## L1. BACKGROUND OF THE STUDY

### L1.1 General Description

The Project aims at rehabilitating and expanding both Njoro and Town sewage works in order to minimize adverse effects on the natural environment in the Study area owing to an increase of sewage outflow from Nakuru Municipality, which will be produced as a result of Nakuru urban development and population increase. The environmental impact assessment to be carried out under the Study mainly focuses on ascertaining the present environmental conditions in the Study area and anticipated environmental impact during construction and after implementation of the Project.

The environmental study area consists of Lake Nakuru National Park including Lake Nakuru, Nakuru Municipality and sites of the sewerage facilities. It is fully and commonly known that the ecology of Lake Nakuru is very delicate and sensitive and it is evident that it will certainly require a long period and a great effort to scientifically, qualitatively and quantitatively clarify the ecology. Therefore in this study only an attempt is made to describe at preliminary level the ecology mainly based on the various literature accumulated so far.

During a field investigation period from June to September 1993, a major effort has been placed on data collection, analysis and formulation of an environmental impact assessment format.

This report presents initial findings obtained through a filed investigation. The environmental impact assessment will actually be undertaken upon completion of the project design and will be reported in a specific report, forming a part of the final report.

### L1.2 Background to the Project

Nakuru is the Headquarters of Rift Valley Province and is the fourth largest urban centre in Kenya. The municipal area extends mainly on the southern slope of Menengai Cratre between El. 2,100 m and El. 1,860 m and covers the area of 65 $km^2$. It bounders Lake Nakuru National Park to the south.

According to the previous study, population in the municipality is forecasted at 361,000 for 1993, while it was only 95,000 in 1979 according to the 1979 census. There have been more than 34 major industrial establishments of various categories and scales. Such rapidly increasing population and progressive expansion of economic and industrial development activities have been generating a great amount of potable water demand. Current water consumption is approximately 24,000 $m^3$/day.

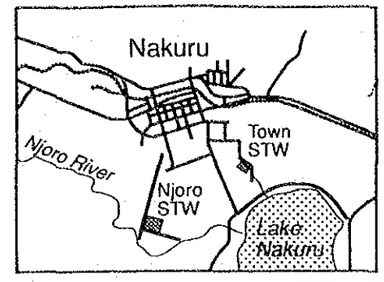
In order to cope with increasing water demand, additional water supply of 13,300 $m^3$/day is expected to be commissioned by the Greater Nakuru Water Supply Project, Eastern Division, Stage 1, soon after completion of the contemplated Nakuru Sewage Works Rehabilitation and Expansion Project. The sewage generation will increase accordingly.

The central part of the municipal area has been provided with the public sewerage system and the existing sewers cover an area of about 12.9 $km^2$. The sewage generated from the area is collected into Njoro STW with a daily treatment capacity of 3,600 $m^3$/day and Town STW with a daily treatment capacity of 3,400 $m^3$/day.

However the current sewage generation of approximately 9,000 $m^3$/day far exceeds the treatment capacity, resulting in deteriorating quality of treated effluent. If the additional water supply is made without a proper countermeasure, it will eventually increase pollution load into Lake Nakuru. At present NWCPC is implementing an augmentation programme of Njoro STW, to be increased by 6,000 $m^3$/day, which is scheduled to be completed by middle of 1994. It has however been clarified through a sewage generation analysis that additional expansion works are essentially required for both Njoro and Town STW to properly treat the augmenting sewage.

