REPUBLIC OF KENYA

MINISTRY OF WATER DEVELOPMENT

NATIONAL WATER CONSERVATION AND PIPELINE CORPORATION

STUDY ON CONSTRUCTION OF DAM IN MALEWA RIVER SYSTEM FOR GREATER NAKURU WATER SUPPLY PROJECT

FINAL REPORT

VOLUME II MAIN REPORT

[redacted]

JAPAN INTERNATIONAL COOPERATION AGENCY

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PREFACE

In response to a request from the Government of the Republic of Kenya, the Japanese Government decided to conduct a study on the construction of a Dam in Malewa River System for Greater Nakuru Water Supply Project and entrusted the Cooperation Agency (JICA).

JICA sent to Kenya a study team headed by Mr. Masashi Yamaguchi, Nippon Koei Co., Ltd. and composed of members from Nippon Koei Co., Ltd. and the INA Civil Engineering Consultants Co., Ltd. three times between February 1989 and July 1990.

The team held discussions with the officials concerned of the Government of Kenya, and conducted field surveys. After the team returned to Japan, further studies were made and the present report was prepared.

I hope that this report will contribute to the promotion of the project and to the enhancement of friendly relations between our two countries.

I wish to express my sincere appreciation to the officials concerned of the Government of the Republic of Kenya for their close cooperation extended to the team.

December 1990

Kensuke Yanagiya

Kensuke Yanagiya
President
Japan International
Cooperation Agency

Mr. Keisuke Yanagiya
President, Japan Inter National Cooperation Agency
Tokyo, Japan

Dear Sir,

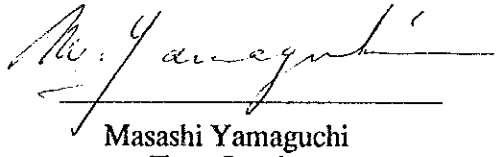
LETTER OF TRANSMITTAL

We have the pleasure of submitting you a Final Report for the Study for Construction of Dam in Malewa River System, Greater Nakuru Water Supply Project, Eastern Division.

The objective of the study was to formulate the optimum water supply plan for three urban centers (Nakuru Municipality and both Gilgil and Naivasha Towns) and two rural areas (Gilgil and Naivasha). For this purpose the Study Team elaborated the survey, investigation and studies on various items during the period from January, 1989 to November, 1990. The findings and results of the them are reported in six (6) volumes as per attached herewith.

It is concluded that the surface runoff of the Malewa River is a sole water source available for the project and the project is therefore vital to the success of the prosperous socio-economic development of the region and the water demand in future. However it was forecast that the project will enhance environmental impacts especially on Lake Nakuru. In this connection it is recommended that the Government of Kenya establish the counter measure best suitable to the site on natural and social environmental before implementation of this project.

All members of the Study Team wish to express grateful acknowledgement to the personnel of your agency, Advisory Committee, Ministry of Foreign Affairs, and Embassy of Japan in Nairobi as well as officials and individuals of the Government of Kenya for their assistance and cooperation extended to the Study Team.



Masashi Yamaguchi
Team Leader

December 1990

CONSTRUCTION OF DAM IN MALEWA RIVER SYSTEM
FEASIBILITY STUDY REPORT

VOLUME I EXECUTIVE SUMMARY

VOLUME II MAIN REPORT

VOLUME III SUPPORTING REPORT (I)

- Annex A Topographic Survey
- Annex B Geological Investigation

VOLUME IV SUPPORTING REPORT (II)

- Annex C Construction Material Survey
- Annex D Hydrological Investigation
- Annex E Water Demand Forecast and Assessment of Willingness - to - Pay
- Annex F Water Resources Development Planning

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THE REPUBLIC OF KENYA

MINISTRY OF WATER DEVELOPMENT

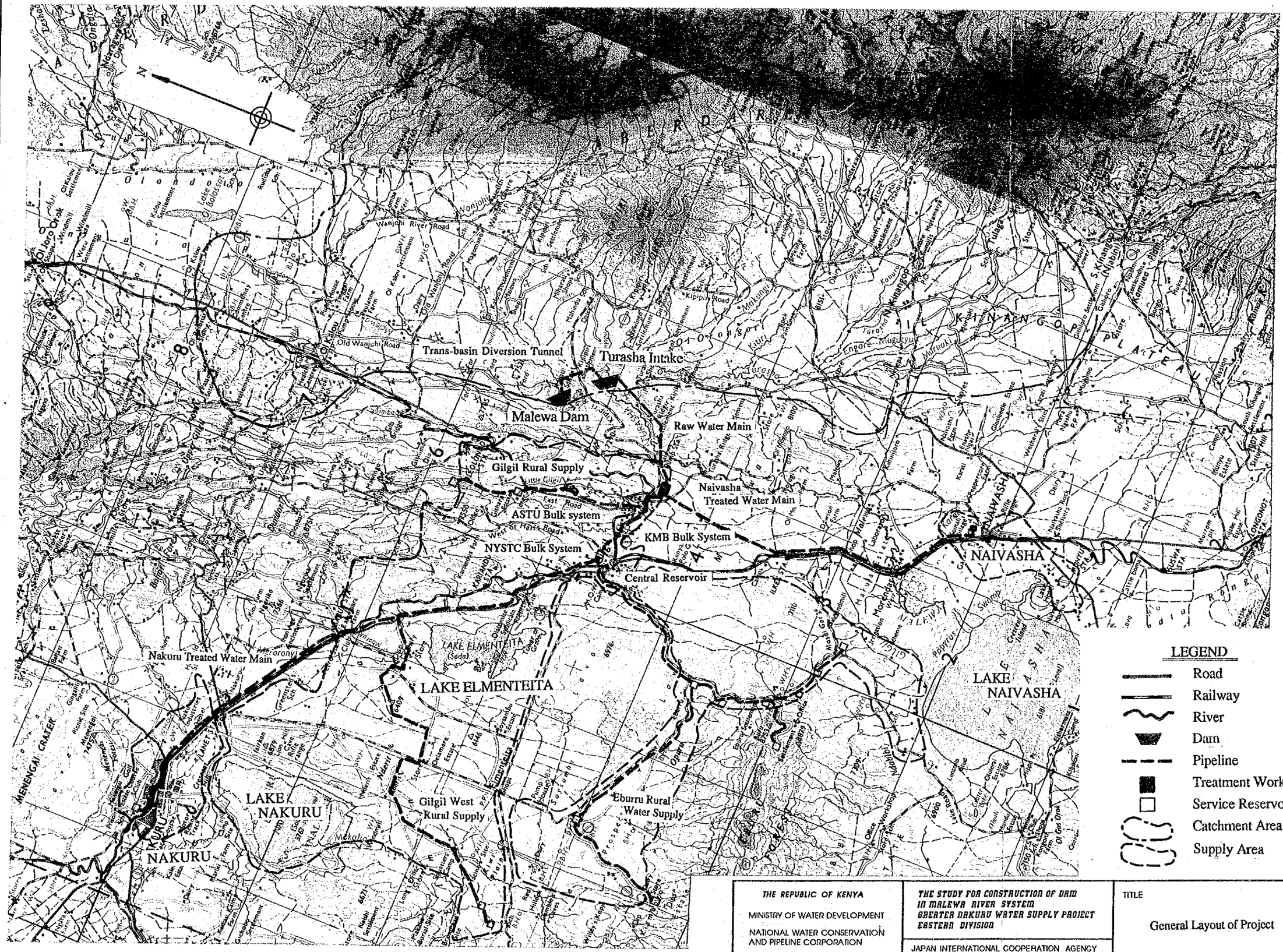
NATIONAL WATER CONSERVATION AND PIPELINE CORPORATION

THE STUDY FOR CONSTRUCTION OF DAM IN MALEWA RIVER SYSTEM GREATER NAKURU WATER SUPPLY PROJECT EASTERN DIVISION

JAPAN INTERNATIONAL COOPERATION AGENCY

TITLE

Prospective View of the Proposed Dam Site



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THE STUDY FOR CONSTRUCTION OF DAM IN MALEWA RIVER SYSTEM GREATER NAKURU WATER SUPPLY PROJECT EASTERN DIVISION

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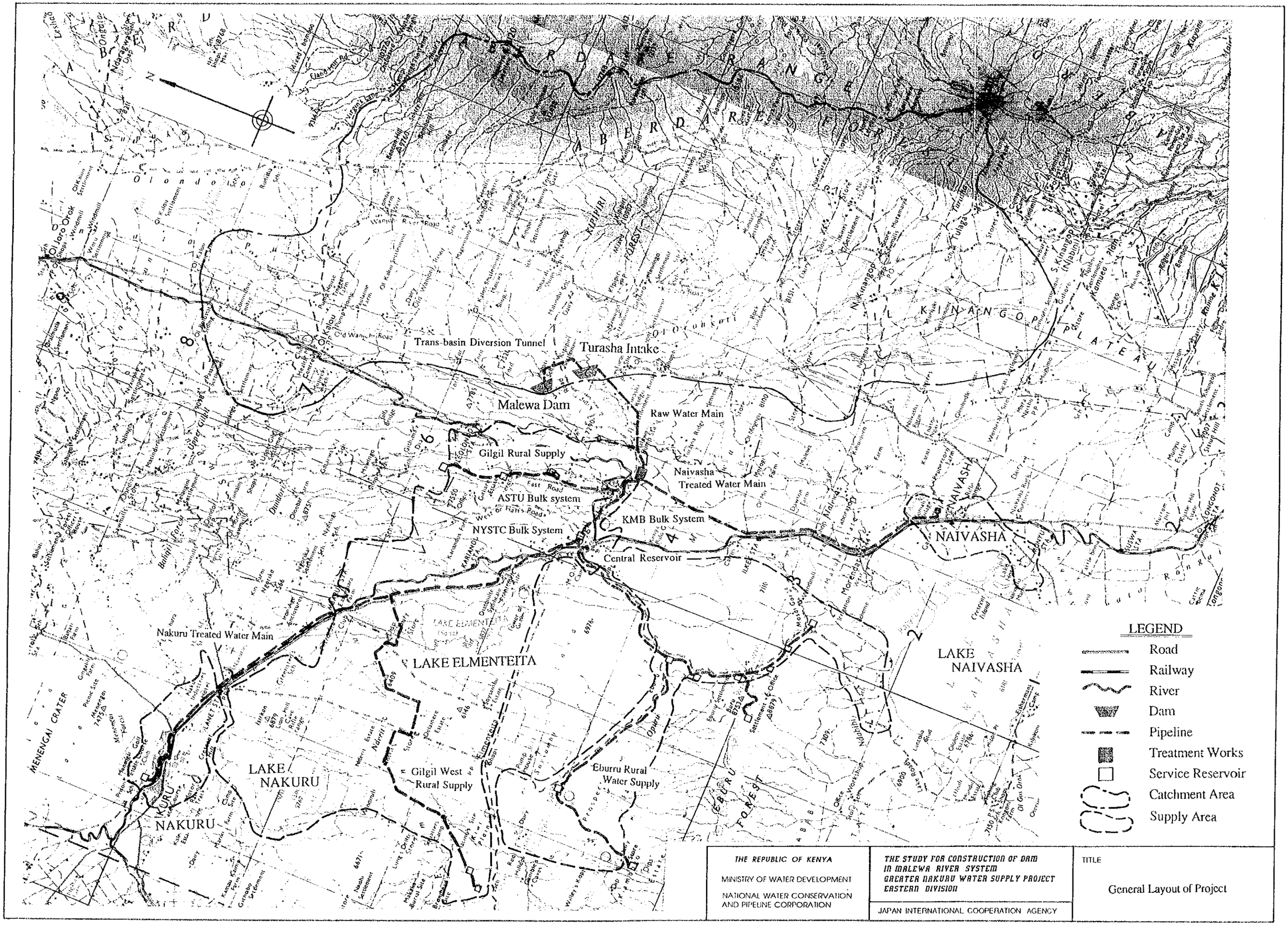
General Layout of Project



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General Layout of Project

CONCLUSIONS AND RECOMMENDATIONS

I. CONCLUSIONS

1.01 Project Objective. The objective of the Project is to augment and secure a safe water supply to three urban areas (Nakuru municipality and both Gilgil and Naivasha towns) and two rural areas (Gilgil and Eburru) in the Eastern Division of the Greater Nakuru, through the expansion of source works by the construction of a new dam/reservoir. The additional capacity is intended to meet the increased demand up to 2015, and will improve primarily the provision of basic needs and the health condition of the inhabitants.

