chogoria

Nominal Diameter	Flow m3/d	Length m	Diameter m	Flow l/sec	Flow m3/h	Losses m/km	Velocity m/s
110 mm	1,140	1000	0.0998	13.19	47.50	30.906	1.69
160 mm	1,387	1000	0.1456	16.05	57.79	6.614	0.96
160 mm	1,514	1000	0.1456	17.52	63.08	7.817	1.05
160 mm	2,042	1000	0.1456	23.63	85.08	13.874	1.42
225 mm	2,122	1000	0.207	24.56	88.42	2.527	0.73

(6) Maua

Nominal Diameter	Flow m3/d	Length m	Diameter m	Flow l/sec	Flow m3/h	Losses m/km	Velocity m/s
110 mm	440	1000	0.0998	5.09	18.33	5.028	0.65
160 mm	450	1000	0.1456	5.21	18.75	0.804	0.31
160 mm	1,160	1000	0.1456	13.43	48.33	4.710	0.81
160 mm	1,180	1000	0.1456	13.66	49.17	4.865	0.82
225 mm	2,410	1000	0.207	27.89	100.42	3.216	0.83

(7) Tigania

Nominal Diameter	Flow m3/d	Length m	Diameter m	Flow l/sec	Flow m3/h	Losses m/km	Velocity m/s
110 mm	472	1000	0.0998	5.46	19.67	5.738	0.70
110 mm	734	1000	0.0998	8.50	30.58	13.261	1.09
160 mm	1,018	1000	0.1456	11.78	42.42	3.679	0.71
160 mm	1,153	1000	0.1456	13.34	48.04	4.656	0.80
160 mm	1,703	1000	0.1456	19.71	70.96	9.789	1.18
225 mm	1,438	1000	0.207	16.64	59.92	1.216	0.49
225 mm	2,456	1000	0.207	28.43	102.33	3.334	0.84
280 mm	1,875	1000	0.2578	21.70	78.13	0.672	0.42
280 mm	2,191	1000	0.2578	25.36	91.29	0.898	0.49
280 mm	2,765	1000	0.2578	32.00	115.21	1.390	0.61
280 mm	4,458	1000	0.2578	51.60	185.75	3.438	0.99

APPENDIX Q

ENVIRONMENTAL IMPACT ASSESSMENT

APPENDIX Q ENVIRONMENTAL IMPACT ASSESSMENT

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1. OBJECTIVE AND SCOPE OF EIA

Kenyan EIA guidelines stipulate that the objective of an EIA is to manage the safety of the environment during the project's implementation, commissioning, operation, and decommissioning. This approach was therefore adopted for the EIA of this project.

Environmental impacts of the project were studied during the Master Plan (M/P) stage of the study through an Initial Environmental Examination (IEE) study. The results of this study, given in the Interim Report indicated that there are several items requiring a more detailed EIA study during this Feasibility Study (F/S) stage. Project components of the F/S and M/P are similar, but the supply area by the F/S study is approximately half of the master plan area. This EIA supporting report covers all 7 towns projects.

Environmental impact will occur in the different phases of the project which can mainly be classified as construction and operation. The IEE results suggested impacts on both the construction stage and operation stage, the following EIA therefore considers both stages.

(1) Construction Stage

Construction activities will mainly affect the human environment through resettlement, deterioration of roads, interruption of local transport, etc.

Working and material stock areas are necessary for construction. This can lead to interruption of local transportation, and degradation of the regional economy may occur close to the town area. Land acquisition is potentially an issue, particularly if it causes resettlement of residents. In this case the project needs to provide for adequate compensation or alternative land for those affected. Other impacts are relatively insignificant, and no serious environmental problems are anticipated. It is therefore the estimation of the impact of land requirements that will be the main focus of the EIA for the construction stage.

Items affecting the natural environment are limited. However, Mt. Kenya Forest is a significant environmental conservation area in which the intake and raw water pipeline are located. It will therefore be necessary to estimate the impacts on plants, animals, and soils in this area.

(2) Operation Stage

Wastewater disposal is one of the major problems arising from the water supply project. It includes water pollution and the degradation of sanitary conditions for residents. Meru Town's sewerage system covers only 30% of the town and appropriate solutions will be required for the remainder of the project area.

According to the IEE results, several projects do not satisfy the hydrological conditions. Existing water rights on downstream have already exceeded measured flow rate in Sep. 1996, hence, water shortage will appear especially in drought season.

2. ENVIRONMENT IMPACT ASSESSMENT

2.1 Land Acquisition

(1) Land Acquisition for the Existing Project

Land acquisition for the existing project was carried out for pipeline routes and the treatment plant and reservoir sites. In the case of pipeline routes, land acquisition is in the form of wayleaves, where land is occupied during the construction period only, but with the Ministry retaining a right of access to the pipeline after construction. Even if the route passes through private land, landowners can therefore manage their land again after completion of the work. On the other hand, land required for permanent structures such as treatment plants, storage tanks, and so on, needs to be procured from the owners.

As a result of hearing survey at each DWO, there has been no land acquisition problem arisen concerning the pipeline routes. The reason is that consumers prioritize the water supplying higher than the land deduction by construction. Further, this pipeline routes land acquisitions are limited during the construction period only, they do not get serious damage from the project. Though all DWO do not possess sufficient land acquisition data for the permanent structures, they insist any problems have not occurred on existing projects.

(2) Land Acquisition Method

Land acquisition methods depend on whether it is government or private land. For government land such as in gazetted forests, roads, etc., a letter of request for

the land is required. It is issued under the name of Permanent Secretary of MLRRWD and is addressed to the Commissioner of Lands to allocate, or degazette the land.

In the case of private land there are three methods as follows:

1) District Water Office makes agreement with the land owners, or community to donate the land for the project.

2) MLRRWD negotiates with the individual land owner for the land.

3) Land evaluation is carried out by the physical planner belonging to District Commissioner's office.

(3) Land Acquisition for this Project

The Meru project is similar to other water supply projects and wayleaves will therefore be required for pipeline routes and full land acquisition for permanent structures.

1) Pipeline Routes

Wayleaves will be required along all pipeline routes which will be mainly within existing road reserves. The land will be restored to the previous land owners after construction. Most local roads pass through agricultural areas where plots are often cultivated up to the road edge. A six meter wayleave width is required as shown in ***Figure Q-1*** for pipeline construction, it is therefore temporarily necessary to acquire a strip of land along the road edge. However, judging from past experience, few problems will arise.

2) Permanent Structures Spaces

Land acquisition for structures differs from pipeline routes, as it needs to be obtained permanently. The project needs to procure land for local administration offices, the treatment plant and storage tanks. Land ownership of the identified areas is uncertain at present, and confirmation of ownership is required before project implementation.