Fig L-1

Key Map





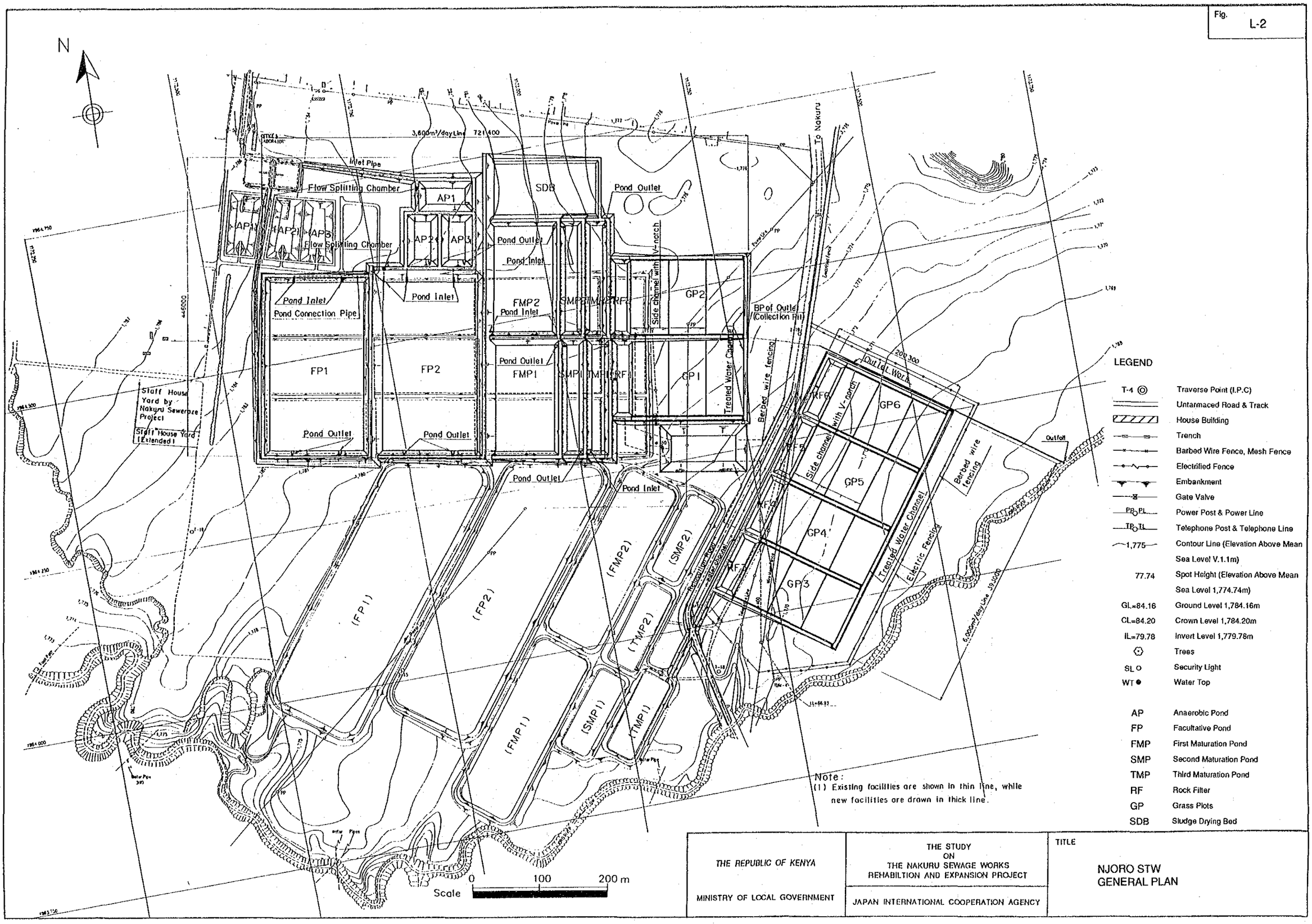


Scale

0 1 2 km

| | | |
|---|---|---|
| THE REPUBLIC OF KENYA | THE STUDY ON THE NAKURU SEWAGE WORKS REHABILTION AND EXPANSION PROJECT | TITLE |
| MINISTRY OF LOCAL GOVERNMENT | JAPAN INTERNATIONAL COOPERATION AGENCY | GENERAL LAYOUT OF THE PROJECT |

Fig. L-2



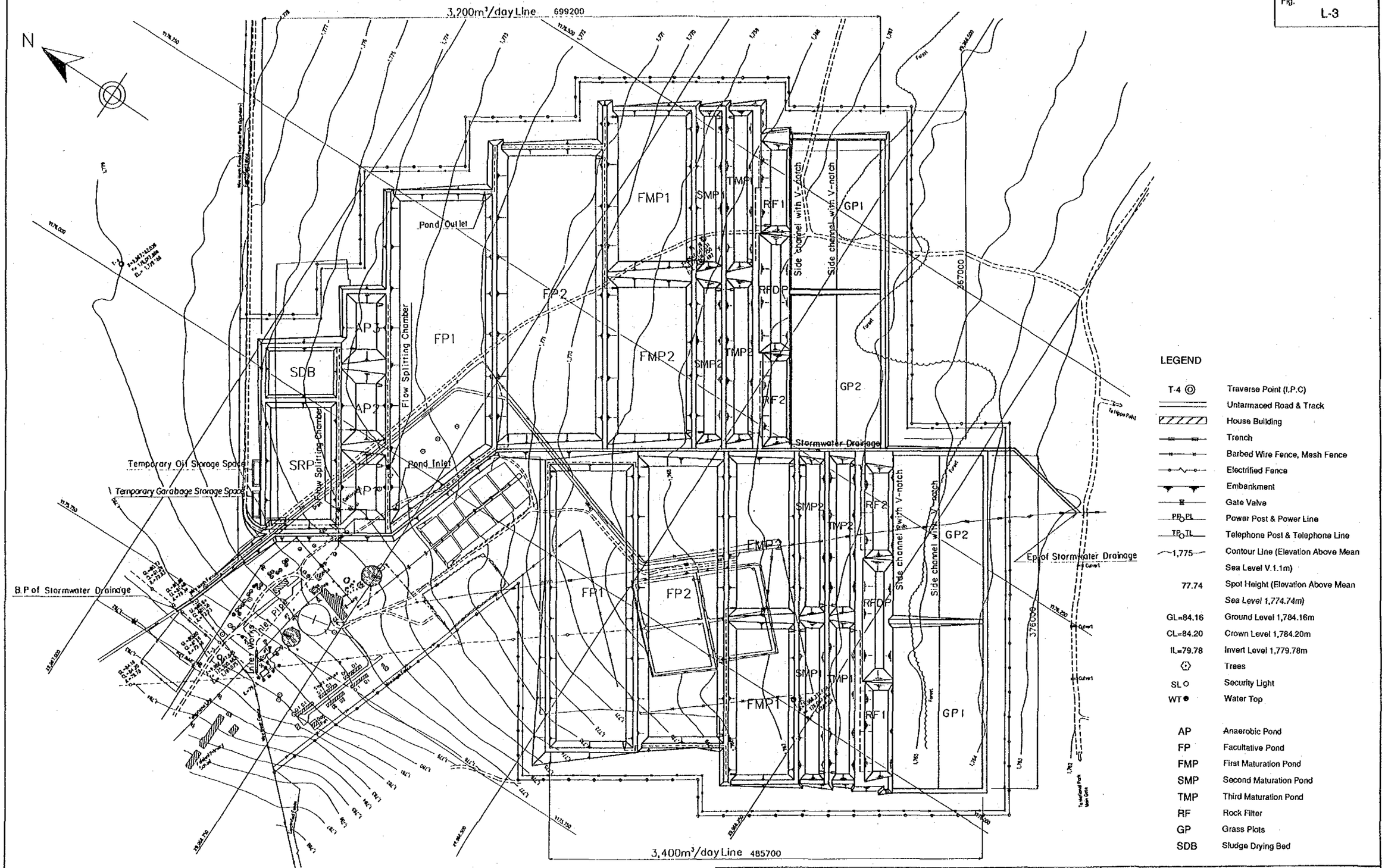

LEGEND

| | |
|---|---|
| T-4 ◎ | Traverse Point (I.P.C) |
| | Untarmaced Road & Track |
| | House Building |
| | Trench |
| | Barbed Wire Fence, Mesh Fence |
| | Electrified Fence |
| | Embankment |
| | Gate Valve |
| PP○PL | Power Post & Power Line |
| TP○TL | Telephone Post & Telephone Line |
| 1,775 | Contour Line (Elevation Above Mean Sea Level V.1.1m) |
| 77.74 | Spot Height (Elevation Above Mean Sea Level 1,774.74m) |
| GL.=84.16 | Ground Level 1,784.16m |
| CL.=84.20 | Crown Level 1,784.20m |
| IL.=79.78 | Invert Level 1,779.78m |
| ⊙ | Trees |
| SL○ | Security Light |
| WT● | Water Top |
| AP | Anaerobic Pond |
| FP | Facultative Pond |
| FMP | First Maturation Pond |
| SMP | Second Maturation Pond |
| TMP | Third Maturation Pond |
| RF | Rock Filter |
| GP | Grass Plots |
| SDB | Sludge Drying Bed |

Note:
(1) Existing facilities are shown in thin line, while new facilities are drawn in thick line.

| | | |
|---|---|---|
| THE REPUBLIC OF KENYA | THE STUDY ON THE NAKURU SEWAGE WORKS REHABILTION AND EXPANSION PROJECT | TITLE |
| MINISTRY OF LOCAL GOVERNMENT | JAPAN INTERNATIONAL COOPERATION AGENCY | NJORO STW GENERAL PLAN |