1.02 Present Water Supply. Upon completion of the Stage 1 Project, which is under construction with a full swing for a scheduled completion in 1992, the water supply capacity will amount to 35,360 m^3/day in Nakuru municipality, 6,380 m^3/day in Gilgil town, 1,480 m^3/day in Naivasha town, 1,000 m^3/day in Gilgil rural area. There is no systematic public water supply in Eburu rural area. Groundwater is widely used in both Naivasha town and Nakuru municipality, but is contaminated by highly concentrated fluoride.

1.03 Forecast Population. The population in the beneficial area has been forecast to grow steadily in future at the rate slightly higher than the national average of 3.7 per cent per annum. The population during the planning horizon has been projected as summarized below.

Beneficial Area	Unit	1990	1995	2000	2005	2010	2015
Nakuru municipality	10^3	295.6	412.0	574.0	752.4	960.3	1,225.6
Gilgil Town	10^3	18.0	24.1	30.7	39.2	50.0	63.9
Naivasha Town	10^3	41.2	60.8	78.7	96.7	118.7	145.8
Gilgil Rural	10^3	20.5	24.7	28.5	32.9	38.0	43.8
Eburu Rural	10^3	30.9	37.5	45.7	55.6	66.0	78.4
Total	10^3	406.2	559.1	757.6	976.8	1,233.0	1,557.5

1.04 Need for the Project. It has been assumed that the existing source works, excluding the groundwater source, will continue to serve during the planning horizon. Under such condition water deficit in the beneficial area has been estimated for the period after the completion year of the Stage 1 Project.

Beneficial Area	Water Deficit (cu.m/day)				
	1995	2000	2005	2010	2015
Nakuru Municipality	9,830	41,040	59,550	84,020	116,150
Gilgil Town	1,460	3,200	5,600	8,860	13,490
Naivasha Town	7,260	11,700	14,370	17,650	21,680
Gilgil Rural	610	900	1,210	1,560	2,000
Eburru Rural	2,200	2,700	3,300	4,030	4,930
Total	21,360	59,540	84,030	116,120	158,250

1.05 Water Resources. The service area extends over a vast area astride three lake drainage basins, i.e., Lake Naivasha with a drainage area of 3,401 km^2, Lake Elementaita with a drainage area of 588 km2, and Lake Nakuru with a drainage area of 1,536 km^2. It was ascertained that the Malewa river basin with a drainage area of 1,653 km^2 , the major water source of Lake Naivasha, is blessed with a relatively rich stream flow still untapped. It is the precious water source not only for the Project but also for the natural and social environment in and around the lake.

1.06 Proposed Water Resources Development. Through the various technical and economic comparative studies, it is concluded that the Malewa Dam Scheme is the most sound and promising among the alternatives. The proposed scheme will regulate the runoff of the Malewa river throughout the year by the reservoir to be created by Malewa Dam and will release the water into the Turasha river through a trans-basin diversion tunnel, when the runoff of the Turasha river is short of water. The dam, rockfill with a center core and 80 m in height, is proposed to be sited at about 10 km upstream from the confluence of the Turasha river and creates a reservoir with a gross storage capacity of 71.8 million m^3.

1.07 Proposed Water Supply Scheme. The water supply scheme is an integral part of the Project and mainly comprises raw water transmission system, water treatment works, both Nakuru and Naivasha treated water transmission systems, both Gilgil West and East rural and Eburru rural supply systems, and three bulk supply systems. It is concluded that the water supply scheme will be most beneficial if implemented in three stages keeping pace with the growing water demand. The water supply facilities have been designed to cater for the maximum daily demand. The water treatment works therefore have a production capacity of 200,000 cu.m/day at a full development stage, increasing from 100,000 cu.m per day at the Stage 2-1.

1.08 Overall Project Implementation Programme. The Project has been planned to be materialized in three stages as summarized below.

(1) Stage 2-1 (Expected year of commissioning : 1997)
- Malewa dam, including the trans-basin diversion tunnel
- Raw water transmission system, Phase 1
- Water treatment works, Phase 1
- Nakuru treated water transmission system, Phase 1
- Naivasha treated water transmission system, Phase 1
- Gilgil and Eburu rural supply systems, Phase 1
- KMB and NYSTC - GMB bulk supply systems

(2) Stage 2-2 (Expected year of commissioning : 2004)
- Raw water transmission system, Phase 2
- Water treatment works, Phase 2
- Nakuru treated water transmission system, Phase 2
- Naivasha treated water transmission system, Phase 2
- Gilgil and Eburu rural supply systems, Phase 2
- ASTU bulk supply system

(3) Stage 2-3 (Expected year of commissioning : 2011)
- Water treatment works, Phase 3
- Nakuru treated water transmission system, Phase 3
- Naivasha treated water transmission system, Phase 3

1.9 Construction Cost Estimate. The construction cost of the Project has been estimated at the 1990 price level as summarized below.

	Stage of the Project	Foreign Currency Portion (US$10^6)	Local Currency Portion (Kshs.10^6)	Total (Kshs.10^6)
(1)	Malewa Dam Scheme	54.6	414.0	1,642.8
(2)	Water Supply Scheme			
	Stage 2-1	59.2	486.4	1,818.3
	Stage 2-2	58.3	544.6	1,856.8
	Stage 2-3	13.1	201.6	497.4
	Sub-total	130.6	1,232.6	4,172.5
	Total	185.2	1,646.6	5,815.3

1.10 Present Environment. Although the Project will directly benefit more than one million people, special attention should be devoted to its adverse effects on the natural and social environment, particularly in Lakes Naivasha and Nakuru and their surrounding areas. The general characteristics of both lakes are as summarized below.

(1) Lake level, area and volume

	Description	Unit	Lake Naivasha (1961 - 1984)	Lake Nakuru (1959- -1982)
(a)	Water level fluctuation			
	Maximum	El. m	1,886.9	1,760.6
	Minimum	El. m	1,883.2	1,756.3
	Average	El. m	1,885.2	1,758.6
(b)	Max. water depth at average level	m	13	2.2
(c)	Lake area at average level	km^2	185	43.7
(d)	Water volume at average level	10^6m^3	863	76.3

(2) Lake water quality (recorded in June,1990)

	Description	Unit	Malewa River	Lake Naivasha		Lake Nakuru	
				Upper Layer	Lower Layer	Upper Layer	Lower Layer
(a)	pH		8.2	8.7	8.7	10.4	10.5
(b)	Conductivity	µs/cm	130	275	278	17,560	17,520
(c)	DO	mg/l	7.4	8.3	7.8	9.7	5.5
(d)	COD	mg/l	8	39	39	191	192
(e)	T-N	mg/l	2.7	3.3	3.3	33.8	28.6
(f)	T-P	mg/l	0.89	0/34	0.32	3.01	3.01

In 1988, the most severe drought year in the last 25 years, the level of Naivasha declined to as low as El. 1,982.0 m. The lake is an important source of the irrigation supply for the existing irrigated lands of 7,895 acres. Of the entire irrigated lands 3,543 acres have been developed for horticulture crops, which has been greatly contributing to the economy of the Kenya. Among the aquatic fauna, fishes such as Tilapia, black-bass and crayfish are the important resources for the regional economy. Salvinia molesta is the predominant aquatic flora and from time to time it spreads over a wide area, as much as 19 km^2 in 1979.

It is not rare that Lake Nakuru is prone to dry up in a severe drought year, most recently in 1988. The lake has been designated as the national park and is blessed with many varieties of birds. Lesser - flamingo and white pelican are the most representative ones and are attractive tourism resources. It is, however, noted that the flamingoes do not breed in the lake and their numbers have varied greatly in the past, from 1.4 million in 1973 to only 3,300 in 1990. It has been reported in the literature that there is a very delicate ecological balance between the lake water quality, the quantity of Spirulina and the number of the flamingoes.

There are two sewage treatment works with the total treatment capacity of 7,000 m^3/day in Nakuru municipality , while the actual quantity of sewage inflow has amounted to 8,840

m^3/day. All the outflow from the treatment works is directly discharged into Lake Nakuru. It is presumed that such sewage inflow must have had a certain effect upon the ecology of the lake.

1.11 Forecast Changes in Lake Level and Water Quality. It is inevitable that the implementation of the Project will reduce the inflow into Lake Naivasha and increase the sewage effluent from the Nakuru municipality. The reduced inflow and augmented sewage will result in changing substantially the water balance of both lakes, which in turn will change the avality of the lakes water. The changes in the lake level and water quality have been forecast in relation to the quantities of the water supply/sewage inflow as summarized below.