Table Q-1 Numbers of Structures in Each Project (2010)

Project	Treatment Plant	Storage Tank	Total
Meru	1	18	19
Nkubu	1	1	2
Isiolo	0	1	1
Chuka	1	4	5
Chogoria	1	3	4
Maua	1	1	2
Tigania	1	3	4

Source : Study team

2.2 Local Transportation

Typical road widths in the project area range from 2.0 m to 6.0m as shown in ***Figure Q-1***. Areas where local transportation may be particularly affected are shown in ***Figure Q-2 to Q-8***. Small tracks with around 2.0m road width, allow only one vehicle to pass at a time. However, the traffic volume on these small tracks is very light and, as they will not be used for the main transmission pipelines, there will be little impact except, locally by the timber industry. The overall impact is therefore negligible. Roads connecting local communities are generally around 6.0m wide, with enough room for vehicles to pass each other. These roads however have a larger traffic volume, some of which are utilized as local bus routes, giving an important service to the communities. Confirmation of traffic volumes and road widths of these rural roads is required. Some pipeline routes plan to cross the trunk road to Isiolo and other important roads in the urban area. Although vehicles can not travel at high speed inside the town area, the volume of traffic is high especially in daytime. Hence, it is necessary to carefully control construction work to prevent disruption of the transportation system especially within the urban areas.

2.3 The Natural Resources in Mt. Kenya Area

An environmental conservation survey for Mt. Kenya forest was carried out in the early 1980s. The forest conservation study however concentrated on the western side of the mountain and impacts on the eastern side, where this project is located, were not mentioned. Timber is a major industry within the area and deforestation has spread remarkably close to the intake site. Construction methods requiring deforestation should be strictly forbidden, and the raw water pipeline routed carefully to ensure minimum impact.

2.4 Wastewater Disposal

Wastewater volumes will increase in parallel with improved water supplies. If this wastewater is not effectively treated and disposed of, the sanitary environment for the residents will deteriorate with consequential impact on human health. There are several plans for protection against wastewater pollution, and current District plans concerning wastewater are listed below.

(1) Environmental Action Plan

An Environmental Action Plan was prepared in 1992 at district level. It described the present situation and prepared a strategy concerning a 5 year period. However, the Plan merely indicated a planning direction and did not consider the detail planning such as project scale, project cost, and funding sources.

The report concluded that certain diseases could be controlled through a primary health program and suggested that malaria control programs should be executed by the government.

1) Meru District

Existing sanitary conditions in Meru district are summarized in the following subjects.

- Very poor sanitary standards in the area
- Most of inhabitant using pit latrines
- Traditional taboos that adults are not expected to share latrines with their sons and daughters.
- Face with water related diseases due to poor sanitation in a great part of ASAL areas.

The report described that these diseases could control through the primary health program and suggested to execute malaria control programs by government.

2) Isiolo District

Poor drainage, sewerage system and lack of proper sanitation were picked up as the existing problem in the report. Hence, many types of diseases

like malaria, etc. were common in the living environment and following methods were requisite to promote environmental health.

- Improvement of community knowledge on environmental health issue

- VIP latrines construction with slab casting

Existing latrines were in poor conditions and they were easy to collapse in rainy season. It was therefore that EAP promoted to construct VIP latrines.

3) Tharaka-nithi District

Existing sanitary conditions in the Tharaka-nithi district were as follows;

- Poor urban sewerage and drainage system

- Poor personal hygiene education

- Poor water quality which leads to prevalence of water-borne diseases

To improve the environmental conditions described above, following projects were suggested in the EAP report.

- Malaria prevention program

- Establishment of sanitation and sewerage facilities

- VIP latrines construction promotion

(2) District Development Plan

District Development Plans are prepared every 5 years. They describe development strategy by sector and prepare a prioritized list of projects for implementation.

1) Meru

Most projects relating to environmental health improvement were concerned with the construction or renovation of hospitals or related facilities. There were, for example, no projects carried out for the improvement of sanitary conditions during 1989-1993. The District-wide water and sanitation

program was the only project (ranked 5th) which was included in the 1994-1996 Plan period. Although Local Government is also concerned with improvement in sanitation, no such projects were included under this heading. On site sanitation improvement is not therefore given a high priority and almost all projects concentrated on health center construction. It therefore appears that significant sanitation improvement will not be accomplishing in the immediate future.

2) Isiolo

The projects to be executed during 1989-1993 have objectives to promote primary health care. It means that people owe more aware or responsibility for their own health problem rather than hospital. Achievement of the projects to be concerned with sanitation program during 1989-1993 are;

Table Q-2 Achievement Projects 1989-1993

No.	Activities	Central	Sericho
1	Ventilated Improved Pit Latrines	384 nos	30 nos
2	Pit Latrine Lining	136 nos	-
3	Slab Castings	192 nos	-
4	Permanent Drain	900 m	-

Source : Isiolo District Development Plan 1994-1996

On the basis of the projects results, development strategy during 1994-1996 in Isiolo district is prepared as in below.

- Conducting Malaria control campaigns by the public health department
- Construction of fero cement tanks, water jars, and VIP latrines for demonstration

Projects list to be ranked in the district development plan is shown in ***Table Q-3***. There are 10 projects are proposed during 1994 - 1996 for the health condition improvement, and two health promotion projects are ranked in 6th and 10th priority. The sewerage connection project is listed in the programme of the local government and it is ranked 3rd priority. Further, the projects concerned with the water supply also treat the sanitation program and they propose 2nd priority in their list. Projects belong to the

health sector are ranked low priority and it is supposed that the project implementation possibility is rather than low to compare with the other sectors. The sewerage connection has not been done yet, however, the town council plans to implement the project, if budgetary matter solves. The construction of VIP latrines had already carried out during 1989-1993, and the proposed project is realizable.

3) Tharaka-nithi

There had been no projects and programme executed about the sanitation during 1989-1993. In the plan of 1994-1996, no project exists in the sector of health, but the water sector has the sewerage project in Chuka town ranked in 21st, and the local government sector also has the sanitation programmes which is ranked 2nd. The sewerage project prioritizes quite low ranking, so that it will not be able to be conducted. The sanitation study has the second priority among the projects, however, it has not been executed yet at present.

(3) Physical Sewage Planning

1) Meru

Physical planning for extending the existing Meru sewerage project took place in 1983 but this was not implemented and the existing facilities have continued to be used without augmentation. Proposed new sewered areas to be connected to the existing facilities were as follows;

1) Makutano
2) Kenyare Housing Estate
3) Mujini Area
4) Majengo Area
5) Shauri Yako Area

This sewerage improvement project was not mentioned in the 1994-1996 District Development Plan. Hence, project implementation is unlikely to be in the immediate future. The next District Development Plan is however under preparation.

2) Isiolo

Isiolo sewerage system was constructed in 1984 and no extension of reticulation system has been done since then. Proposed sewered areas to be connected with existing sewerage network are listed in below.

i Burapesa Area
ii Upper Kuramawa Area
iii Low Density Residential Area

Sewerage connection project is ranked in the district development plan list, but it has not been executed yet presently.