Fig. L-3




LEGEND

| | |
|---|---|
| T-4 ◎ | Traverse Point (I.P.C) |
| | Untarmaced Road & Track |
| | House Building |
| | Trench |
| | Barbed Wire Fence, Mesh Fence |
| | Electrified Fence |
| | Embankment |
| | Gate Valve |
| PP PL | Power Post & Power Line |
| TP TL | Telephone Post & Telephone Line |
| 1,775 | Contour Line (Elevation Above Mean Sea Level V.1.1m) |
| 77.74 | Spot Height (Elevation Above Mean Sea Level 1,774.74m) |
| GL=84.16 | Ground Level 1,784.16m |
| CL=84.20 | Crown Level 1,784.20m |
| IL=79.78 | Invert Level 1,779.78m |
| | Trees |
| SL ○ | Security Light |
| WT ● | Water Top |

| | |
|---|---|
| AP | Anaerobic Pond |
| FP | Facultative Pond |
| FMP | First Maturation Pond |
| SMP | Second Maturation Pond |
| TMP | Third Maturation Pond |
| RF | Rock Filter |
| GP | Grass Plots |
| SDB | Sludge Drying Bed |

| | | |
|---|---|---|
| THE REPUBLIC OF KENYA | THE STUDY ON THE NAKURU SEWAGE WORKS REHABILITION AND EXPANSION PROJECT | TITLE |
| MINISTRY OF LOCAL GOVERNMENT | JAPAN INTERNATIONAL COOPERATION AGENCY | TOWN STW GENERAL PLAN |

## L2. DESCRIPTION OF THE PROPOSED PROJECT

The general layout of the Project is shown in Fig. G-1. The major construction works of the Project can be devided into following seven kinds of works;

(1) Njoro Sewege Treatment Work, 3,600 $m^3$/day Line Rehabilitation
(2) Njoro Sewege Treatment Work, 6,000 $m^3$/day Line Rehabilitation
(3) Njoro Sewege Treatment Work, Sludge Drying Bed Construction
(4) Town Sewege Treatment Work 3,400 $m^3$/day Line Rehabilitation
(5) Town Sewege Treatment Work 3,200 $m^3$/day Line Expansion
(6) Town Sewege Treatment Work Drying Bed Construction
(7) Stormwater Retension Pond Construction

The project site of the above works 1), 2) and 3) is shown in Fig. G-2, the site of the above works 4), 5), 6) and 7) is shown in Fig. G-3. ThePrincipal features of the above structural works are described below.

### L2.1. Njoro Sewege Treatment Work, 3,600 $m^3$/day Line

(1) Inlet Connection Pipe

| | | |
|---|---|---|
| Design discharge (Hourly Maximum) | : | 0.100 $m^3$/sec |
| Inlet water level | : | El. 1,786.1 m |
| Pipe diameter | : | D300 mm & D450 mm |
| Pipe length | : | 315 m |
| Flow splitting chamber | : | 1 no. |

(2) Waste Stabilization Ponds, Rock Filters and Grass Plots

| | Anaerobic Ponds | Facultative Ponds | First Maturation Ponds | Second Maturation Ponds | Third Maturation Ponds | Rock Filters | Grass Plots |
|---|---|---|---|---|---|---|---|
| Number of Ponds | 3 | 2 | 2 | 2 | 2 | 2 | 2 |
| Design Discharge (Average Daily) | 1,800 $m^3/d$ | 1,800 $m^3/d$ | 1,800 $m^3/d$ | 1,800 $m^3/d$ | 1,800 $m^3/d$ | 1,800 $m^3/d$ | 1,800 $m^3/d$ |
| $BOD_5$ Concentration | | | | | | | |
| Influent | 800 mg/L | 384 mg/L | 115 mg/L | - | - | 30 mg/L | - |
| Effluent | 384 mg/L | 34 mg/L | - | - | 30 mg/L | - | 15 mg/L |
| Normal Operation Level | El.1,784.5m | El.1,784.0m | El.1,779.0 m | El.1,778.5m | El.1,778.0m | El.1,777.5m | - |
| | | | El.1,778.0m | El.1,777.5m | El.1,777.0m | El.1,776.5m | - |
| Ponds Dimension | | | | | | | |
| Bottom area | 24m x 57m | 139m x 251m | 88m x 158m | 18m x 158m | 18m x 158m | 17.4m x 97.4m | 110m x 165m |
| Surface area at NOL | 42m x 75m | 151m x 263m | 97m x 167m | 27m x 167m | 27m x 167m | 27m x 107m | - |
| Effective depth | 3.0 m | 2.0 m | 1.5 m | 1.5 m | 1.5 m | 1.6 m | - |
| Effective volume | 6,777 $m^3$ | 74,602 $m^3$ | 22,577 $m^3$ | 5,514$m^3$ | 5,514 $m^3$ | 3,667 $m^3$ | - |
| Min. freeboard | 0.5 m | 0.5 m | 0.5 m | 0.5 m | 0.5 m | 0.5 m | - |
| Side slope | 1.0 : 3.0 | 1.0 : 3.0 | 1.0 : 3.0 | 1.0 : 3.0 | 1.0 : 3.0 | 1.0 : 3.0 | - |
| Retention Period | 3.7 days | 41.4 days | 12.5 days | 3.0 days | 3.0 days | | |

(3) Pond Connection Pipes

| | | |
|---|---|---|
| AP - FP | D300 - 450 mm, | length 490 m, including one flow splitting chamber |
| FP - FMP | D300 mm, | length 375 m |
| FMP - SMP | D300 mm, | length 10 m |
| SMP - TMP | D300 mm, | length 10 m |
| TMP - RF | D300 mm, | length 160 m |

(4) Outlet Works

| | | |
|---|---|---|
| Design discharge (Hourly Maximum) | : | 0.100 ~ 0.222 $m^3$/sec |
| Dimensions | : | W675 m x W675 mm |
| Length | : | 495 m |
| Outfall | : | W675 mm x H4.3 m |

L2.2 Njoro Sewege Treatment Work, 6,000 $m^3$/day Line Rehabilitation

(1) Rock Filters and Grass Plots

| | Rock Filters | Grass Plots |
|---|---|---|
| Number of Ponds | 4 | 4 |
| Design Discharge (Average Daily) | 1,500 $m^3$/day | 1,500 $m^3$/day |
| $BOD_5$ Concentration | | |
| Influent | 30 mg/L | - |
| Effluent | - | 15 mg/L |
| Normal Operation Level | El.1,771.6 m | - |
| Ponds Dimension | | |
| Bottom area | 17.4m x 97.4m | 92m x 165 m |
| Surface area at NOL | 27m x 89m | - |
| Effective depth | 1.6 m | - |
| Effective volume | 3,027 $m^3$ | - |
| Min. freeboard | 0.5 m | - |
| Side slope | 1.0 : 3.0 | - |