(1) Forecasted lake level, area and volume

Lakes	Supply/Sewage (m3/day)	Rate to 2015 (%)	Lake Level (El. m) Max.	Min.	Ave.	Lake Area (sq.km) Max.	Min.	Ave.	Water Volume (mil.cu.m) Max.	Min.	Ave.
Naivasha	Without the Project	0	1,886.9	1,883.2	1,885.2	297	138	185	1,273.0	536.0	863.0
	56,000	34	1,886.4	1,883.0	1,884.8	257	138	170	1,128.6	536.0	794.2
	105,000	63	1,886.2	1,882.5	1,884.3	235	133	156	1,075.0	471.0	715.4
	121,000	73	1,886.0	1,882.0	1,883.9	226	129	150	1,029.4	407.8	657.4
	138,000	83	1,885.8	1,881.5	1,883.6	213	123	145	983.8	345.2	615.6
	151,000	91	1,885.7	1,881.0	1,883.4	207	117	143	961.0	284.4	588.8
	166,000	100	1,885.5	1,880.0	1,883.1	198	101	139	921.8	171.2	549.0
Nakuru	Without the Project	9	1,760.6	1,756.3	1,758.6	52.0	26.0	43.7	171.8	22.9	76.3
	8,600	18	1,761.2	1,757.5	1,759.3	53.9	36.9	46.7	203.6	31.9	107.7
	25,900	36	1,762.9	1,759.5	1,761.0	58.7	47.0	53.2	299.4	117.0	192.8
	43,200	55	1,765.1	1,762.0	1,763.3	65.4	56.1	59.9	436.0	247.6	323.2
	60,400	73	1,767.3	1,764.3	1,765.6	72.4	63.0	67.2	587.8	384.6	469.2
	95,000	100	1,771.7	1,768.9	1,770.1	90.0	76.9	81.2	935.3	707.2	802.2

(2) Forecasted water quality

Lake	Lake Level (El.m)	DO (mg/l) Upper Layer	DO (mg/l) Lower Layer	COD (mg/l) Upper Layer	COD (mg/l) Lower Layer	T-N (mg/l)	T-P (mg/l)
Malewa reservoir		10.2	1.4	15.9	11.4	3.06	0.13
Lake Naivasha	1,883.1	9.60	8.26	38.88	38.32	3.33	0.30
	1,883.4	9.6	8.1	38.8	38.1	3.34	0.30
	1,883.6	9.6	8.0	38.6	37.9	3.34	0.30
	1,883.9	9.6	7.8	38.1	37.4	3.35	0.30
	1,884.3	9.6	7.7	37.8	37.0	3.35	0.30
	1,884.8	9.6	7.2	39.3	38.3	3.36	0.30
Lake Nakuru	1,758.6	9.9	7.6	191.5	192.4	31.85	5.28
	1,761.0	9.7	0.1	183.5	177.1	63.98	18.57
	1,765.6	9.7	0.0	180.9	187.5	64.37	20.86
	1,770.1	9.4	0.0	188.8	193.3	73.58	23.82

Although the Malewa reservoir water has been forecast to eutrophicate, it is judged suitable as a source of the water supply.

It is obvious that the level of the Lake Naivasha will falls two meters below the lowest level recorded in the 1988 drought year and the lake area will diminishes to a great extent. The water quality shows little change, probably due to the fact that the decreased water quantity is quite small compared to the lake water volume. The conductivity and pH are likely to remain within the same fluctuation range as recorded in the past.

The level of Lake Nakuru will increas tremendously, approximately 11 m higher than the highest ever recorded level, if the whole of the potential sewage effluent of 95,000 m^3/day, corresponding to 70 % of the water supply to the municipal area in 2015, discharges into the lake. It is deduced that T-N and T-P will continue to increase over a considerable period of time. It is predicted that COD value may not change greatly. This phenomenon is explainable in that the lake area and volume will expand proportionally to the increasing sewage inflow, evidently resulting in increasing the sedimentation and decomposition volumes. The increased decomposition volume may, however, cause much more oxygen consumption than at present and may also impede the supply of oxygen from the surface, resulting in reduction of the DO value to almost nil.

1.12 Forecast Impacts on the Natural and Social Environments. Apart from the serious foreseeable impacts of the Project due to the changes in the lake levels and water quality of both Lakes Naivasha and Nakuru, others impacts have been identified which will occur at the full development stage of the Project, unless any suitable counter measures are taken up.

(1) Lake Naivasha

(a) Since the lake level will fall to El. 1,880 m, most of the existing pumping facilities will eventually become impossible to operate properly for a long period, probably resulting in severe damage to horticulture and fodder crop production.

(b) A small lake appears in a dry period at the east of Crescent Island, since the lake bed between the island and the eastern shore of the lake will be exposed at a lake level below El. 1,881.0 m. When this happens dredging work will be required in order to secure water traffic for fishery and tourism.

(c) The reduction of water volume and recession of the lake area may naturally lead to changes in the ecology of the aquatic - eco system, although it is not possible to assess this quantitatively at this stage. This will also affect the attractiveness of the lake as a tourism resource.

(2) Lake Nakuru

(a) The rise in lake level will causes submergence of the southern part of the municipal area, the whole of the road encircling the lake and the greater portion of the grass land extending on the souther rim of the lake. The grass land is the main feeding ground of the wildlife.

(b) The salinity of the lake water will evidently be reduced to a great extent, causing serious changes in the aquatic-eco system, which will directly affect the habitat of the flamingoes.

(c) The DO value is predicted to decrease to a very low level at the lower layer. The situation may be so critical that the aquatic fauna would be exposed to the verge of extinction.

1.13 Conservation of Environment. It will be indispensable to create an appropriate atmosphere for coexistence of the contemplated water supply and the natural and social environment. A conceptual countermeasure is introduced in this report which requires verification and study at a later stage.

(1) Lake Naivasha

It has been suggested that the quantity of the water supply should be reduced and to set a lowest lake level to be maintained for conservation of the natural and social environment. The lowest level proposed is tentatively El. 1,882 m, the same level as the recorded in the 1988 drought period, mainly based on the following facts :

(a) There will be no notable difficulty in operation of the existing intake facilities at the lake level El. 1,882 m.

(b) The segregation of Crescent Island should not take place.

(c) Such a drought as experienced in 1988 occurs very rarely in the long run and covers a short period in a year, when it occurs. The 1988 drought year corresponds to a drought frequency of once in 25 years.

(d) Since the water quality changes little, no special qualitative problem is foreseeable in the source of irrigation supply.

If the lake level is maintained at El. 1,882 m during the drought period, the water supply by the Project will be secure for 73 per cent of the required water supply for 2015.

(2) Lake Nakuru

On June 6, 1990, the Government of Kenya acceded to the Ramsar Convention for Conservation of Wetlands of International Importance and listed Lake Nakuru as the first site in Kenya and in eastern Africa. The international and national importance of preserving the precious ecology of Lake Nakuru is therefore unquestionable and it is essential to introduce positive physical countermeasures to mitigate the effects of sewage effluent inflow into the lake.

In Section 8.4.4 it is suggested that one of the most suitable countermeasures to preserve the ecology of Lake Nakuru would be to use the treated sewage effluent for irrigation of suitable crops. This will require further study, but as a first approximation it is pointed out that 6,100 ha of sugar cane would utilize the full amount of sewage effluent which would otherwise discharge into Lake Nakuru.

1.14 Economic Evaluation. Tha main economic benefits of the Project will accrue from the incremental consumer's surplus and water revenue, improved sanitation, and impacts on regional socio-economic development. The Economic Internal Rate of Return (EIRR) was estimated at 3.94 % based on the economic costs including associated costs and the tangible benefits, i.e., the incremental consumer's surplus and water revenue. The resultant EIRR is lower than an opportunity cost of capital in Kenya (10 %). However it should not to be hastily concluded that the Project is economically infeasible, since intangible benefits, such as improved public health and hygiene and the contribution to a sustained economic growth of a safe and stable water supply, are not taken into account in the EIRR.

No allowance has been made for the cost of countermeasures to preserve the ecology of Lake Nakuru as it is assumed at this stage that use of the treated effluent for irrigation of suitable crops will be viable as a separate project.

1.15 Financial Evaluation. The financial benefit of the Project will be the revenue to NWCPC from the incremental sales of water. The unit water rates were taken on the basis of existing average rates by types of sales : bulk water supply and direct water distribution. The Financial Internal Rate of Return (FIRR) was estimated at 2.31 %, which means that all the costs of the Project would be recovered by revenue, assuming that the increase in the average water rate keeps pace with the assumed rate of inflation of 8 %.

1.16 Overall Conclusion. Notwithstanding the relatively low economic and financial returns, it could be recognized that the Project is one of the basic important needs to insure the subsistence of more than 1.5 million people in the central part of the Rift Valley Province. It has been confirmed that a safe and stable water supply greatly contribute for the preservation of the public health and hygiene and promotion of a sustained economic growth. It is evident that there is no adequate and ample water resources other than the Malewa river system in and around the proposed water service area.

The Project should, however, be designed and implemented with the utmost care to the prevailing natural and social environment, in particular in the areas of Lakes Naivasha and Nakuru. A further study and elaboration as noted in the "Recommendation" are absolutely prerequisite prior to the commencement of the Project.

II. RECOMMENDATIONS

2.01 Further Studies. In order to make sound the implementation of the Project, further elaboration should be continued by the NWCPC. Among others the following is deemed to be key issues.

(1) Environmental aspects

Without exaggeration, it may be said that the Project's success depends chiefly on the formulation of countermeasures best adaptable to the environment of Lake Nakuru. For this purpose, it is recommended to take up a master plan study on drainage and sewage disposal in the drainage area of Lake Nakuru. The study will focus on, but not necessarily limited to ,(i) assessment of the ecology of the lake, (ii) study of storm water drainage, (iii) study of sewage treatment and disposal including re-use of treated sewage, (iv) formulation of a long term drainage and sewage disposal plan, and (v) establishment of an action programme to realize the proposed master plan.

As an integral part of the master plan study, the environmental monitoring should be initiated as early as possible. It is also important to clarify more qualitatively and quantitatively the natural and social environment under "with -"and "without - Project "conditions. Especially due attention should be paid for the water quality, aquatic fauna and flora, existing water uses, and horticulture crop production.

(2) Construction material survey

A test embankment and a large-scale shearing test are essentially required to further ascertain the physical and mechanical characteristics of the welded tuff, which will be used for the major part of the dam embankment.

2.02 Conservation Flow. In order to sustain the existing water uses and preserve aqua-ecology in the river, it has been suggested to maintain a certain amount of flow throughout the year in the downstream from the Malewa dam site and the Turasha intake. In the current study, the conservation flow has actually been taken into account as set forth below.

River	Low Flow Season (cu.m/sec)	Flood Season (cu.m/sec)
Malewa river, downstream from dam	0.22	0.22
Malewa river, downstream from 2GB1	0.35	0.83
Turasha river, downstream from intake	0.24	0.24

2.03 Operation of the Malewa Reservoir. The operation of the Malewa reservoir is of crucial importance to mitigate the adversed effect on Lake Naivasha and its surrounding area. It is strongly recommended that the reservoir shall strictly be regulated so as not to lower the proposed lowest level of Lake Naivasha. For this purpose, a reservoir operation rule should be established during the stage of detailed design.

2.04 Resettlement and Afforestation Plans. There are five families in the proposed Malewa reservoir area. An adequate resettlement plan is prerequisite to ensure livelihood of the inhabitants. The afforestation and/or sodding are recommended to be carried out in the borrow area and quarry sites to protect the exposed land surface from erosion.

2.05 Organization. In order to attain the environmental monitoring, it is recommended to constitute an organization, composing of an inter-ministerial committee, a data bank unit, an environmental management unit and coordinating unit.