3) Other Towns

There are no sewerage reticulation planning exist in other towns. Chuka town has the oxidation pond plan and they have already identified the pond location. Though the sanitation facilities scheme is listed in the district development plan, implementation schedule has not decided due to budgetary problem.

(4) Estimation of Wastewater Volume

1) Meru

Existing wastewater flows were estimated by monitoring flows into the existing wastewater treatment plant. The results of which are shown below.

Table Q-4 Wastewater Flows

Meru Unit : m3/day

Date	9/5	9/12	12/5	12/19	1/2	1/16	1/29	2/15	2/26	2/27	2/28	Average
Volume	271	280	295	1,111	1,088	1,172	1,708	1,148	685	753	368	807

The present water supply volume is approximately 3,200 m3/day, therefore the wastewater flows are around 25 % of the quantity of water supplied. Wastewater volumes for 2005 was roughly estimated in the following table by applying this percentage to the projected future flows. The result indicates that the projected wastewater volume is approximately twice the

existing volume, which is already over loading the existing facilities. New facilities are required at a new location, outside the urban area, at an elevation that will enable all the town to be connected by gravity. Rural areas will also be affected by an increase in wastewater volumes. However, in these areas it is not economical, or feasible to construct water born sewerage systems. Improvement of on-site sanitation systems, linked to the promotion of hygiene education is required for improving the sanitary conditions in rural areas.

Table Q-5 Estimated Wastewater Volume of Meru Project (2005)

m3/day

Area	Water Supply in F/S	Wastewater Volume
U. Igoki	5,615	1,404
Mulanthankare	656	164
Nkabune	157	39
Ngonyi	211	53
L. Igoki	290	73
Thura	378	95
Munithu	361	90
Chungu	538	135
Ntakira	568	142
Nthimbiri	221	55
Githongo	318	80
Kithrune	378	95
Mpuri	184	46
Katheri	606	152
Total	10,481	2,623

2) Other Towns

Other town does not have water demand projection in 2005 so that wastewater volume will be estimated 2010 water demand projection data. Relation between supplying water and wastewater volume is shown in below.

Table Q-6 Wastewater Flow Rate in Both Towns

Unit : m3/day

Town	Water Supply Volume (a)	Wastewater Inflow (b)	Percentage (= b/a)
Meru	3,200	807	25.2
Isiolo	2,800	631	22.5
Average	3,000	719	24.0

Present average water supply volume is approximately 3,000 m3/day, and wastewater inflow is around 24.0 % of water supply volume. If the sewerage collection system covered the town center solely, planning scale would be same as existing systems in both towns and wastewater rate would be estimated in following table.

Table Q-7 Estimated Wastewater Volume in Seven Towns (2010)

m3/day

Town	Water Supply in 2010	Wastewater Volume
Nkubu	2,000	480
Isiolo	8,000	1,920
Chuka	4,000	960
Chogoria	3,000	720
Maua	1,500	360
Tigania	4,000	960

Estimated wastewater volume is more than three times as large as existing treatment capacity and it is over loading for the existing facilities. Extension or new plant construction will be sought to improve the environment. Other town does not have any treatment plant, and it is not economical, or feasible to construct new sewerage systems. It is also recommended that improvement of on-site sanitation systems, or the promotion of hygiene education for those areas.

2.5 Hydrological Situation Aspects

Total water volume registered as water right is over the river flow rate result in Isiolo and Maua. Though the water act describes that domestic water has the first priority among all water uses, the actual operation depends on the individual situation. Accordingly, the confirmation of the actual operation in each area is requisite to coordinate the water among consumers. It is sought to make arrangement for river water taking particularly in dry season.

3. ENVIRONMENTAL IMPACT MITIGATION METHOD

3.1 Land Acquisition

Land acquisition along pipeline routes is temporary, and major impacts can be avoided by good liaison between the DWO and land owners during project planning. On the

other hand, permanent land acquisition is required for structures. Confirmation of land requirement and agreement with owners is a requisite for project implementation, and should take place well in advance of construction for the project to proceed smoothly.

3.2 Local Transportation

Pipeline crossings of trunk, and busy urban roads, present the greatest potential serious impact on local transportation and even regional economy. These roads are busy especially in the morning and evening, requiring careful traffic control measures to be applied. It is recommended that these measures give adequate consideration to working space for construction, and to avoid working in critical locations during peak traffic times.

3.3 Flora and Fauna in Mt. Kenya Area

Many types of animals are living in the forest area but the project should have minimal impact on them. Manual labour construction is considered more suitable to conserve the environment rather than using heavy equipment inside the forest. Construction methods listed below should be avoided within the forest habitat.

(1) Excessive widening or grading the existing road inside the forest for the use of heavy equipment

(2) Excessive use of heavy equipment

(3) Construction of base camp or work space inside the forest

(4) Use of blasting for construction

3.4 Wastewater Disposal

(1) Meru

Wastewater disposal facilities were constructed in 1974 but no charges were raised on connected households until 1996. A sewage billing and collection system was initiated in Jan 1997 with the sewage charge set at 60 % of the water tariff price. However, the income from this billing and collection system is not sufficient to budget for rehabilitation and expansion of facilities. This situation could be improved, however, through comprehensive metering of water supplies and other methods of reducing the level of unaccounted water The establishment of a metering system and a leakage reduction program is therefore seen as the quickest way to support sewerage system improvement. There are no sewerage

systems in the rural areas. The District Development Plan does not plan to construct any. Hence, promotion of appropriate on-site sanitation linked to hygiene education is recommended.

(2) Isiolo

Facilities in Isiolo was also constructed in 1983 and was used free of charge. Sewerage billing collection was started from 1992 and sewage charge was 90 % of the water tariff price. The sewage charge was revised in 1996 and become 5 Ksh per Cu.m. If the project did not conducted by the lack of budget, implementation of the low cost project like pit latrines construction would be effective especially for the peripheral area.

(3) Other district

As mentioned former section, there are no wastewater treatment facilities existing in other towns. Based on the present conditions, construction of facilities is quite costly and is not realizable. Accordingly, promotion activity to improve the sanitary condition will be the first step for the inhabitants of the towns.

4. CONCLUSION

Environmental impacts and assessment of the project are summarized below.

(1) Land acquisition for permanent structures such as the treatment plant and reservoirs is necessary for project implementation. Procedures for this, together with liaison with land owners should commence well in advance of construction.

(2) Construction methods appropriate for the conservation of the natural environment in Mt. Kenya forest is given high priority. Also, natural resources should be monitored under the control of appropriate authorities.

(3) Implementation of a realizable sanitation improvement program is recommended for the town. Promoting appropriate low cost on-site sanitation systems such as VIP latrines together with a sanitary hygiene education program is recommended.