(2) Pond Connection Pipes

TMP - RF D375 mm, length 835 m

L2.3 Njoro Sewege Treatment Work, Sludge During Bed Construction

| | | |
|---|---|---|
| Number of Ponds | : | 1 |
| Design Discharge (Average Daily) | : | 9,600 $m^3$/day |
| Ponds Dimension | | |
| Bottom area | : | 74.8m x 151.8m |
| Surface area | : | 82.0m x 159.0m |
| Effective depth | : | 1.2 m |
| Effective volume | : | 14,635 $m^3$ |
| Side slope | : | 1.0 : 3.0 |

L2.4 Town Sewege Treatment Work, 3,400 $m^3$/day Line

(1) Inlet Connection Pipe

| | | |
|---|---|---|
| Design discharge (Hourly Maximum) | : | 0.094 $m^3$/sec |
| Inlet water level | : | El. 1,779.5 m |
| Pipe diameter | : | D450 mm |
| Pipe length | : | 460 m |
| Flow splitting chamber | : | 1 no. |

(2) Waste Stabilization Ponds, Rock Filters and Grass Plots

| | Facultative Ponds | First Maturation Ponds | Second Maturation Ponds | Third Maturation Ponds | Rock Filters | Grass Plots |
|---|---|---|---|---|---|---|
| Number of Ponds | 2 | 2 | 2 | 2 | 2 | 2 |
| Design Discharge (Average Daily) | 1,700 $m^3$/day | 1,700 $m^3$/day | 1,700 $m^3$/day | 1,700 $m^3$/day | 1,700 $m^3$/day | 1,700 $m^3$/day |
| $BOD_5$ Concentration | | | | | | |
| Influent | 280 mg/L | 84 mg/L | - | - | 30 mg/L | - |
| Effluent | 32 mg/L | - | - | 30 mg/L | - | 15 mg/L |
| Normal Operation Level | El.1,770.5 m El.1,769.0 m | El.1,786.0 m | El.1,767.5 m | El.1,767.0 m | El.1,766.0 m | - |
| Ponds Dimension | | | | | | |
| Bottom area | 78m x 305m | 58m x 164m | 30m x 96m | 30m x 96m | 17.4m x 91.4m | 170m x 100m |
| Surface area at NOL | 90m x 317m | 67m x 173m | 39m x 105m | 39m x 105m | 27m x 101m | - |
| Effective depth | 2.0 m | 1.5 m | 1.5 m | 1.5 m | 1.6 m | - |
| Effective volume | 52,320 $m^3$ | 15,827 $m^3$ | 5,231 $m^3$ | 5,231 $m^3$ | 3.454 $m^3$ | - |
| Min. freeboard | 0.5 m | 0.5 m | 0.5 m | 0.5 m | 0.5 m | - |
| Side slope | 1.0 : 3.0 | 1.0 : 3.0 | 1.0 : 3.0 | 1.0 : 3.0 | 1.0 : 3.0 | - |
| Retention Period | 30.7 days | 9.3 days | 3.0 days Total | 3.0 days 46.0 days | - | - |

(3) Pond Connection Pipes

| | | |
|---|---|---|
| SC - FP | D300 - 450 mm, | length 460 m, including one flow splitting chamber |
| FP - FMP | D300 mm, | length 310 m |
| FMP - SMP | D300 mm, | length 55 m |
| SMP - TMP | D300 mm, | length 150 m |
| TMP - RF | D300 mm, | length 320 m |

L2.5 Town Sewege Treatment Work, 3,200 $m^3$/day Line

(1) Inlet Works

| | | |
|---|---|---|
| Design Discharge | : | 0.089 $m^3$/sec |
| Inlet water level | : | El.1,779.75 m |
| Coarse screen | : | W 0.6 m x H 1.2 m |
| Fine screen | : | W 0.6 m x H 1.35 m |
| Constant velocity grit removal channel | : | W 0.8 m x D 0.5 m x L 9 m |
| Parshall flume | : | Throad width 150 mm |
| Inlet pipe | : | D 300 mm, D 450 mm |
| Pipe length | : | 460 m |
| Flow splitting chamber | : | 1 no. |

(2) Waste Stabilization Ponds

| | Anaerobic Ponds | Facultative Ponds | First Maturation Ponds | Second Maturation Ponds | Third Maturation Ponds | Rock Filters | Grass Plots |
|---|---|---|---|---|---|---|---|
| Number of Ponds | 3 | 2 | 2 | 2 | 2 | 2 | 2 |
| Design Discharge (Average Daily) | 1,600 $m^3$/day | 1,600 $m^3$/day | 1,600 $m^3$/day | 1,600 $m^3$/day | 1,600 $m^3$/day | 1,600 $m^3$/day | 1,600 $m^3$/day |
| $BOD_5$ Concentration | | | | | | | |
| Influent | 800 mg/L | 384 mg/L | 115 mg/L | - | - | 30 mg/L | - |
| Effluent | 384 mg/L | 33 mg/L | - | - | 30 mg/L | - | 15 mg/L |
| Normal Operation Level | El.1,775.0m | El.1,774.0m El.1,772.5m | El.1,770.5m | El.1,778.5m | El.1,769.5m | El.1,767.5m | - |
| Ponds Dimension | | | | | | | |
| Bottom area | 23m x 52m | 100m x 311m | 76 x 163m | 28m x 94m | 28m x 94m | 17.4m x 85.4m | 160m x 100m |
| Surface area at NOL | 41m x 70m | 112m x 323m | 85m x 172m | 37m x 103m | 37m x 103m | 27m x 95m | - |
| Effective depth | 3.0 m | 2.0 m | 1.5 m | 1.5 m | 1.5 m | 1.6 m | - |
| Effective volume | 6,099 $m^3$ | 62,276 $m^3$ | 20,256 $m^3$ | 4,832 $m^3$ | 4,832 $m^3$ | 3,240 $m^3$ | - |
| Min. freeboard | 0.5 m | 0.5 m | 0.5 m | 0.5 m | 0.5 m | 0.5 m | |
| Side slope | 1.0 : 3.0 | 1.0 : 3.0 | 1.0 : 3.0 | 1.0 : 3.0 | 1.0 : 3.0 | 1.0 : 3.0 | - |
| Retention Period | 3.8 days | 42.0 days | 12.6 days | 3.0 days | 3.0 days | - | - |