2.06 Regional Development Issue. The feasibility study was completed under such population distribution condition that, indeed, nearly 80 per cent of the whole population continues to concentrate in Nakuru municipality, which occupies only 92 sq.km in the western bound of the entire proposed water service area of 1,445 sq.km. Besides, the water source has been identified far way, about 50 km from the municipality in the Malewa river basin, which is separated from the Lake Nakuru drainage basin. As a consequence it is anticipated that the Project enhances various natural and social environmental impacts especially on Lake Nakuru, and incurs a greater amount of investment for construction of water transmission facilities.

In this context it is suggested that the Government of Kenya promptly takes the initiative to formulate a comprehensive regional development plan to set forth clearly a long term perspective of well balanced development in the area, covering the adequate population distribution, urban and rural development, land use, water and energy supplies, solid waste and sewage disposals, agricultural and industrial developments.

PRINCIPAL FEATURES OF THE PROJECT

1. Malewa Dam Scheme

1.1 Dam and Apartment Structures

(a)	Reservoir		
	Catchment area		635 sq. km
	Full supply level		El. 2,149.00 m
	Minimum supply level		El. 2,123.50 m
	Flood water level		El. 2,151.80 m
	Active storage capacity		71.80 x 10^6 cu.m
	Gross storage capacity		55.92 x 10^6 cu.m
	Dead storage capacity		15.88 x 10^6 cu.m
(b)	River diversion system		
	Design flood		240 cu.m/sec.
	Crest level of coffer dam		El. 2,115.00 m
	Volume of coffer dam,	core	16,700 cu. m
		filter	8,900 cu.m
		outer shell-1	50,200 cu.m
		outer shell-2	48,700 cu.m
	Diversion tunnel,	shape	Circular
		diameter	3.65 m
		length	342 m
	No. of rows		2
(c)	Dam		
	Type		Rockfill with center core
	Crest level		El. 2,154.00 m
	Dam height		80.0 m
	Crest length		360.0 m
	Crest width		10.0 m
	Slope, upstream		1 : 2.70
	downstream		1 : 2.20
	Embankment volume,	core	166,900 cu.m
		filter	110,900 cu.m
		inner shell	59,100 cu.m
		outer shell-1	516,200 cu.m
		outer shell-2	148,100 cu.m
(d)	Spillway		
	Type		Non-gated, fan shaped
	Crest level		El. 2,149.00 m
	Crest length		101.0 m
	Design flood		960 cu.m/sec.
	Design flood for stilling basin		460 cm.m/sec.
	Chuteway, width x length		20.0 m x 182 m
	Energy dissipator,	type	Stilling basin
		width x length	20.0 m x 80.0 m
(e)	River outlet facilities		
	Flow regulating device		Hollow jet valve, D500 mm

1.2 Trans-basin Diversion Tunnel

(a)	Intake	
	Type	Vertical shaft
	Design discharge	2.30 cu. m/sec.
	Sill level of inlet	El. 2,120 m
	Flow regulating device	Hollow jet valve, D750 mm
(b)	Tunnel	
	Shape	Semi-circular
	Tunnel height and width	H=1.8 m, W=1.8 m
	Length	2,420 m
	Slope	1 : 1,000
	Design discharge	2.30 cu.m/sec.
	Flow in tunnel	Free flow
(c)	Outlet	
	Type	Step-wise

2. Water Supply Scheme

2.1 Raw Water Transmission System

(a)	Intake	
	Design discharge	2.30 cu.m/sec.
	Normal intake level	El. 2,103.20 m
	Inlet sill level	El. 2,102.00 m
	No. of inlets	2
	Dimension of each inlet, width x height	2.50 m x 1.20 m
(b)	Tunnel	
	Design discharge	2.30 cu.m/sec.
	Shape,	Semi-circular
	Tunnel width x height	1.80 m x 1.80 m
	Tunnel length	190 m
	Slope	1 : 1,500
(c)	Desilting work	
	Design discharge	2.30 cu.m/sec.
	Normal water level	El. 2,102.50 m
	Sand settling basin, width x length	4.0 m x 14.0 m (2 chambers)

(d) Pipeline

	Stage 2-1	Stage 2-2
Design discharge	102,500 m^3/day	102,500 m^3/day
Flow	Gravity	Gravity
No. of rows	1	1
Pipe material	Steel	Steel
Pipeline configuration		
D 1,000 mm	6,800 m	6,800 m
D 900 mm	2,600 m	2,600 m

2.2 Treatment works

Treatment method	Stage 2-1	Stage 2-2	Full treatment Stage 2-3
Production capacity	100,000 m^3/day	50,000 m^3/day	50,000 m^3/day
No. of treatment units	50,000 m^3/day x 2	50,000 m^3/day x 1	50,000 m^3/day x 1

Principal features of the 50,000 m^3/day unit :

(a)	Rapid mixing chamber	
	Type	Hydraulic
	Number	1
(b)	Flocculating chamber	
	Type	Hydraulic, vertical flow
	Number	4
	Width and length of a chamber	10.2 m x 12.5 m
(c)	Sedimentation basin	
	Type	Conventional, horizontal flow
	Number	4
	Width and length of a basin	12.5 m x 50.0 m
(d)	Filters	
	Type	Conventional, constant rate filtration, backwash and surface wash
	No. of filter beds	8
	Width and length of a bed	8.70 m x 8.00 m
	Filter media	Sands, 600 mm thick
	Filter bed	Gravel, 350 mm thick
(e)	Clear water reservoir	
	Storage capacity	2,084 m^3
	High water level	El. 2,072.00 m
	Low water level	El. 2,069.00 m
(f)	High level tank	
	Storage capacity	1,100 m^3
	High water level	El. 2,087.0 m
	Low water level	El. 2,084.8 m
(g)	Sludge lagoon	
	Storage capacity	3,400 m^3
	Number	2
	Width x length x depth	72.4 m x 48.4 m x 1.6 m
(h)	Wash water pond	
	Storage capacity	7,400 m^3
	Number	1
	Width x length x depth	36.7 m x 102.7 m x 2.3 m

2.3 Nakuru Treated Water Transmission System

(a) Main pipeline

	Stage 2-1	Stage 2-2
Design discharge		
Treatment works - KMB	82,520 m^3/day	89,550 m^3/day
KMB - Central Reservoir	81,690 m^3/day	88,350 m^3/day
Central Reservoir - Gilgil West Branch	71,740 m^3/day	76,450 m^3/day
Gilgil West Branch - R6 in Nakuru	70,960 m^3/day	75,900 m^3/day
Flow	Gravity	Gravity
No. of rows	1	1
Pipe material	Steel	Steel
Pipeline configuration		
Treatment works - Central Reservoir		
D 1,000 mm	1,800 m	4,150 m
D 900 mm	5,600 m	3,250 m
Central Reservoir - R6 in Nakuru		
D 900 mm	-	2,170 m
D 800 mm	24,210 m	30,340 m
D 750 mm	8,300 m	-

(d) Service reservoirs

Reservoir	Water Level (El.m) HWL	Water Level (El.m) LWL	Number and Storage Capacity (m^3) Stage 2-1	Stage 2-2	Stage 2-3
Gilgil					
– Central	2,051.70	2,047.00	1 x 4,100	1 x 2,940	1 x 2,940
Nakuru					
– R1	1,983.03	1,979.03	1 x 1,200	1 x 800	1 x 800
– R2	1,935.20	1,932.20	1 x 300	1 x 150	1 x 150
– R3	1,903.00	1,898.80	2 x 4,410	1 x 2,520	2 x 2,520
– R4	1,888.46	1,884.46	1 x 1,600	1 x 2,400	1 x 2,400
– R5	1,850.96	1,846.96	2 x 4,800	1 x 5,400	1 x 5,400
– R6	1,915.90	1,911.70	2 x 2,625	1 x 3,675	1 x 3,675
– R7	1,871.01	1,866.51	2 x 3,600	1 x 6,300	1 x 6,300

2.4 Naivasha Treated Water Transmission System

(a) Main pipeline

	Stage 2-1	Stage 2-2
Design discharge	16,700 m^3/day	9,900 m^3/day
Flow	Gravity	Gravity
No. of rows	1	1
Pipe material	Steel	Steel
Pipeline configuration		
D 500 mm	25,700 m	-
D 450 mm	3,000 m	4,000 m
D 400 mm	-	24,700 m

(b) Service reservoirs

Reservoir	Water Level (El.m) HWL	LWL	Number and Storage Capacity (m^3) Stage 2-1	Stage 2-2	Stage 2-3
R1	1,994.0	1,990.0	1 x 1,600	1 x 600	1 x 600
R2	1,962.0	1,958.0	2 x 4,200	1 x 2,400	1 x 2,400

2.5 Gilgil East Rural Supply System

(a) Boosting facilities

Type of pump: Multi-stage volute pump

	Treatment works	Reservoir No. 1	Reservoir No.2
No. of pumps	2	2	2
Pump capacity	0.596 m^3/min.	0.374 m^3/min.	0.225 m^3/min.
Pump height	171 m	136 m	149 m

(b) Pumping main

Design discharge	Stage 2-1	Stage 2-2
Treatment works - Reservoir No.1	780 m^3/day	550 m^3/day
Reservoir No.1 - No.2	490 m^3/day	340 m^3/day
Reservoir No.2 - No.3	295 m^3/day	205 m^3/day
No. of rows	1	1
Pipe material	UPVC	UPVC

Pipeline configulation

Treatment works - Reservoir No.1	D150 mm, L = 7,100 m
Reservoir No.1 - No.2	D125 mm, L = 4,300 m
Reservoir No.2 - No.3	D100 mm, L = 4,600 m

(c) Service reservoirs

Reservoir	Water Level (El.m) HWL	LWL	Number and Storage Capacity (m^3) Stage 2-1	Stage 2-2	Stage 2-3
No.1	2,210.0	2,207.8	1 x 660	1 x 500	–
No.2	2,335.0	2,332.8	1 x 440	1 x 330	–
No.3	2,460.0	2,458.0	1 x 300	1 x 200	–

2.6 Gilgil West Rural Supply System

(a) Distribution main (each stage)

Design discharge Nakuru treated water main - Reservoir No.1	Stage 2-1	Stge 2-2
D150 mm, L = 15,000 m	780 m^3/day	550 m^3/day
D100 mm, L = 11,700 m	480 m^3/day	280 m^3/day
D80 mm, L = 2,200 m	170 m^3/day	160 m^3/day

(b) Boosting facility (each stage)

Type of pump	Multi-stage volute pump
No. of pumps	2
Pump capacity	0.114 m^3/min.
Pump height	104 m

(c) Pumping main (each stage)

	Stage 2-1	Stge 2-2
Design discharge (Reservoir No.1 - No.2)	150 m^3/day	100 m^3/day
No. of raws	1	1
Pipe material	Steel pipe	Steel pipe
Pipeline	D100 mm, L = 2,100 m	D100 mm,L = 2,100 m

(d) Service reservoirs

Reservoir	Water Level (El.m)		Number and Storage Capacity (m^3)		
	HWL	LWL	Stage 2-1	Stage 2-2	Stage 2-3
No.1	1,860.0	1,858.0	1 x 50	1 x 50	–
No.2	1,960.0	1,956.4	1 x 180	1 x 90	–