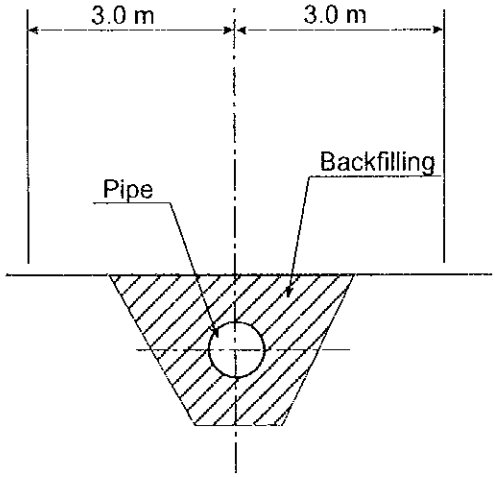
(4) It is significant to regulate about intake discharge among the interested parties. This will need to be sought especially in drought term. To realize the water rights coordination, DWO should be necessary to monitor river and have strong competence for the illegal water users.

TABLES

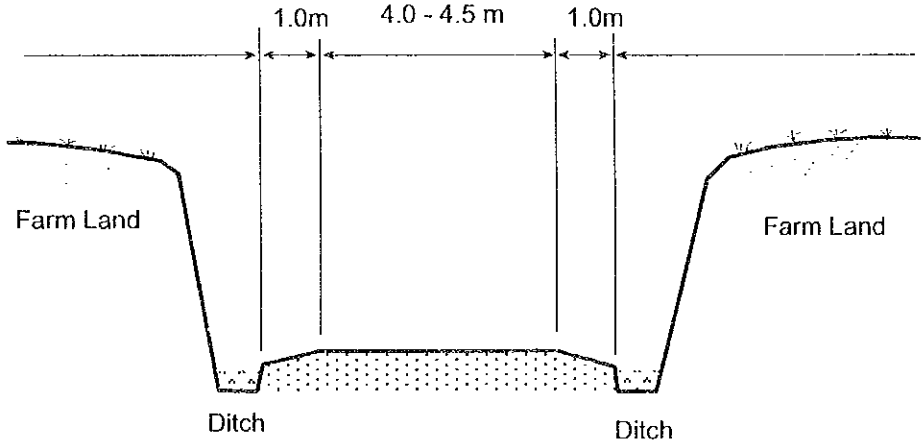
Table Q-3 Sanitation Projects in the District Development Plan

Title	Rank	Description	Fund
Meru District			
Health Sector			
Water and Sanitation Programme, District Wide	5th of 7	Spring protection, Well protection, water jars, ferrocement tanks, VIP latrines, slabs pit ventilation pipes, drainage etc. On-going since 1987 and aimed at raising the standard of sanitation.	GOK
Isiolo District			
Health Sector			
Primary Health Care Project	6th of 10	Supplement curatives with preventive measure Funding Source : Catholic Mission	-
Health Provision	10thof 10	Together with the Ministry of Health (Public Health) the NGO is working on a new project proposal to prevent the spread of malaria which is a major killer disease in Isiolo District	CHEK Council for Human Ecology
Local Government Sector			
Sewerage Connections : Isiolo Town Bulla Pesa	3rd of 7	Sewage connections will be done together with as one project.	
Water Supply Sector			
Sanitary Improvement Project District Wide (Construction of VIP latrines)	2nd of 3	Construct VIP latrines in all the divisions. Sanitation problem which pose health risks are prevalent in the district.	GOK/ SIDA
Tharaka-nithi District			
Water Supply Sector			
Urban water supplies and sewerage in Chuka town project	21stof 22	Existing town council requires sewerage and water supply due to population increase.	GOK Project cost: 100 mil Ksh
Local Government Sector			
Water and sanitation studies Karingani location Chuka Division	2nd of 9	The town has no sewerage facilities and proper treatment works and garbage collection	GOK Project cost: 5 mil Ksh