(3) Pond Connection Pipes

| | | |
|---|---|---|
| AP - FP | D300 - 450 mm, | length 470 m, incl. one flow splitting chamber 1 no. |
| FP - FMP | D300 mm, | length 370 m |
| FMP - SMP | D300 mm, | length 50 m |
| SMP - TMP | D300 mm, | length 130 m |
| TMP - RF | D300 mm, | length 380 m |

L2.6 Town Sewege Treatment Work, Drying Bed Construction

(1) Sludge Drying Bed

| | | |
|---|---|---|
| Number of Ponds | : | 1 |
| Design Discharge (Average Daily) | : | 3,200 $m^3$/day |
| Ponds Dimension | | |
| Bottom area | : | 40.8m x 84.8m |
| Surface area at NOL | : | 48.0m x 92.0m |
| Effective depth | : | 1.2 m |
| Effective volume | : | 4,726 $m^3$ |
| Min. freeboard | : | 0 m |
| Side slope | : | 1.0 : 3.0 |

## L2.7 Stormwater Retention Pond

### (1) Stormwater Drainage

| | | |
|---|---|---|
| Shape | : | Trapezoidal |
| Dimensions | | |
| Bottom width | : | 1.10 m |
| Height | : | 2.00 m |
| Side slope | : | 1.0 : 0.475 |
| Length | : | 1,110 m |

### (2) Stormwater Retention Pond

| | | |
|---|---|---|
| Number of Ponds | : | 1 |
| Normal Operation Level | : | El.1,777.0 m |
| Ponds Dimension | | |
| Bottom area | : | 68m x 126m |
| Surface area at NOL | : | 77m x 135m |
| Effective depth | : | 1.5 m |
| Effective volume | : | 14,222 $m^3$ |
| Min. freeboard | : | 0.5 m |
| Side slope | : | 1.0 : 3.0 |

## L3. PRESENT ENVIRONMENTAL CONDITION IN THE STUDY AREA

### L3.1 Present Environmental Conditions of the Proposed Sewerage Sites

#### L3.1.1 Geographic and Demographic Conditions

The project site will be sub-divided into Njoro two sites and Town STWs.

(1) Njoro STW

The Njoro STW is located in Nakuru West Ward and is located on the left bank of the Njoro river as shown in Fig. L-1. The site is surrounded by the Njoro river on the south - west and it borders Lake Nakuru National Park on the east and a residential area on the north as shown in the vicinity map in Fig. L-2. The elevation of the site is in a range of El. 1,774 m to El. 1,785 m, sloping towards the south-east in general.

There are no inhabitants within the existing sewage works site. The area around the existing sewage works has wholly been designated as the site of the construction of the sewage works. There is a rural road running along the boundary between the sewage works and the national park and may be required to be relocated depending on the layout of the new sewage works to be realized under the Project.

(2) Town STW

The location of Town STW is as shown in Fig. L-1 and the vicinity map in Fig. L-3.

With a gradual extension of the urban area, the entrance area has gradually been developed for residence and institutional services as shown in the vicinity map. The existing sewage treatment works occupies an area of about 13 ha, extending along a gentle slope of land whose elevation ranges from 1,766 m to 1,786 m.

Within the area of the sewage works, a large number of farmers grow "***Sukumawiki***" (kale) by using raw drainage water from the existing drain running along the eastern boundary of the sewage works. According to an agricultural survey, these products are mainly sold in a local market.

L3.1.2 Existing Environmental Issue

(1) Njoro STW

The north side of the proposed site has partly been developed into a residential area. The existing two anaerobic ponds are a major concern because they emanate an offensive odour. The scam generated in the ponds cover the surface of the ponds and prevents the odour from spreading. $H_2S$ is generated from anaerobic processes in the ponds. Depending on wind direction and velocity those inhabitants who are living close to the ponds may suffer from offensive odour problem.

Treated sewage is conveyed through a concrete pipe to the Njoro river, which virtually debauches into Lake Nakuru at about 2 km downstream from the outlet of the conveyance pipe on the Njoro river.

(2) Town STW

It is unlikely to result in the offensive odour problem, although the existing sewage works has resorted to a Tricking Filter Process. The built-up area is about 100 m from the filter process and the sewage works site is covered by a large number of trees.

Treated effluent is discharged directly into Lake Nakuru through an open channel in a distance of about 700 m. A main storm drain runs down along the eastern boundary of existing sewage works and discharges into Lake Nakuru. At its mouth on the lake, it has been observed that various rubbish and other refuse spreads out. These are supposed to be transported through the drainage channel from the town during the storm period.

The raw drainage water is being used as a source of irrigation supply without regard to hygienic conditions. Adequate monitoring and precautionary measures are suggested and will be given to the local authority concerned to prevent breaking out of diseases and epidemics.

### L3.1.3 Land Acquisition and Compensation

#### (1) Njoro STW

The site proposed for the construction of sewage works under the Project is registered as the public land and therefore no land acquisition procedure will be required. There are no inhabitants but the land is being used illegally for cultivation of maize. If such cultivation is allowed to continue during the time of the project implementation, it may be required that appropriate compensation be made.

Some portion of the project facilities would be extended to the National Park area as shown in Fig. L-2. Cooperation of KWS is required to ensure that the land for construction of the extended sewage works is made available.

#### (2) Town STW

It is unavoidable to locate the proposed sewage and stormwater treatment facilities in the adjacent national park area owing mainly to land constraint. For the same reasons with Njoro STW cooperation with KWS is a prerequisite for Town STW.