2.7 Eburru Rural Supply System

(a) Distribution main (each stage)

Design discharge Central reservoir		Stage 2-1 (m^3/day)	Stage 2-2 (m^3/day)
- Reservoir No.1	D250 mm, L = 10,200 m	3,700	2,220
Reservoir No.1 - No.2	D250 mm, L = 14,300 m	1,900	1,110
Reservoir No.2 - No.3	D200 mm, L = 8,700 m	1,900	1,110
Reservoir No.1 - No.4	D200 mm, L = 3,400 m	1,900	1,110
Reservoir No.4 - No.5	D200 mm, L = 3,700 m	1,900	1,110
Reservoir No.5 - No.6	D150 mm, L = 4,600 m	950	555
Reservoir No.5 - No.7	D100 mm, L = 1,700 m	950	555
Reservoir No.7 - No.8	D100 mm, L = 1,800 m	950	555
Reservoir No.8 - No.9	D100 mm, L = 2,300 m	950	555

(b) Boosting facilities

Type of pump	Multi-stage volute pump

	Reservoir No.3	Reservoir No.4	Reservoir No.5	Reservoir No.6
No. of pumps	2	2	2	2
Pump capacity	1.450 m^3/min.	1.450 m^3/min.	1.450 m^3/min.	0.726m^3/min.
Pump height	297 m	134 m	199 m	294 m

(c) Service reservoirs

Reservoir	Water Level (El.m) HWL	LWL	Number and Storage Capacity (m^3) Stage 2-1	Stage 2-2	Stage 2-3
No.1	2,014.0	2,010.4	1 x 90	1 x 90	–
No.2	1,890.0	1,886.4	1 x 90	1 x 9	–
No.3	1,955.0	1,953.0	1 x 1,200	1 x 800	–
No.4	2,170.0	2,166.4	1 x 90	1 x 90	–
No.5	2,350.0	2,346.4	1 x 90	1 x 90	–
No.6	2,620.0	2,617.8	1 x 660	1 x 330	–
No.7	2,260.0	2,256.4	1 x 90	1 x 90	–
No.8	2,100.0	2,096.4	1 x 90	1 x 90	–
No.9	2,020.0	2,017.8	1 x 660	1 x 330	–

2.8 Bulk Supply System in Gilgil

Scheduled phase of construction

KMB, GMB - NYSTC	Stage 2-1
ASTU	Stage 2-2

	GMB-NYSTC	KMB	ASTU
Design discharge	7,060 m^3/day	2,030 m^3/day	1,140 m^3/day
(a) Boosting facilities			
Type of pump	-	-	Multi-stage volute pump
No. of pumps	-	-	2
Capacity of pump	-	-	0.825 m^3/min.
Pumping height	-	-	25 m
(b) Distribution main			
Flow	Gravity	Gravity	Pumping
No. of rows	1	1	1
Pipe material	UPVC	UPVC	UPVC
Pipeline configuration			
D 100 mm	-	130 m	-
D 150 mm	-	-	2,530 m
D 300 mm	260 m	-	-

(c) Service reservoir

Reservoir	Water Level (El.m) HWL	LWL	Number and Storage Capacity (m^3) Stage 2-1	Stage 2-2	Stage 2-3
KMB	2,029.1	2,025.5	1 x 760	–	–
ASTU	2,063.6	2,060.0	–	1 x 720	–

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Bird's-eye Views by CAD System

Abbreviation and Local Terms

1. Abbreviation of Measures

1.1 Length

mm	=	millimeter
cm	=	centimeter
m	=	meter
km	=	kilometer

1.2 Area

m^2, sq.m	=	square meter
ha	=	hectare
km^2, sq.km	=	square kilometer

1.3 Volume

lit, l	=	liter
lcd	=	liter per capita per day
cu.m, m^3	=	cubic meter
cu.m/day, m^3/day	=	cubic meter per day
MCM	=	million cubic meter

1.4 Weight

mg	=	milligram
mg/l	=	milligram per liter
g	=	gramme
kg	=	kilogram
t	=	ton

1.5 Time

s, sec	=	second
min	=	minute
h, hr	=	hour
d	=	day
yr	=	year

1.6 Money

Kshs.	=	Kenya Shilling(unit of Kenya currency, US$1.00 = Ksh 23.0 = ¥ 150)
US$, $	=	US dollar
¥	=	Japanese Yen

1.7 Electric Measures

kV	=	kilovolt
kW	=	kilowatt
MW	=	megawatt
kWh	=	kilowatt hour
kVA	=	kilovolt ampere

1.8 Other Measures

mmho	=	micromho = conductance
ppm	=	parts per million
ppb	=	parts per billion
MPN	=	most probable number
‰	=	mill
%	=	per cent
PS	=	0.736 kW
°	=	degree
'	=	minute
"	=	second
℃	=	degree centigrade
n.a.	=	not available
COD	=	Chemical Oxygen Demand
T-N	=	Total Nitrogen
I -	=	Inorganic -
O -	=	Organic -
T-P	=	Total - Phosphorus
DO	=	Dissolved Oxygen
pH	=	Exponent of hydrogen ion concentration

1.9 Derived Measures Based on the Same Symbols

cu.m/sec, m^3/s	=	cubic meter per second
cu.m/day, m^3/day	=	cubic meter per day
t/ha	=	ton per hectare
lpcd	=	liter per capita per day

2. Other Abbreviations

BS	=	British Standards
JIS	=	Japanese Industrial Standards
ASTM	=	American Society for Testing and Material
GNP	=	gross national products

GDP	=	gross domestic product
GRDP	=	gross regional domestic product
El.	=	elevation
FWL	=	flood water level
FSL	=	full supply level
MSL	=	minimum supply level
HWL	=	normal operation level
LWL	=	minimum operation level
f.o.b	=	free on board
c.i.f.	=	cost, insurance and freight
ICB	=	international competitive bid
LCB	=	local competitive bid

3. Abbreviation of Organizations

MOA	=	Ministry of Agriculture
MENR	=	Ministry of Environment & Natural Resources
MOF	=	Ministry of Finance
MOLD	=	Ministry of Livestock Development
MOLG	=	Ministry of Local Government
MOTW	=	Ministry of Tourism & Wildlife
MOTC	=	Ministry of Transport & Communication
MORD	=	Ministry of Regional Development
MOWD	=	Ministry of Water Development
NES	=	National Environmental Secretariat
NWCPC	=	National Water Conservation & Pipeline Corporation
SOK	=	Survey of Kenya
KWS	=	Kenya Wildlife Service
NMC	=	Nakuru Municipal Council
NTC	=	Naivasha Town Council

ASTU	=	Anti-Stock Theft Unit
KYSTC	=	National Youth Service Training Center
GMB	=	Gilgil Military Barracks
KMB	=	Kenyatta Military Barracks
WWF	=	World Wide Fund for Nature
JICA	=	Japan International Cooperation Agency
OECF	=	Overseas Economic Cooperation Fund, Japan

I. INTRODUCTION

1.1 Historical Background

The contemplated project is an integral part of the Greater Nakuru Water Supply Project which covers a vast area of approximately 6,370 km^2 and is divided into Western and Eastern Divisions. The Western Division with a total area of 3,755 km^2 is composed of 7 rural areas (South Baringo, Londiani, Molo, Rongai, Elburgon, Njoro and Lake Nakuru Settlement) and 5 urban centers (Lumbawa, Londiani, Molo, Elburgon and Njoro towns), while the Eastern Division with a total area of 2,615 km^2 is sub-divided into 4 rural areas and 3 urban centers as shown in Fig. 1.1. The land area of the respective area is as tabulated below.

Classified Area	Sub-area	Area (km^2)
Urban Area	Nakuru municipality	91.7
	Gilgil town	3.9
	Naivasha town	78.0
Rural Area	Gilgil rural	550
	Eburru rural	721
	Subukia	570
	Bahati	600
Total		2,614.6

The Nakuru municipality is the capital of the Rift Valley Province and is the fourth largest urban center within Kenya, following to Nairobi, Mombasa and Kisumu.

The population in the Eastern Division was approximately 251,000 in 1979, of which 92,600 concentrated in Nakuru municipality. During a 10-year period from 1969 to 1979, the Eastern Division had marked the population growth rate as high as 5.2 per cent per annum, 1.2 per cent greater than the national average. It was higher in the urban areas, 6.7 per cent per annum, 2.5 per cent exceeding that in the rural areas, having been accelerated by a continuous rural-urban emigrant.

Rapidly increasing population and progressive expansion of economic and industrial development activities have been generating a great amount of potable water demand. The actual supply has, however, been suppressed owing to lack of the source of supply. The Government of Kenya seriously thought of need of establishing a long-term water supply plan

in order to accomplish the prosperous regional development and to ameliorate the lives of the inhabitants and embarked upon the survey and study of the Greater Nakuru Water Supply Project. The long term water supply plan was initially formulated by the "Greater Nakuru Water Supply Project, Preliminary Design Report, 1985" (hereinafter referred to as "the 1985 Preliminary Design Report"), and was finally endorsed by the "Greater Nakuru Water Supply Project, Supplementary Report to Preliminary Design Report (hereinafter referred to as "the Supplementary Report").

The Supplementary Report concludes that the most technically and economically promising plan is to develop and make full treatment of the surface water resources of the Malewa river basin and implements it in two stages to meet the whole water demand up to a year 2005. The Stage 1 Project contemplates to use the unregulated runoff of the Turasha river in order to urgently improve the water supply situation specifically in both the Nakuru municipality and Gilgil town, and the Stage 2 Project (the Project) envisages to create a reservoir by means of constructing a dam in the Malewa river basin to achieve a safe and stable water supply for three urban areas (Nakuru municipality and both Gilgil and Naivasha towns) and two rural areas (Gilgil and Eburru) in the Eastern Division.

The Stage 1 Project is under construction by NWCPC with financial assistance from the OECF and is scheduled to be completed at the beginning of 1992. Its development plan and design were formulated by the "Preliminary Design Report, July 1988" (hereinafter referred to as "the 1988 Preliminary Report") and the "Final Design Report, August 1988" (hereinafter referred to as "the Final Report") respectively.

1.2 Organization and Management of the Study

The Government of Kenya regards it as vital to implement the Project as soon as possible in order to successfully accomplish the initial objective and requested the Government of Japan to extend a technical assistance for a feasibility study for Construction of Dam in Malewa River System for Greater Nakuru Water Supply Project (hereinafter referred to as "the Study"), as an initial step to realize the Project.

In response to the request, JICA, the official agency responsible for the implementation of the technical cooperation programs of the Japanese Government, dispatched its mission twice to Kenya : the first mission in March, 1986 to conclude the Scope of Work for the Study between JICA and MOWD and the second mission in October, 1988 to confirm the Scope of Work. In January, 1990, the Government of Kenya further requested to add a preliminary

environmental investigation to the original Scope of Work. This request was virtually accepted by the JICA and its scope of work was confirmed by a minute of meeting in February, 1990.

The Study was basically carried out in conformity with the Scope of Work and the three minutes of meetings in 1986, 1988 and 1990, and was actually commenced from February, 1989 and extended to November, 1990. MOWD was represented by NWCPC in execution of the Study.