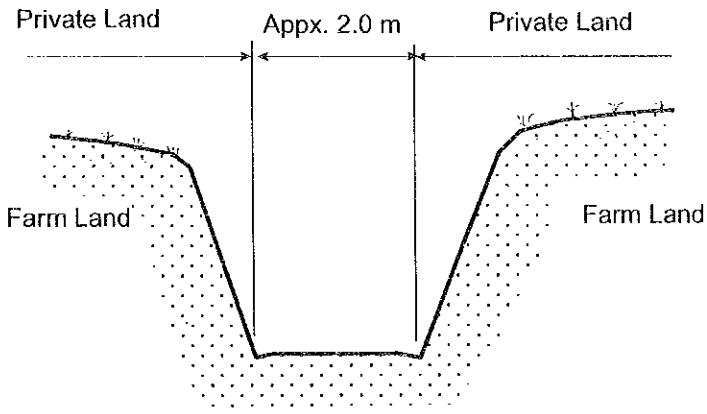
FIGURES



Typical Cross Section of Wayleaves

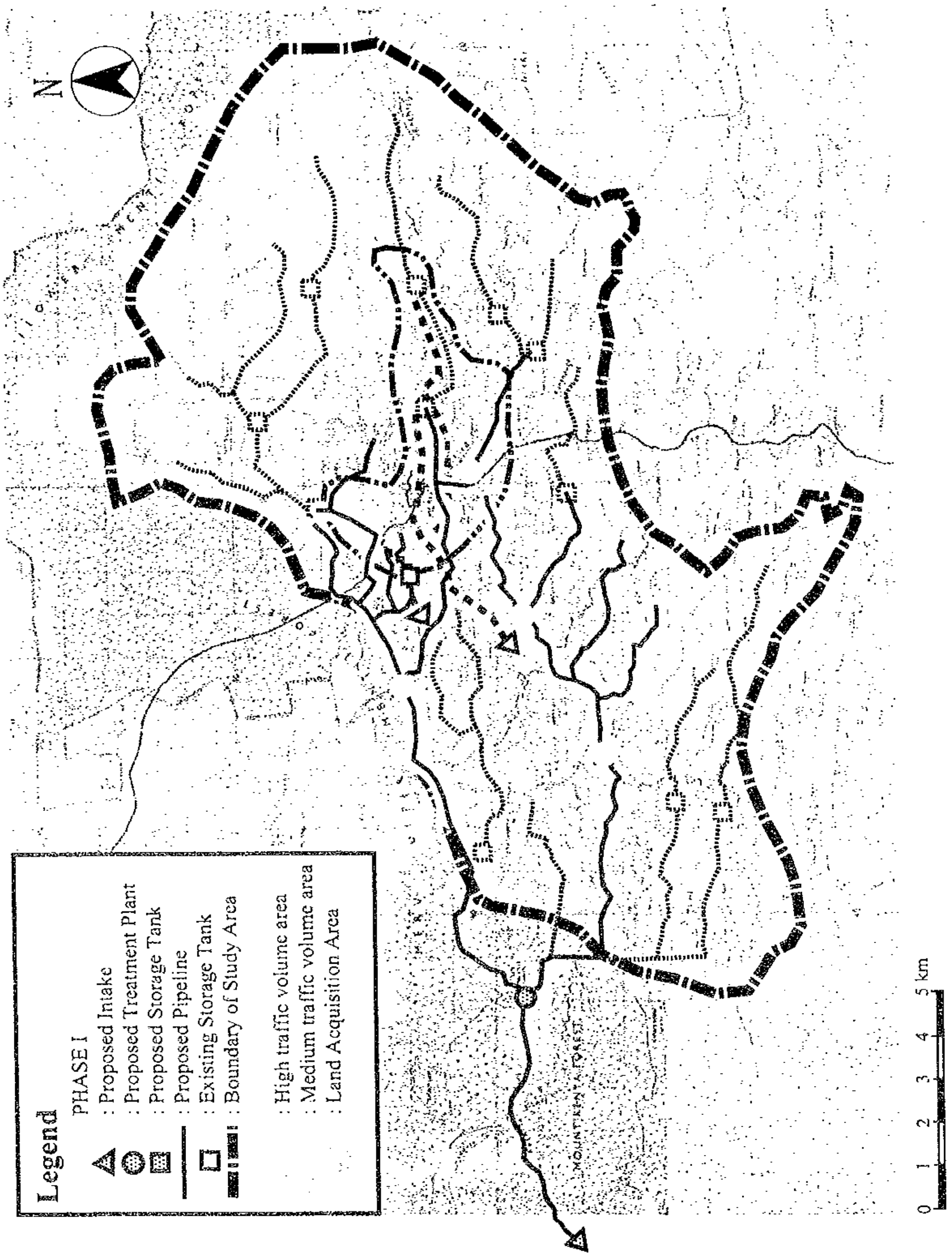


Typical Cross Section of Local Road

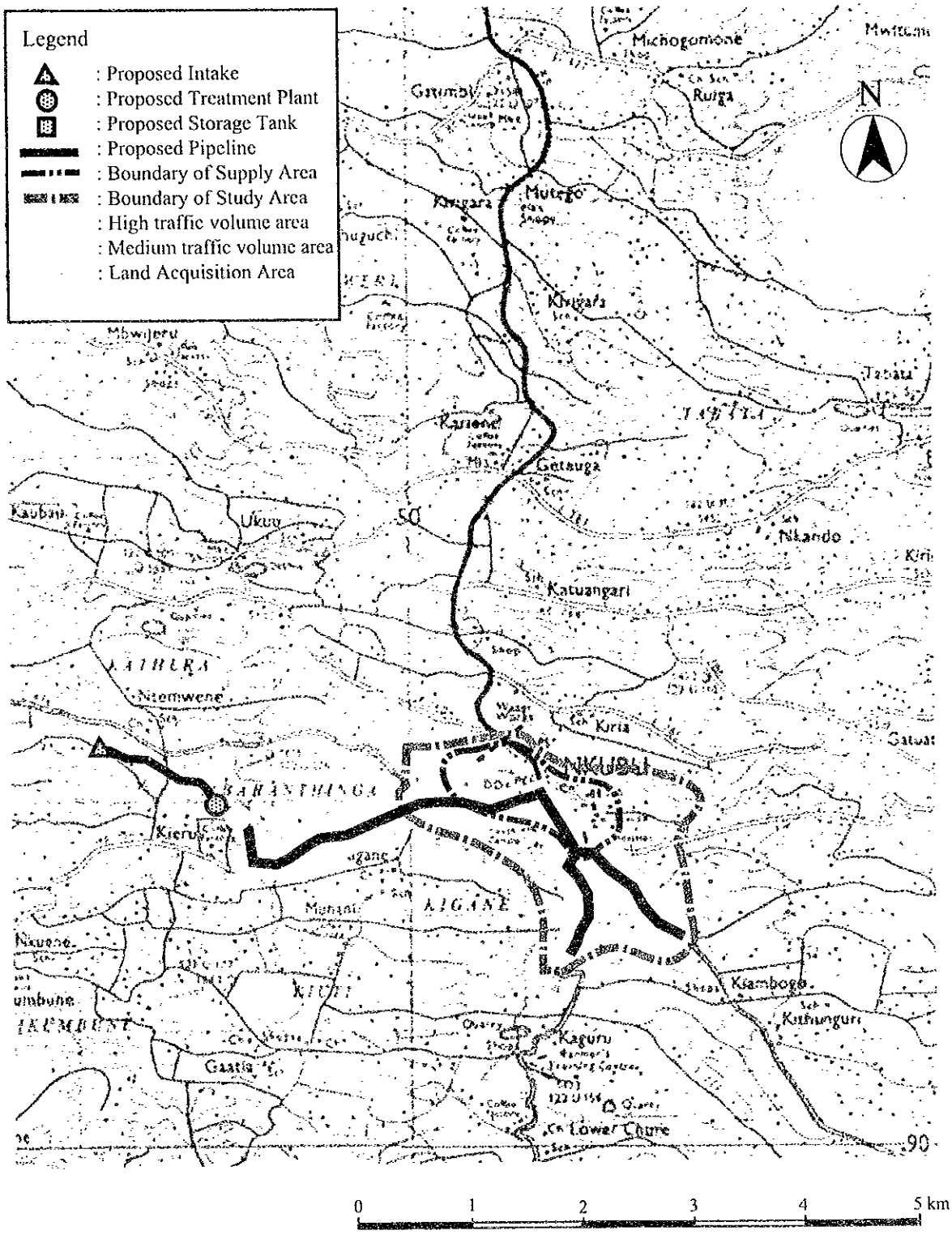


Typical Cross Section of Local Track

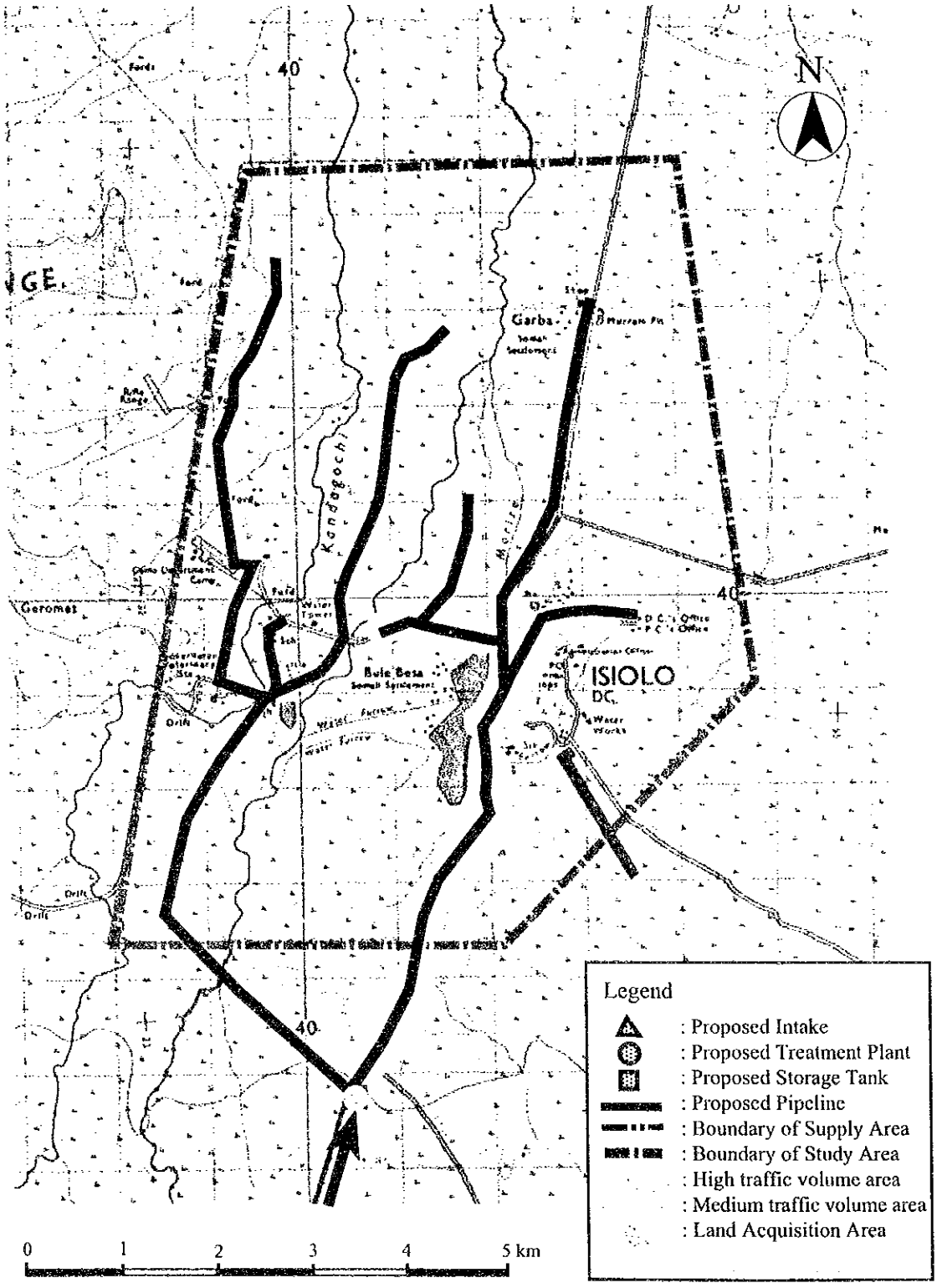
THE STUDY ON THE WATER SUPPLY FOR SEVEN TOWNS IN EASTERN PROVINCE IN THE REPUBLIC OF KENYA	Figure Q-1