## L3.2 Present Environmental Conditions of Lake Nakuru Basin

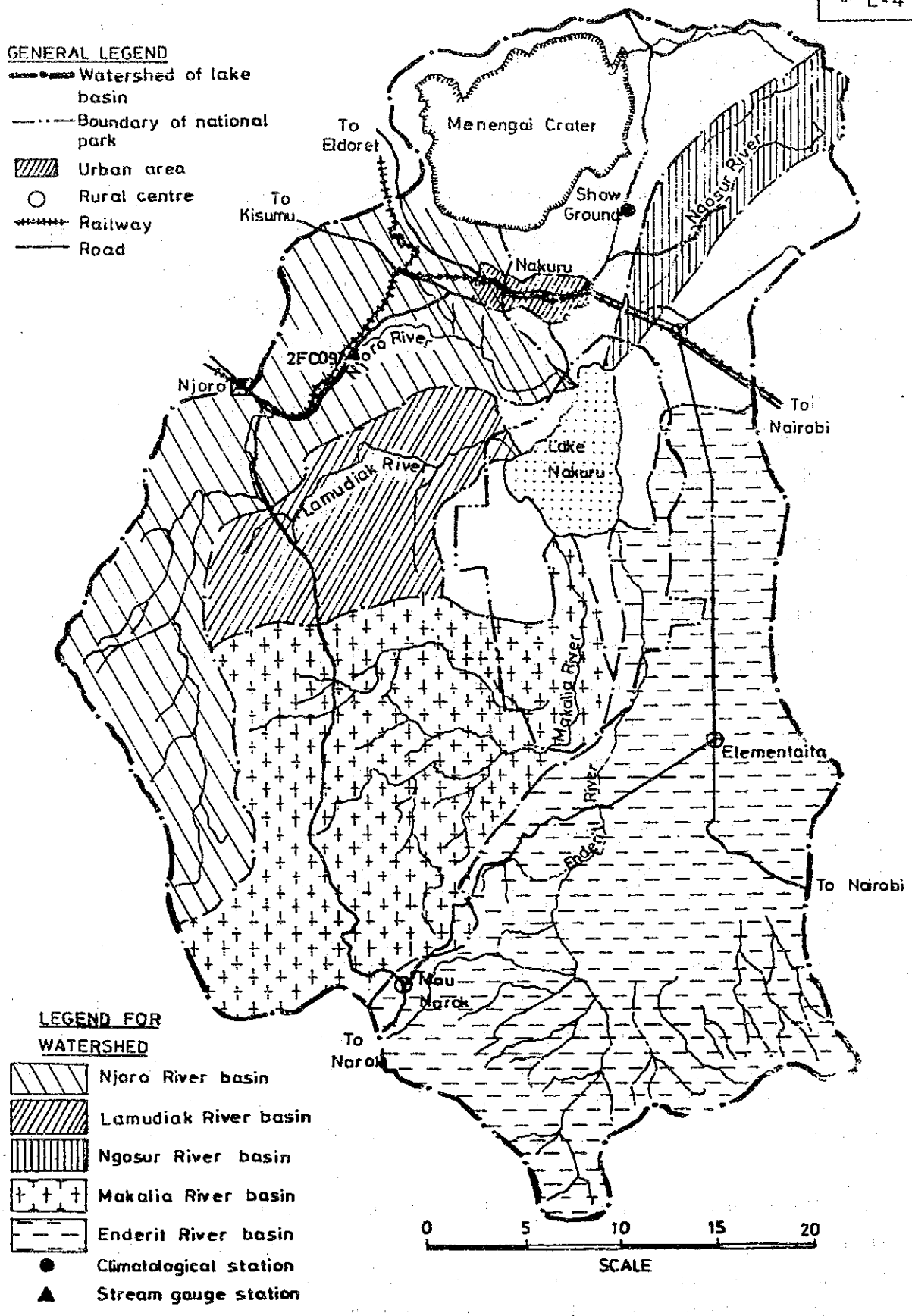
### L3.2.1 Geographic and Demographic Conditions

Lake Nakuru is located on the floor of the Rift Valley. It drains an area of 1,682 $km^2$ but has no outflowing river. Of the drainage area, 188 $km^2$ is designated as Lake Nakuru National Park. The lake was registered by Ramsar Convention in 1989.

Menengai Crater with a summit elevation of El. 2,098 m forms the northern boundary of the basin and Mau Escarpment with the highest altitude El. 3,098 m forms the southern boundary. The eastern and western boundaries adjoin Lake Elementaita and the Rongai river watersheds, respectively. The basin map of Lake Nakuru is as presented in Fig. L-4.

Within the drainage area, there are two urban centers, Nakuru Municipality and Njoro Town and their present populations are estimated to be approximately 361,000 and 15,000, respectively. According to the 1979 census they were 95,000 and 6,100 respectively. It is presumed that the population in the other part of lake basin has also fairly increased more or less at the same rate as the national average of 3.6 % per annum during the same period.

Fig. L - 4




| | | |
|---|---|---|
| THE REPUBLIC OF KENYA | THE STUDY ON THE NAKURU SEWAGE WORKS REHABILITATION AND EXPANSION PROJECT | TITLE: MAP OF LAKE NAKURU BASIN |
| MINISTRY OF LOCAL GOVERNMENT | JAPAN INTERNATIONAL COOPERATION AGENCY | |

L.3.2.2 Land Use

*Subjected to such high population growth and economic development, land use in the* drainage area has changed drastically in recent years. It could be clearly demonstrated by land use maps. Fig. L-5 and L-6 show the land use condition in 1970 and 1986, respectively. Table L-1 gives the change in land use between 1970 and 1986.

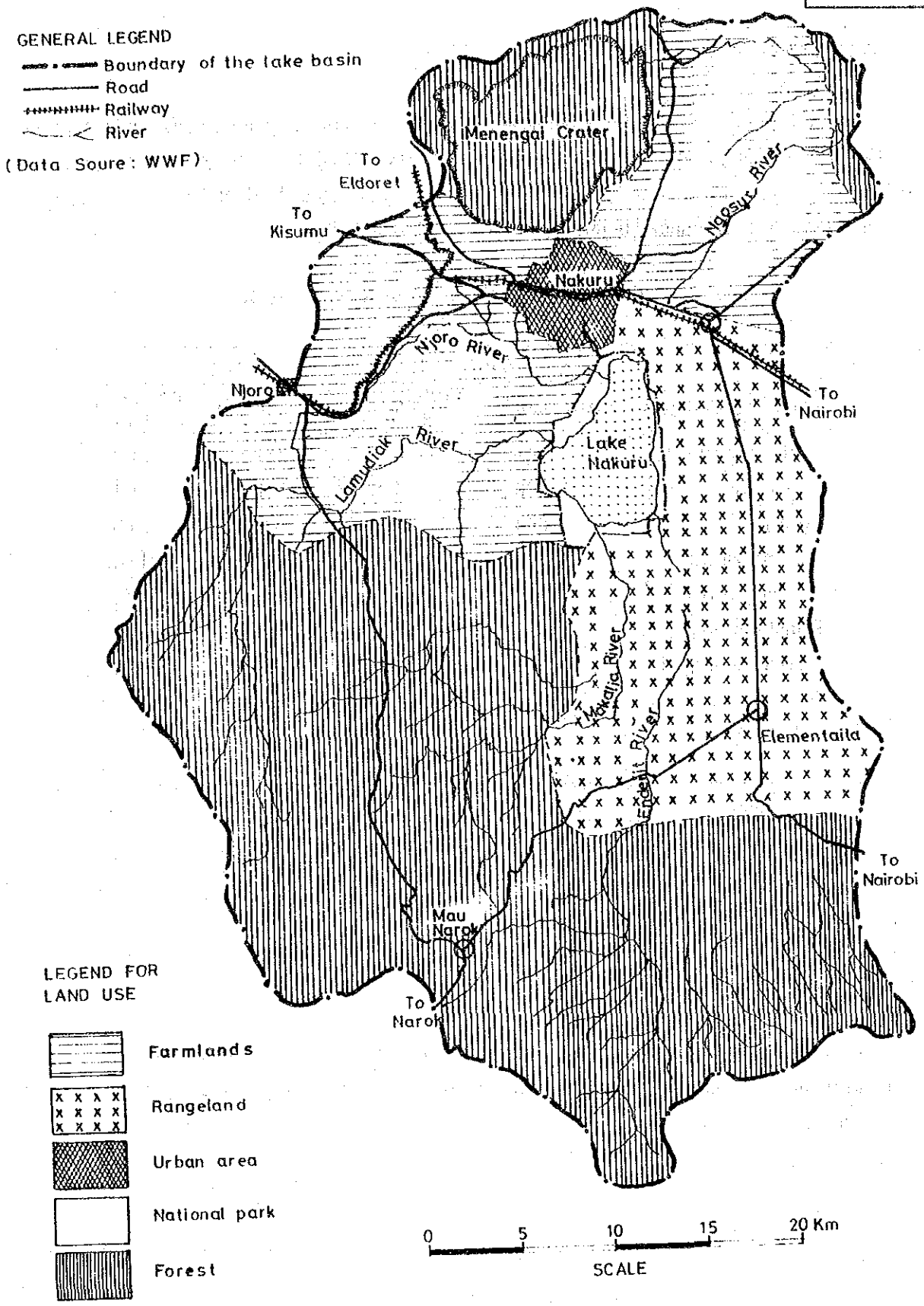
**Table L-1 Land Use in Lake Nakuru Basin**