JICA has organized and maintained an Advisory Committee throughout the period of the Study to furnish from time to time the Study Team with technical advice and assistance. The members of the committee was as presented in Table 1.1.

JICA appointed a Study Team, composing of a number of experts in various fields from Nippon Koei Co.,Ltd. and associated with INA Civil Engineering Consultants Co.,Ltd. The members of the Study Team were also as presented in Table 1.1.

1.3 Objective and Scope of the Study

The objective of the Study was to carry out a feasibility study of the Project. In order to achieve this objective the Study was programmed to proceed progressively in three phases and the scope of works of the various phases were stipulated as summarized below.

(1) Phase 1 Study

This phase focused on selection of the most promising damsite among the alternatives. For this purpose the following surveys, investigations and studies were executed.

- Collection and review of existing data and information;
- Identification of alternative damsites;
- Aerial photography and photogrammetric mapping of reservoir areas and damsites;
- Preliminary geological investigation, including test drilling and bore hole permeability tests;
- Preliminary construction material survey, including laboratory tests of earthfill and rockfill materials and concrete aggregates;
- Hydrological investigation;
- Water demand forecast;
- Selection of a promising damsite.

(2) Phase 2 Study

This phase aimed to formulate the optimum development plan of and to verify the technical and economical feasibility of the Project, taking into consideration of the environmental aspects. The major work items during this phase were as follows:

- Socio-economic survey;
- Additional geological investigation at the proposed damsite and quarry site;
- Additional construction material survey;
- Additional hydrological investigation;
- Preliminary environmental investigation;
- Formulation of optimum development plan;
- Preliminary design of the major project components;
- Construction planning and cost estimate;
- Project evaluation including economic and financial analysis.

(3) Phase 3 Study

This study particularly dealt with additional environmental investigation. In principle the environmental investigation under the Study was classified into two categories ; the preliminary survey for both the Malewa reservoir and Lake Naivasha and a fundamental survey for Lake Nakuru. The major work items of the various surveys were as follows:

(a) Preliminary investigation

- Collection of data and information;
- Agricultural survey;
- Inventory survey of irrigation facilities;
- Reconnaissance groundwater survey;
- Analysis of water balance in Lake Naivasha;
- Water quality investigation;
- Forecast of impacts during and after construction of the Project.

(b) Fundamental investigation

- Collection of fundamentals such as existing literatures, data and documents on environment, including preparation of topographic map of Lake Nakuru;
- Analysis of water balance in Lake Nakuru;

- Water quality investigation.

During the course of the various phases all the interim results derived from the various studies, surveys and investigations have been reported to MOWD/NWCPC in the form of the Interim Report and Progress Reports, and were discussed between MOWD/NWCPC and the Study Team to direct and improve the subsequent activities. This final report (draft) has been prepared by summarizing the procedures, findings and results of the various investigations and analytical works, preliminary design, cost estimate and project evaluation including environmental impact assessment.

1.4 Acknowledgement

The Study Team wishes to record its appreciation to Mr. H. K. Rotich, Managing Director of NWCPC, and Mr. Mwongera, Director for Water Development of MOWD, for their kind and constant assistance throughout the period of the Study. Heart-felt thanks are due to :

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Mr. M.Trajanow	Chief, Dam Construction Unit, MOWD;
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Mr. K.O.Kombudho	Acting Deputy Director, NES;
Prof. S.Njuguna,	Assistant Director for Botanical Science, National Museum;
Mr. G.J. Mbuthia	Town Engineer, Nakuru municipality;
Mr. A. H. J. T. Bidu	Town Clerk, Naivasha town.

The Study Team would also like to express their thanks and appreciation to the officials of the various government departments and agencies concerned, who have provided the Study Team with valuable advice, information and data in performing the Study.

II. BACKGROUND

2.1 Country Background

Kenya lies astride the equator in Eastern Africa between the Indian Ocean to the east and Lake Victoria to the west, with a total area of 582,646 km^2. The country is surrounded by five neighbor countries : Sudan, Ethiopia, Somalia, Tanzania and Uganda.

Topographically, Kenya may be divided into seven regions : Coastal plain in the east ; Nyika bushland and Tana swampy plain in the vicinity of the coastal plain ; Eastern plateau region ; Northern plain ; Kenya Highlands in the west-central part ; the Rift Valley and Western plateau.

It is worth noting that the Northern plain region is of arid and semi-arid nature and extends really over three-fifths of the whole territorial area. The Rift valley region, where the Project is located, is bounded by steep escarpments with altitude more than 3,000 m on the east and west, and is featured by a series of extinct valcanoes and a chain of lakes without outlets.

The climate in Kenya is dominated particularly by three distinct air masses. During the period from November to March, very dry winds, called the Harmattan dominate the western part of the country, while the north-east trade winds prevail in the eastern parts. By April the south-east monsoon marchs from the Indian Ocean, bringing about rainfall over the central, southern and easter parts of the country. From July, the Congo air streams, which is extremely unstable and generates convectional storms, penetrate through Equatorial Africa. The average annual rainfall over the entire country is approximately 450 mm, varying largely in the range of 250 mm or less in the Northern plain and more than 1,000 mm in the Kenya highlands, Western plateau and Coastal plain.

Perrenial rivers are, therefore, concentrated in the Kenya highlands, Western plateau and Coastal plain, but their runnoffs vary geographically and seasonally to a great extent. The largest river in Kenya is the Tana river with a drainage area of 62,160 km^2, followed by the Ewaso Ngiro (north) river with a drainage area of 56,980 km^2.

Mainly characterized by climatic condition and availability of water resources, only about 20% of the whole territorial area is deemed to be highly potential for cultivation, mostly concentrating in the above-said three region. Therefore these regions are desely populated

compared with the other regions. In the cultivated districts of those provinces, population density exceeds 386 per km^2, while it is less than 4 per km^2 in the northern half of the country. The nationwide population density in arable areas is about 276 per km^2.

2.2 General Socio-Economy

2.2.1 Existing Conditions of Socio-economy

The population in Kenya is estimated to have reached 23 million by the end of 1988 according to the government department concerned. The Census in 1979 showed a total of 15.3 million, implying an annual average growth rate of around 3.4% since 1969, the previous census year.

Economic performance in Kenya during the Fifth Development Plan (1984-1988) was slightly better than expected : the real average annual growth rate of GDP was 5.1% per annum while its target was 4.9% per annum in real terms as given in Table 2.1. Manufacturing and services including trade, restaurants and hotels mainly contributed to the growth. In 1988, however, agriculture was still a dominant sector with a share of 28.9% in GDP, followed by government services with 15.3%, manufacturing with 13.1% and trade, restaurants and hotels with 11.4%.

During the same period, current account deficits had worsen from Kshs.609 million in 1983 to Kshs. 8,060 million in 1988 mainly due to trade imbalance, although foreign earnings from tourism had increased greatly with an average annual growth rate of 22%, which exceeded that of imports (Table 2.2). The deficits were compensated by the inflow of foreign capital, especially the Government's long-term foreign debt, which sometimes brought about net surplus in overall balance. In the last two years, however, the inflow of foreign capital fell short of the current account deficits, resulting in deficits in overall balance.

Table 2.3 presents recent trends of foreign trade by major commodities. Coffee has the largest share of 27% in total exports in 1988, followed by tea of 20%, petroleum products of 18% and fruits and vegetables of 10%. During the period from 1984 to 1988, export of fruits and vegetables had rapidly grown at a rate of 12% annually while the growth of other major commodities relatively stagnated. For imports, machinery and transport equipment comes the first with a share of 38%, the second chemicals of 18% and the third manufactured goods of 16%. Imports of these major commodities had increased very rapidly at a rate more than 16% per annum.

2.2.2 Prospects for Socio-economic Development

In 1986, the Government set a long-term policy of socio-economic development in Kenya up to the year 2000, publicly known in " Sessional Paper No. 1 of 1986 on Economic Management for Renewed Growth". In response mainly to Kenya's rising population, more than 3% growth a year, this policy aims to realize a rapid economic growth with a sufficient provision of employment opportunities and with more efficient economic activities.

The Government set the growth target of GDP at 5.9% per annum during the period from 1988 to 2000. The attainment of the target depends crucially on the growth of agricultural sector, estimated at 5.3 % per annum during the same period.

Population is forecasted to reach 34.8 million in 2000 with the annual growth rate of 3.7%, slightly decreased from the existing level of 3.8% (1984-88), "if families were gradually to decide to have fewer children". With the current level of fertility rate remaining, Kenya's population would increase by 4.3% a year to 38.5 million from 19.5 million in 1984.

Based on the above projection, per capita GDP would increase by 2.1% a year, even though the population increase at 3.7% per annum. Moreover, the rapid increase in population would have a significant effect on employment opportunities. "Even if the economy creates jobs at 3.4% a year from 1984 to 2000 which would be a small improvement over the decade from 1972 to 1982, the unemployment rate would increase substantially". Therefore, the informal sector as well as the modern is expected to play a key role in creating employment opportunities for new entrants to labour market.

The Government set other goals guiding the socio-economic development in Kenya to the end of the century as may be summarized below:

- To rise productivity in both the public and private sectors,
- To provide basic needs for all Kenyans, taking into account "cost-sharing",
- To secure food based on increased productivity in the production of both food and export crops,
- To improve rural-urban balance so as to spread the benefits of economic growth widely throughout Kenya and,
- To gradually change economic structure from an agrarian into an urban-based industrial economy, with agriculture and small-scale industry and services leading the way up to 2000.

2.3 Major National Policies related to the Project

Among the long-term policies of the " Sessional Paper No.1 of 1986", more attention is paid to "rural-urban balance" and "budget rationalization" as far as the Project is concerned.

(1) Rural-urban balance

In anticipation of increasing migration from rural areas which will accelerate the growth of urban populations, especially in Nairobi and Mombasa, the Government intends to realize a more dispersed pattern of urban development, which is essential to promote the growth of agriculture and of related off-farm employment opportunities. Infrastructure is taken as the "first element in the strategy for rural-urban balance" and its provision is prioritized in terms of region, towns and kinds of infrastructure due to the limited resources available for new investments. Priority in budget allocation for water supply is given to "larger towns that have development potential but foresee deficiencies in current supply".

(2) Budget rationalization

Present budget deficits and an objective of rapid economic growth call for more efficiency of the Government's investments through the emphasis on identification of high-yielding projects and the active participation of private sector. Even within a field of basic needs, resources are shifted towards "more immediately productive activities such as youth polytechnics and water supplies in growing rural market towns". In relation to the budget rationalization, the Sixth Five Year Development Plan, 1989 - 1993 (the Sixth Five Year Plan), describes the necessity of extension of cost-sharing even in the fields of basic needs such as water supply, health and education.

(3) Policies of water supply sector

The basic goal of the national water development policy is "to facilitate the provision of water in sufficient quantity and quality to meet the needs of human beings, agriculture, livestock and industry".