JAPAN INTERNATIONAL COOPERATON AGENCY	Typical Cross Section of Wayleaves and Local Roads



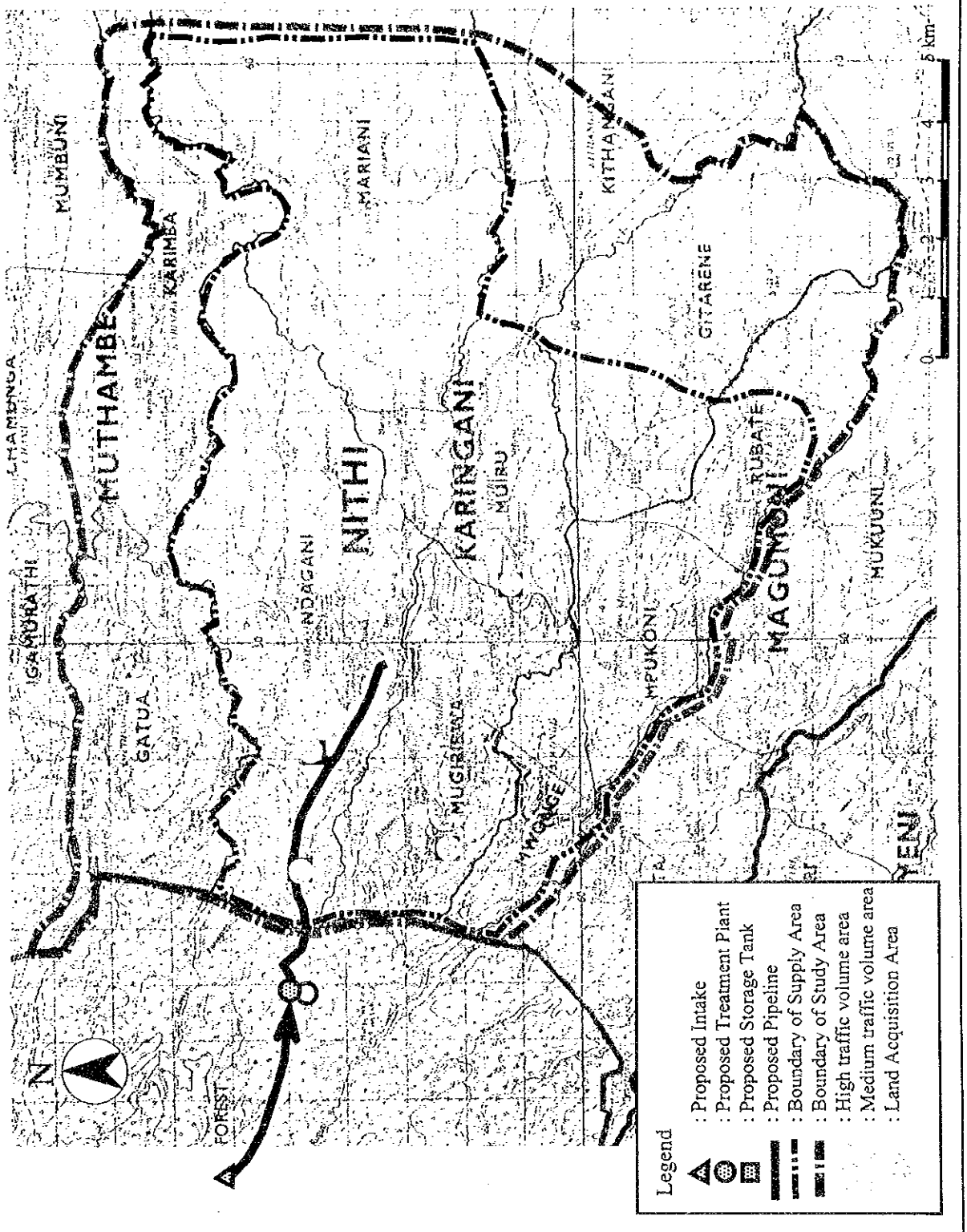
THE STUDY ON THE WATER SUPPLY FOR SEVEN TOWNS IN EASTERN PROVINCE IN THE REPUBLIC OF KENYA	Figure Q - 2
JAPAN INTERNATIONAL COORERATION AGENCY	Social EnvironmentalConsideration Necessity Area in Meru