| Land Use Category | 1970 | | 1986 | |
|---|---|---|---|---|
| | Area ($km^2$) | Proportion (%) | Area ($km^2$) | Proportion (%) |
| National park | 49 | 2.9 | 188 | 11.2 |
| Urban area | 26 | 1.5 | 58 | 3.4 |
| Forest | 894 | 53.2 | 437 | 26.0 |
| Forest (a) | - | - | (361) | (21.5) |
| Forest (b) | - | - | (76) | (4.5) |
| Ranching land | 310 | 18.4 | 191 | 11.4 |
| Agricultural land | 403 | 24.0 | 808 | 48.0 |
| Type (a) | - | - | (185) | (11.0) |
| Type (b) | - | | (623) | (37.0) |
| Total | 1,682 | 100 | 1,682 | 100 |

Note: (1) Forest,
Forest (a) : Indigenous forest, Forest (b) : Plantation forest
(2) Agriculture land,
Type (a) : Large scale farm land, Type (b) : Small scale farm land
(Data source : JICA Study Team)

As shown in the above, it is evident that the forest area has substantially diminished mainly due to an increase of agricultural development. It is very conspicuous in the southern part of the lake basin.

Fig. L - 5

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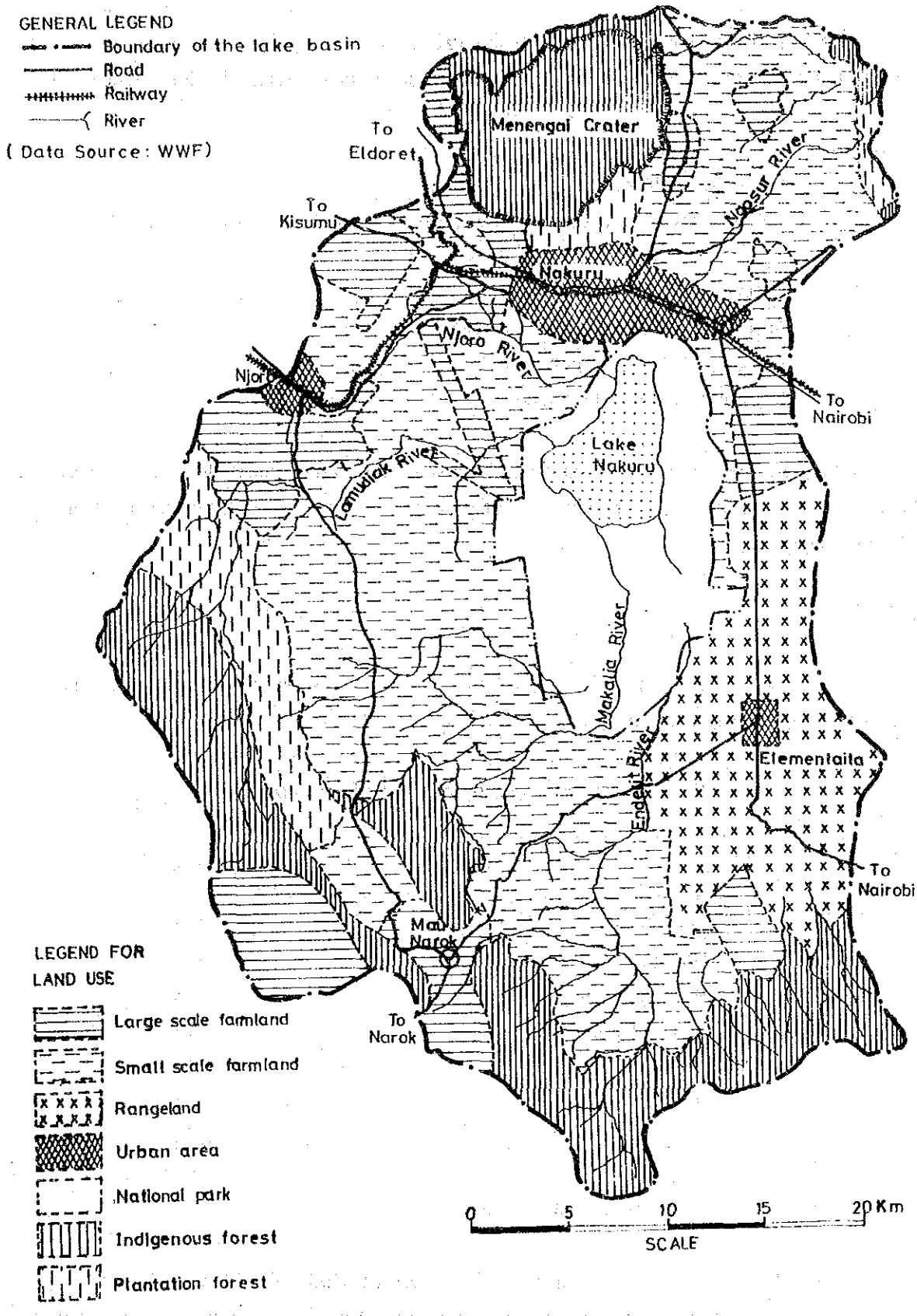
| *THE REPUBLIC OF KENYA*<br>MINISTRY OF LOCAL GOVERNMENT | THE STUDY<br>ON<br>THE NAKURU SEWAGE WORKS<br>REHABILITATION AND EXPANSION PROJECT<br>JAPAN INTERNATIONAL COOPERATION AGENCY | TITLE<br>Land Use Map in 1970 |