Basic directions of the water supply programmes during the period of the Sixth Five Year Plan may be summarized as follows :

- A high priority is given to the provision of adequate good quality water for the growing urban population by enhancing the provision of financial resources for the development of the programmes under the local authorities,

- For rural areas, development of water supply is encouraged, especially in those areas where the Rural Trade and Population Centres are earmarked for development,

- Financial resources are made available through the District Development Fund, and

- The Government encourages the development of appropriate water harvesting technologies suitable to particular environments.

In the year 1993, the last year of the Sixth Five Year Plan, urban population is forecast to reach 5.6 million from 4.0 million in 1988, while rural population would increase from 18.7 million to 21.6 million during the same period. The Government expects 61% of the Kenyan population to be provided with clean water supplies by 1993 : 95% of urban population and 50% of rural population. The following table shows the targets of the population to be served by the organized water systems under the Sixth Five Year Plan.

Water Served Population	1989	1990	1991	1992	1993
Urban population (million)	3.5	3.9	4.4	4.8	5.4
Rural population (million)	5.9	7.1	8.3	9.7	11.1
Total	9.4	11.0	12.7	14.5	16.5
% of total population	40	45	50	55	61

The Government recognizes the needs for taking following measures to attain the target:

- More involvement of the public sector in upgrading its role in water conservancy such as installation of water conservancy devices,

- More encouragement of "Harambee" fund raising to supplement the Government allocations for future water supply projects, and

- Installation of individual water connections in all the properties so that water rates reflect actual consumption.

The investment plan during the period of the Sixth Five Year Plan shows that Kshs. 904.6 million of the gross fixed investment will be allocated to the water and electricity

sector in each year on an average. This amount accounts for about 5.2% of the total fixed investment.

2.4 Water Supply Sector

2.4.1 Public Water Supply Organizations

(1) MOWD

MOWD was established in 1974, reflecting the growing importance on water sector particularly rural water supply and has mainly concentrated on the rural water sector by constructing and opening several hundred schemes under its Rural Water Development Programme.

(2) NWCPC

NWCPC is an autonomous body under MOWD, and was established in 1988 under Section 3 (1) of the State Corporations Act by Legal Notice No. 270 of 1988. The establishment of NWCPC is based on the recognitions of the Government :

(a) that it is required to improve the financial conditions of the water supply sector so as to increase the level of coverage in both urban and rural areas, and

(b) that it is necessary to implement reforms in the water sector with the scheme productive and self-sustaining in order to attract the additional external resources.

Main functions of NWCPC are :

- the development, operation and maintenance of the specified water projects under general direction of MOWD,

- the supply of water in bulk or otherwise to such water consumers as designated by MOWD, and

- the assistance in formulation and execution of national water development policy.

Emphases are put on the efficiency in the operations for existing projects and on the cost recovery.

NWCPC has taken over the management of a large number of large scale water schemes, with effect from 1st July, 1989. According to the Schedule of Water Projects stated in "Kenya Gazette Supplement No. 28", the Greater Nakuru Water Supply Project has been designated to be implemented by NWCPC.

NWCPC is headed by the Managing Director under the NWCPC Board, and consists of five sections as shown in Fig. 2.1 : Corporate Services, Development Services, Operations, Secretary and Finance and Human Resources. Each section is divided into a number of sub-sections as follows :

- Corporate Services : Planning, Scientific Services and Information Technology;
- Development Services : Policy, Standards Development and Monitoring, Design, Dams and Reservoirs Structural Surveys and Construction;
- Operations : Technical Support and Operations;
- Finance and Human Resources : Accounting and Human Resources.

Staff of NWCPC have been and are being seconded from MOWD, and expected to reach 1,783 people.

(3) Local authorities

The local authorities are also involved in development and management of potable water supply. As far as the Eastern Division of the Greater Nakuru Water Supply Project is concerned, there are two local authorities being engaged in public water supply activities.

One is NMC, which operates and manages both the Nakuru and Nakuru Gilgil water supply systems under direction of MOLG and technical guidance from MOWD.

The other is NTC. It has no its own water source facilities and is entirely depending on the bulk water supply from MOWD. NTC, however, operates and maintains only distribution system within the town.

2.4.2 Present Service Level

(1) Urban areas

Residents in urban areas enjoy piped water more favourably than those in rural areas. About 75% of urban population is provided with piped water, of which over 90% is supplied through communal water points or kiosks, at present. The remaining urban population includes those who are not serviced directly.

According to IBRD, overall urban water usage exclusive of Nairobi ranges from 70 lpcd to 160 lpcd. Nairobi's average is estimated at about 180 lpcd.

(2) Rural areas

In 1988, only 26% of rural population is supplied with piped water. The others are forced to fetch water from natural sources which may not well suitable for drinking. Water usage is estimated at 50 lpcd for individual connections and about 10 lpcd for those who fetch water.

MOWD has promoted the Rural Water Supply Programme. It has been argued, however, that the level of operation and maintenance is low and many schemes have to be rehabilitated.

2.4.3 Development Constraints

Major development constraints in water supply sector may be summarized as follows:

(1) Insufficient provision of supply capacity

Rapid population growth with the rate of more than 3% per annum, makes it difficult for supply capacity to catch up with the growing water demand. On supply side, decrease in the supply capacity is partly observed due to deteterioration and/or super-annuation of the water supply facilities. In arid and/or desert areas, it is hardly possible to find adequate and safe water resources.

(2) Financial constraints of the Government budget

As mentioned in the sub-section 2.2.2, the Government budget has been rationalized due to its increased deficits. Although development expenditure of water development at the price 1985 has been increased from Kshs. 426 million in the fiscal year 1985 to Kshs. 800 million in the fiscal year 1989, its recurrent expenditure decreased from Kshs. 320 million to Kshs. 282 million. This suggests that the Government has expected MOWD to reinforce the cost recovery at least for operation and maintenance cost as well as efficient management of water supply schemes.

On the other hand, financial status of MOWD is not considered favorable. In 1984, MOWD water schemes in Kenya cost Kshs.1.15/m^3 for direct O&M cost and Kshs.2.90/m^3 for total O&M cost, on average. However, the average water rate (billable revenue divided by sales volume) was Kshs.1.04/m^3.

To overcome the above situation, cost recovery as well as more efficient management of water systems should be promoted. In setting appropriate water tariffs, the capacity to pay for water, especially among lower income households should be taken into account. For those in rural areas, it may be difficult to collect water bills, since water is sometimes perceived "for free".

III. THE STUDY AREA

3.1 General Description

3.1.1 Location and Topography

The Study Area actually extends over a vast area covering the three lake drainage basins, namely, Lake Nakuru, Lake Elementaita and Lake Naivasha from the east. The characteristics of the respective lake basin are described in the sub-section 3.1.3 of this report, while the locations and topography of the proposed water service area are briefly reported herein.

The Nakuru municipality lies within the drainage area of Lake Nakuru and is located about 160 km northwest of Nairobi, capital of Kenya. It is connected to Nairobi and Kisumu by both the National Highway A104 and railroad, both of which passes through Naivasha and Gilgil towns. The municipal area is extending on the southern slope of Menengai Crater between El. 2,000 m and El. 1,780 m and it bounds on the south with Lake Nakuru National Park, which is located at the lowest part in the floor of the Rift Valley at El. 1,760 m.

The Naivasha town with a gross administrative area of 940 km^2 is located encircling Lake Naivasha and is approximately 86 km distant from Nairobi. The township area is administratively divided into 12 wards, out of which the whole areas of Sokoni, Biashara, Milimani, Lake View and Karati wards and a part of Hell's Gate ward have been regarded as the proposed water service area. The proposed area of approximately 78 km^2 is most densely populated within the township and stretches between El. 1,800 m and El. 2,200 m.

The Gilgil town is situated between Naivasha town and Nakuru municipality and also lies within the drainage area of Lake Naivasha. Its administrative area is spreading over the undulating hilly lands with average altitude El. 2,000 m. There are four bulk water consumers such as the NYTSC, ASTU, GMB and KMB, scattering in the immediate outskirts of the town.

Both the Gilgil and Eburu rural areas encompass a vast undulating hilly topographic lands with elevation ranging from El. 2,300 m to 1,880 m. Both rural areas extend astride Lake Elementaita and Lake Naivasha basins and embraces a number of rural communities, which will be served by the Project.

3.1.2 Regional Geology

The Study Area lies wholly in a main rift of the Rift Valley which is a part of the Great Rift System and has a feature of trough with complex faultings of general orientation from the north to the south.

The Rift Valley is intersected with varied tectonic structures, e.g., faults oblique to its axis and secondary minor troughs right angle to it. The entire stratigraphic sequence consists of Tertiary to Recent volcanic and pyroclastic rocks, with intercalation of lake sediments which are tuffaceous in part. In the contemplated reservoir area, the bedrock is composed of trachytes, welded tuffs and massive tuffs of the Pliocene Kinangop Tuff group interbedded with the lake sediments.

A full description on the regional and site geologies is presented in Annex B and gelogical condition over the proposed reservoir area and damsite is briefly summarized in Section 5.1 of this report.

3.1.3 Climate

There are two distinct wet seasons and one dry season in a year. Hot and dry climate prevails during the period from December to March, while wet and relatively cold climate remains during the period from April to June (major wet season) and from October to November(minor wet season).

The climatological features in the study area is presented in Table 3.1. The annual rainfall and air temperature clearly vary with altitude. The annual rainfall and mean temperature at South Kinangop (El. 2,591 m) are 1,453 mm and 11.6 ^{o}C respectively, while those at Nakuru (El. 1,872 m) are 627 mm and 17.5 ^{o}C respectively. The annual evaporation largely exceeds the annual rainfall, 1,742 mm at Nakuru. The drought year occurs often, most recently in 1988. It is not rare that Lakes Elementaita and Nakuru expose their bottom extensively in such drought year.

3.1.4 Water Resources

(1) Lake Naivasha drainage basin

Lake Naivasha drainage basin with a total area of 3,401 km^2 is the largest one in and around the proposed water service area, and the lake has no outgoing river. The lake is mainly fed by the Malewa river with the drainage area of 1,653 km^2 and Gilgil river with the drainage area of 511 km^2. Among a number of the lakes in the Rift Valley, only the Lake Naivasha is characterized by fresh water. The lake surface area is approximately 140 km^2 at El. 1,884 m, varying largely with the lake level, and the lake level fluctuates greatly throughout the year and from year to year in harmony with change in climate. In the 1988 drought year the lake level declined extremely to El. 1,882 m, the lowest level in the recent 25 years. The Malewa river takes its origin in the western slope of the Abardare Range and joins its major tributary, Turasha river at about 8 km west from Gilgil town. Its surface water resources has been partly used for rural water supply and minor irrigation and being developed on a run-of-river basis for the Stage 1 Project.

The Gilgil river originates in a small hill with summit altitude El. 2,700 m in Bahati Forest and flows down almost in parallel with the main stream of the Malewa river. The runoff of the river has been the source of the Murindati treatment works, serving Gilgil town, but normally runs dry during the dry season in the downstream reach from the Murindati intake.