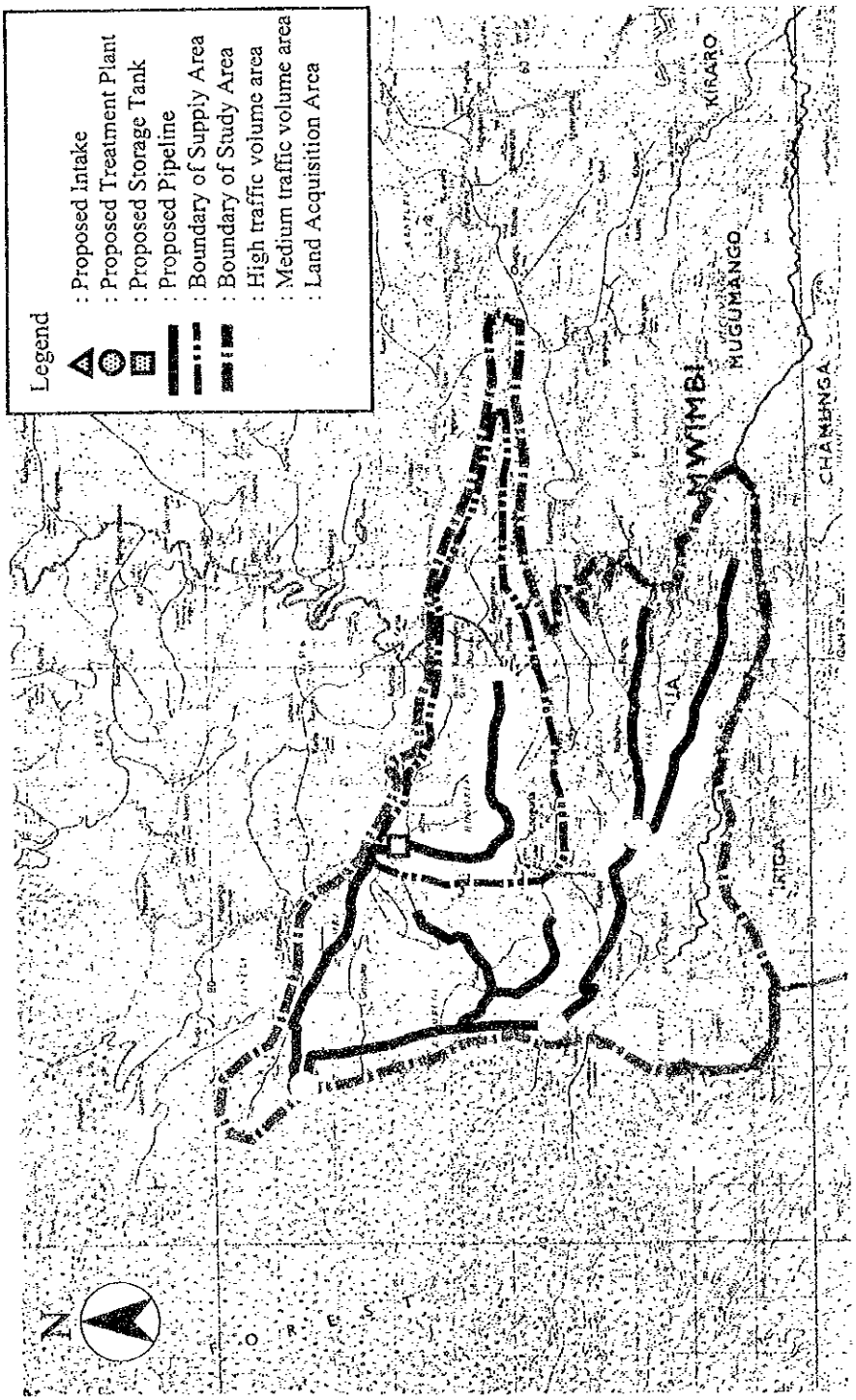
THE STUDY ON THE WATER SUPPLY FOR SEVEN TOWNS IN EASTERN PROVINCE IN THE REPUBLIC OF KENYA	Figure Q-3
JAPAN INTERNATIONAL COOPERATION AGENCY	Social Environmental Consideration Necessity Area in Nkubu



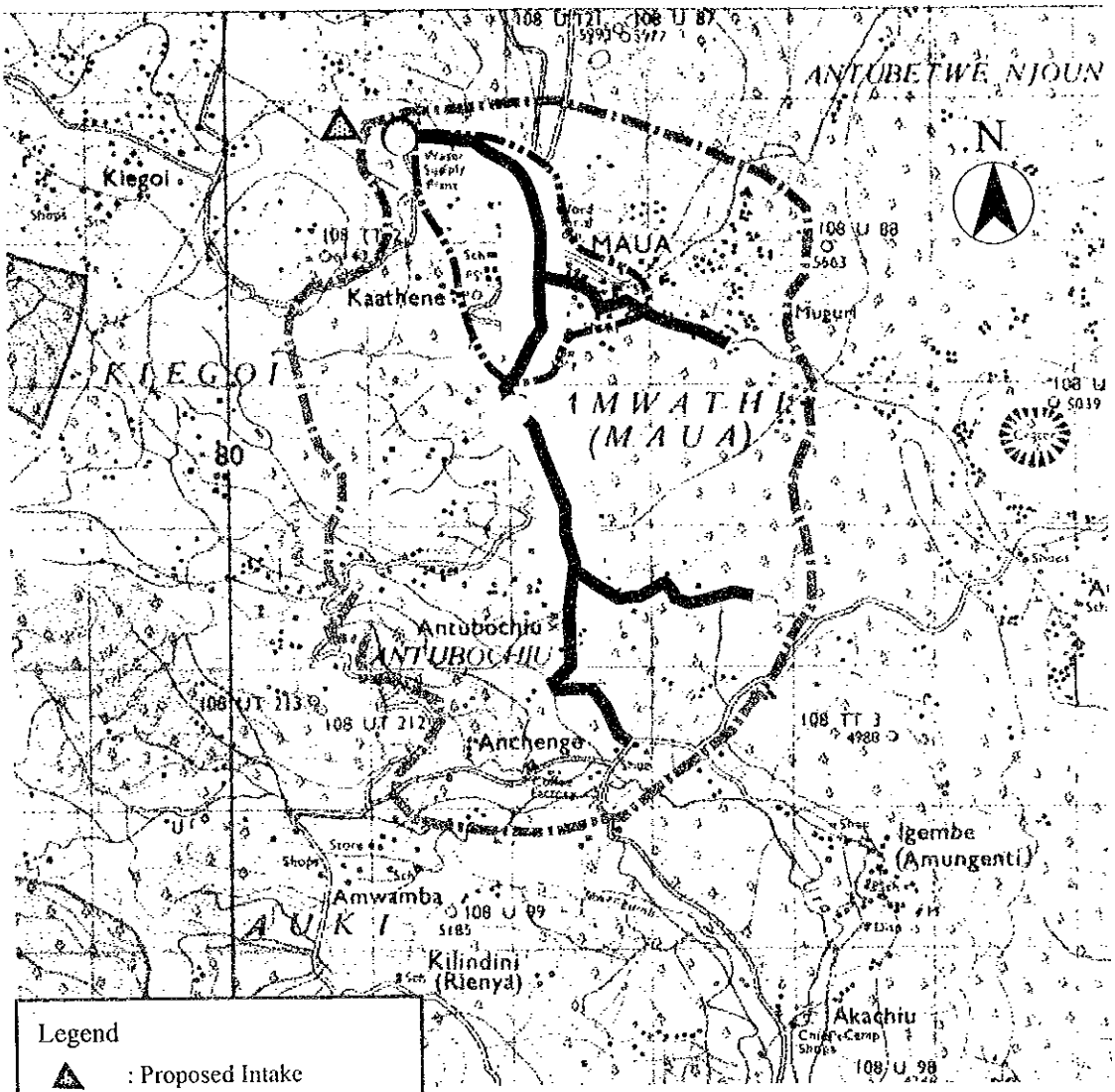
THE STUDY ON THE WATER SUPPLY FOR SEVEN TOWNS IN EASTERN PROVINCE IN THE REPUBLIC OF KENYA	Figure Q-4
JAPAN INTERNATIONAL COORERATION AGENCY	Social Environmental Consideration Necessity Area in Isiolo