(2) Lake Elementaita drainage basin

Lake Elementaita drainage basin with a total area of 588 km^2 lies in between Lake Naivasha basin and Lake Nakuru drainage basin and mainly covers the rolling topographic lands with elevation varying between El. 2,800 m and El. 1,780 m. Also the lake has no outgoing river and its water is of saline, although fresh water is supplied mainly by the Mororoni river, having the drainage area of 188 km^2. Further the lake is very shallow in water, also varying largely with the lake level. The origin of the river is in the same area as the Gilgil river and the runoff of the river has been the sole water source of both the Lanet and Mororoni treatment works, which are currently sustaining approximately 30 % of the potable water supply in Nakuru municipality. A great number of the water right has been so far registered in the Mororoni river so that there is no possibility to further abstract the runoff from the the Mororoni river.

(3) Lake Nakuru drainage basin

Lake Nakuru drainage basin, extenting over an area of 1,536 km^2, is divided into 6 sub-basins, namely, Njoro, Ngosor, Makalia, Enderit and Lamudiac rivers and lake itself including minor rivers. Their drainage areas are 300, 80, 290, 300, 106, and 176 km2 respectively. Like Lake Elementaita, the Lake Nakuru is featured with the saline water and shallow water depth, and because of its geographical location, it now acts as the receptacle of sewage effluent from Nakuru municipality. The lake level varies largely like as the other two lakes and the lake surface area is 43 km^2 at El. 1,758.5 m. Characterized by the small catchment area and uneven distribution of rainfall throughout the year, all the rivers run dry during the dry season.

Among a number of the rivers in the Study Area, the surface runoff of the Malewa river basin remains almost untapped and therefore has been regarded as the water resource for the water service area under the Study. A full description of the hydrology of the Malewa river basin is reported in Annex D.

The runoff of the river has been recorded accurately by MOWD for more than 30 years at two stream gauging stations, i.e., 2GC4 on the Turasha river and 2GB1 on the main stream of the Malewa river. The location of the stream gauging stations are as shown in Fig. 3.1. The long term monthly runoffs of the Malewa and Turasha rivers are presented in Tables 3.2 and 3.3 respectively . The average annual runoffs of the Malewa river is estimated at 3.19 m^3/sec at the proposed damsite and that of the Turasha river 3.57 m^3/sec at the intake site.

The probable floods at the proposed damsite has been derived from the statistical treatment of the recorded floods at 2GC4. The peak discharges are 240 m^3/sec and 960 m^3/sec for the 20- and 1,000-year floods respectively. The probable maximum flood with a peak discharge of 1,753 m^3/sec has been estimated based on the analysis of the probable maximum precipitation and unit hydrograph method.

The suspended loads transported by the Malewa river have been estimated at 123,000 m^3/year based on the observation records. The reservoir dead storage has, however, been designed based on a sediment yield from the catchment area of 0.5 mm/km^2/year for the sake of the safety, which is appropriate to drainage areas having similar geographical conditions to the Malewa river basin in Kenya.

3.1.5 Water Quality

The proposed water service area is situated on the floor of the Rift Valley, which is suffers from a shortage of water resources. Currently the groundwater is is widely used within the proposed water service area as is the most convenient source of potable water supply. In particular the groundwater bears the entire water supply in Naivasha town and nearly 60 % of water supply in Nakuru municipality. It however contains a very high rate of fluoride in places. Especially in Nakuru municipality, the fluoride content is detected as high as 1.9 - 5.5 ppm, exceeding extremely the upper limit (3 ppm) in drinking water quality standard set out in "Design Manual for Water Supply in Kenya" issued by the MOWD in 1985 (hereinafter referred to as "the Design Manual"). In view of the health significance, the long term water supply plan has, therefore, been elaborated placing emphasis on development of the surface water resources.

Although the water quality of both the Malewa and Turasha river waters have been judged suitable for drinking purposes with full treatment in previous studies, further test were made periodically during the study period in order to supplement the existing data. The results of the tests are given in Table 3.4.

According to the results of the tests, concentrations of albuminous ammonia, ammonia, nitrate and chlorine are negligibly small. This fact implies that the river waters are not contaminated by organic matter. Further according to the 1988 Preliminary Report, it has been confirmed by a jar test that color, manganese and iron could be removed easily by means of conventional water treatment processing.

At present no particular source of pollution has been identified within the drainage areas of the Malewa river. Subjected to very high population growth rate, economic and development activities within the drainage areas in future will become thriving, probably resulting in increasing the discharge of various pollutants. It is, therefore, advisable to monitor the quality of the river water carefully and establish appropriate measure for watershed management for conservation of the precious water resources.

3.2 Socio-economic Conditions

3.2.1 Current Population

The population distribution and trends in the proposed water supply area are shown in Table 3.5. Nakuru municipality is estimated to have had a population of 240,000 in 1987, 37,500 in Naivasha Town in 1989, 15,100 in Gilgil town in 1987and 13,600 in Gilgil rural in 1985. Data on population in Gilgil rural is not available. It is noted that the growth of population in both the Nakuru municipality and Naivasha town had been accelerating in recent years at 12.6% per annum as compared with those between 1969 and 1979: 7.0 and 5.2 percent per annum for Nakuru municipality and Naivasha town respectively. On the other hand, recent population growth rates in both the Gilgil town and especially in Gilgil rural decreased in comparison with those between 1969 and 1979.

Among the beneficiary areas, Nakuru municipality is one of the largest cities in Kenya. According to the 1979 census, it had the fourth largest population of 92,900 with a higher annual growth rate of 6.2% than those of the larger cities, for instance 5.0% of Nairobi, during a period from 1969 to 1979 (Table 3.6). In addition, its population density was almost as much high as that of Nairobi. The results of the latest census carried out in 1989 are not available yet.

3.2.2 Economic Activities

The beneficiary areas belong to the driest zone in Nakuru district with rainfall of less than 760mm and their lands are classified as low potential, of which land use usually consists of dairying, crop production, ranching and horticultural production.

Wage employment in the main towns of Nakuru district is shown in Table 3.7. There are about 22,000 wage labourers in Nakuru municipality, some 4,000 in Naivasha town and 3,400 in Gilgil in 1985. It is noted that the growth in wage labourers is the highest in Gilgil town : 8.5 per cent per annum as compared with 3.5% and 3.7% for Nakuru municipality and Naivasha town respectively.

(1) Nakuru municipality

Table 3.8 indicates an aspect of economic development of both the Nakuru municipality and Nakuru district from the viewpoint of employment structure. In the municipality,

those engaged in manufacturing and especially in trade and commerce had remarkably increased between 1969 and 1980/81, while those in the primary sector decreased. The services other than trade and commerce have the largest share of 37% in total employees despite its relative decline of share, followed by manufacturing of 27% and trade and commerce of 26% in 1980/81.

Most of the manufacturing is agro-based with a lot of agricultural commodities supplied from its fertile hinterland. Many are involved in processing and packaging of agricultural products such as coffee, pyrethrum and sisal. Textiles is another major industry. The informal sector is considered to be getting important due to its absorbing capacity of new entrants into the labour market as migrant people from rural areas increase and lead to a rapid growth of population in the Municipality.

The visitors to Lake Nakuru National Park increased at a rate of 7.1% per annum between 1983 and 1987. The rapid increases in visitors and therefore in revenues from them may reflect the recent trend of increases in foreign tourists in Kenya as mentioned in sub-section 2.2.1, as well as the increasing educational use being made of Kenya's national parks by the schools of Kenya.

Year	Total visitors	Total vehicles	Revenue collected (Kshs.)
1983	98,055	16,412	2,467,695
1984	123,858	23,296	3,160,660
1985	125,543	24,137	3,459,927
1986	127,848	22,778	3,822,379
1987	128,895	22,770	7,267,899

(2) Naivasha Town

The population of Naivasha Town appears to be increasing at a rapid rate partly due to its vicinity and better access to Nairobi and Nakuru, which allows the residents to travel to work. A datum on earnings of modern sector wage employment indicates that Naivasha Town depends on community / social / personal services and to much lesser extent on agriculture and forestry, while manufacturing and other services are less developed (Table 3.9).

Agriculture in Naivasha area is characterized by recent developments in horticultural crops, the recent remarkable export goods as mentioned before, such as french beans,

strawberries, citrus and flowers. Favorable conditions for exports such as changes in the exchange rate has encouraged farmers to grow them more than before, and they can do so due to the availability of water for irrigation from Lake Naivasha and other water sources.

(3) Other areas

Gilgil town seems to be developing rapidly, judging from the recent remarkable growth of wage employment as mentioned before. Establishment of the Kenya Post Communication Complex probably contributed to this growth. Its economic structure may be similar to that of Naivasha due to the geographical vicinity for except effects of the lake, for instances irrigated agriculture and fisheries which it does not have.

3.2.3 Regional Development Prospects

In this sub-section, the regional development prospects for the Study Area are described, based on the "Nakuru District Development Plan, 1989 - 1993" (the District Development Plan).

(1) Development potential and needs

The District Development Plan expects the agricultural sector to be the major potential for promoting economic growth in the district, especially in the highland areas with more rainfall and better soils. In the dryer areas to which the Study Area belongs, an emphasis is placed on the potential of horticulture production, in particular, in the Lake Naivasha area. Expansion of large scale horticulture production, however, is confined to a narrow extent mainly due to land and water constraints. For livestock, meat production is expected to increase in Gilgil and Naivasha area. Livestock production is hampered by "tick-borne" diseases and water shortages in dry season.

For manufacturing and commerce, Nakuru municipality has substantial potential to attract private enterprises and create job opportunities due to its good road access to Nairobi, a growing labour market, large nearby markets and a good infrastructural base. There is even greater potential to create jobs in the informal sector of the smaller towns. However industrial development has some constraints such as lack of investment capital, supply conditions, irregular and inadequacy of raw materials. In addition, one of the major constraints to the development is in sufficiency of water supply because all towns in the district have overutilized water systems.

In the social services sector as well, over-utilization of water supply system is one of major problems. The expansion of water supply system is expected to contribute not only to the improvement of the quality of life, but to attraction of investors, as well as to better functioning of health facilities.

(2) Development priorities

The Nakuru District Development Committee (DDC) have development priorities during the plan period (1989 - 93). The priorities may be summarized shown below.

(a) Cash and food crop production

Increase in cash and food crop production is expected to be the driving force of the district economy, which would contribute to food security and rising income and employment, as well as spill-over effects, in particular, through the provision of raw materials for agro-processing. Main crops are maize, wheat, beans, potatoes and millet for food crops and coffee, tea and pyrethrum for cash crops.

Expansion of horticultural production around Lake Naivasha is one of major issues noted, which will be partly realized by providing all weather roads.

(b) Daily and livestock production

Emphasis is put on the intensification of dairy production and the rehabilitation of ranches for beef production. For the measures to attain the objectives, the following are proposed:

- zero-grazing,
- improved livestock rearing,
- artificial insemination,
- control of tickborne diseases,
- beekeeping and
- improvement in the marketing of livestock products.