THE STUDY ON THE WATER SUPPLY FOR SEVEN TOWNS IN EASTERN PROVINCE IN THE REPUBLIC OF KENYA	Figure Q-5
JAPAN INTERNATIONAL COORERATION AGENCY	Social Environmental Consideration Necessity Area in Chuka



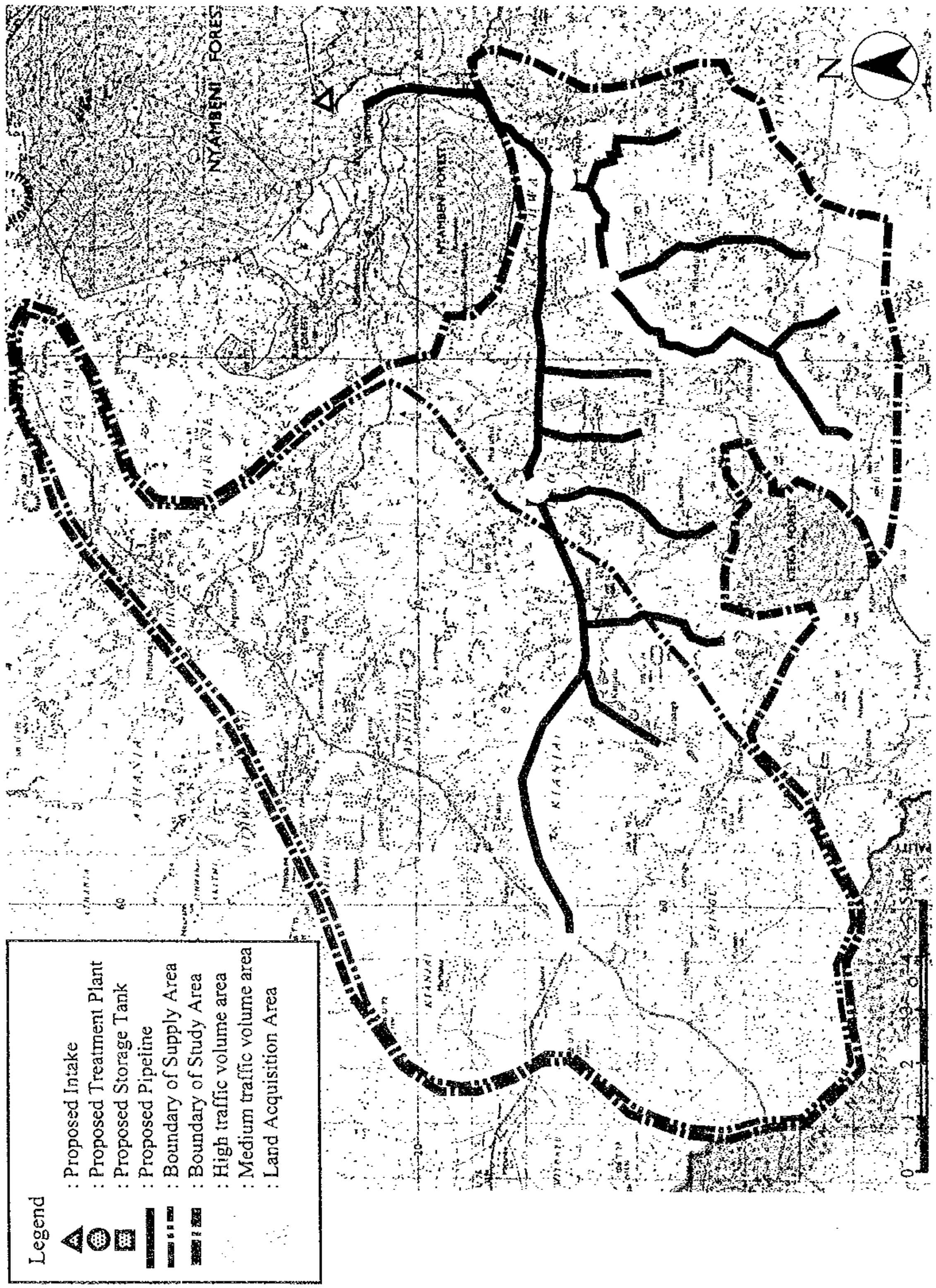
THE STUDY ON THE WATER SUPPLY FOR SEVEN TOWNS IN EASTERN PROVINCE IN THE REPUBLIC OF KENYA	Figure Q-6
JAPAN INTERNATIONAL COORERATION AGENCY	Social Environmental Consideration Necessity Area in Chogoria



Legend

- : Proposed Intake
- : Proposed Treatment Plant
- : Proposed Storage Tank
- : Proposed Pipeline
- : Boundary of Supply Area
- : Boundary of Study Area
- : High traffic volume area
- : Medium traffic volume area
- : Land Acquisition Area

THE STUDY ON THE WATER SUPPLY FOR SEVEN TOWNS IN EASTERN PROVINCE IN THE REPUBLIC OF KENYA	Figure Q-7
JAPAN INTERNATIONAL COOREATION AGENCY	Social Environmental Consideration Necessity Area in Maua



THE STUDY ON THE WATER SUPPLY FOR SEVEN TOWNS IN EASTERN PROVINCE IN THE REPUBLIC OF KENYA	Figure Q-8
JAPAN INTERNATIONAL COORERATION AGENCY	Social Environmental Consideration Necessity Area in Tigania