Fig. L - 6

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| *THE REPUBLIC OF KENYA* | THE STUDY ON THE NAKURU SEWAGE WORKS REHABILITATION AND EXPANSION PROJECT | TITLE |
| MINISTRY OF LOCAL GOVERNMENT | JAPAN INTERNATIONAL COOPERATION AGENCY | Land Use Map in 1986 |

The rapid increase in population, urbanization, agricultural and industrial developments might have resulted in producing various adverse effects as summarized below :

(1) Agricultural development
- Soil erosion in both urban and rural areas
- Pollution by agro-chemicals and fertilizers from both urban and rural sources

(2) Urbanization
- Soil erosion in both urban and rural areas
- Industrial / chemical pollution
- Pollution by domestic waste

Thus there has been serious concern about protection and conservation of the ecology of Lake Nakuru in relation to the expansion of various development activities and population in the catchment area.

L3.2.3 Rivers

Lake Nakuru drains an area of 1,682 $km^2$, which could be divided into six sub-basins as shown in Fig. L-4 and summarized in Table L-2.

**Table L-2 Catchment Area of Lake Nakuru**

| Rivers | Catchment Area ($km^2$) |
|---|---|
| Njoro River | 293 |
| Nderit River | 520 |
| Makaria River | 315 |
| Ngosur River | 77 |
| Lamudiak River | 116 |
| Others | 361 |
| Total | 1,682 |

(Data source : JICA Study Team)

In the above table a catchment area of the others includes the Menengai Crater, lake and small rivers. Of the five major rivers listed up, only the Ngosur river takes its origin in the north, while all the other rivers originate from Mau Escarpment in the north as shown in Fig. L-4.

The climate in the basin area is characterized by two distinct seasons in a year. Dry season prevails from December to February and wet season from March to June. According to the climatological record at Showground in Nakuru Municipality, annual rainfall amounts to 1,014 mm on the average but fluctuates greatly from year to year. A drought year is recorded at intervals of 5 - 10 years. Due to uneven distribution of rainfall in the year, poor vegetation cover, small catchment area, etc. all the rivers, excepting the Njoro river, run dry during the dry season. Treated effluent from Njoro STW sustains a certain portion of base flow of the Njoro river.

### L3.2.4 Quality of River Water and Treated Effluent

The qualities of the river waters and treated effluent from the existing sewage works are as reported in Chapter 4 of this report.

## L3.3 Present Environment of Lake Nakuru and National Park

### L3.3.1 Chronological Events for Formation of Lake Nakuru National Park

Nakuru National Park is one of the most famous parks in Kenya. The birds and wild life form unique spectacular display that attracts thousands of domestic and foreign tourists into the park every year. The national park area is about 188 $km^2$, including the lake itself. The history of Nakuru National Park started after its nomination for conservation as a bird sanctuary. The present park has grown through various steps as presented in Table L-3.

**Table L-3 Chronological Events of Lake Nakuru National Park**

| Year | Chronological Events |
|---|---|
| 1960 | Area of conservation for bird sanctuary |
| 1961 | The southern two thirds was put under protection of the Kenya National Parks. The ceremony was officiated by a bird authority, Sir Peter Scott. |
| 1964 | Birds sanctuary, whole lake and a small strip of land around the lake. |
| 1968 | The whole lake and the surrounding shore (about 6,000 ha) was officially declared a National Park. |
| 1972 | WWF raised money to facilitate expansion to 22,000 ha of land. |
| 1973 | WWF represented by Prince Bernhard of Netherlands and President of WWF signed a conservation agreement with GOK. The agreement supported a park extension programme. |
| 1974 | Park expanded to the present size (188 $km^2$) with assistance of WWF and other conservation bodies. |
| 1976 | Whole park area fenced by chain link |
| 1986 | Solar electric fence installed with 12 wires, 6 of which are live. Each wire carries 5 kV. |
| 1989 | Nominated on the list of Ramsar Convention |

(Data source : KWS and WWF)

L3.3.2 Physical Conditions of Lake Nakuru

Lake Nakuru is one the of four broad shallow soda lakes in Kenya : Nakuru, Elementaita, Bogolia and Magadi, which lie in a semi-arid basin of internal drainage and their water levels and salinities fluctuate drastically in response to changes in rainfall and evaporation. The water in these lakes has a high mineral concentration due to gradual leaching of volcanic soils releasing salts mainly of sodium, bicarbonate ($NaHCO_3$) and carbonate ($Na_2 CO_3$) from surrounding catchment areas which drain into the lake. Lack of outlets in these lakes also contributes greatly to their high alkalinity and salinity.

L3.3.3 Balance of Lake Level

Lake Nakuru has a surface area of 43 $km^2$ at its level El. 1,758.5 m, although it varies largely depending on the level. Its bottom elevation is at around El. 1,756 m.

As noted in the sub-section L3.3.3 of this report, the lake is fed mainly by six rivers, whereas the lake has no outlet. The lake level is therefore maintained only by a balance of direct rainfall on the lake, surface runoffs of the rivers, spring waters and evaporation. It is evident that the lake level varies greatly from year to year, characterized by a climatological condition.

The lake level recording was initially started at the north-west corner in May 1930 and is continued by MOLRRWD ever since with some interruption. Fig. L-7 shows the lake level fluctuation in the past six decades. The level have changed substantially during the recorded period. In the years 1933, 1939, 1947, 1961, and 1987, the lake dried up completely. It is believed that in the dried up periods the floor of the lake had been subjected to wind erosion resulting in clouds of alkaline dust being blown over the surrounding area. The highest level stand at 4.37 m recorded in August 1979.

L3.3.4 Water Quality

Water quality data are mainly available from "Study for Construction of Dam in Malewa River System, Greater Nakuru Water Supply Project, Eastern Division" (the Malewa dam Study) and "Water Quality Data of KWS".

Table L-4 shows the typical value of conductivity and pH in the lake as well as seawater and fresh water for comparison. Lake Nakuru water includes various minerals, and its conductivity value is sometimes recorded to be the same as that of the sea water. The pH value in the lake is higher than that of the sea water. High pH is deemed to be attributable to a high concentration of "$CO^{3-}$" which originated from the alkaline volcanic basin.

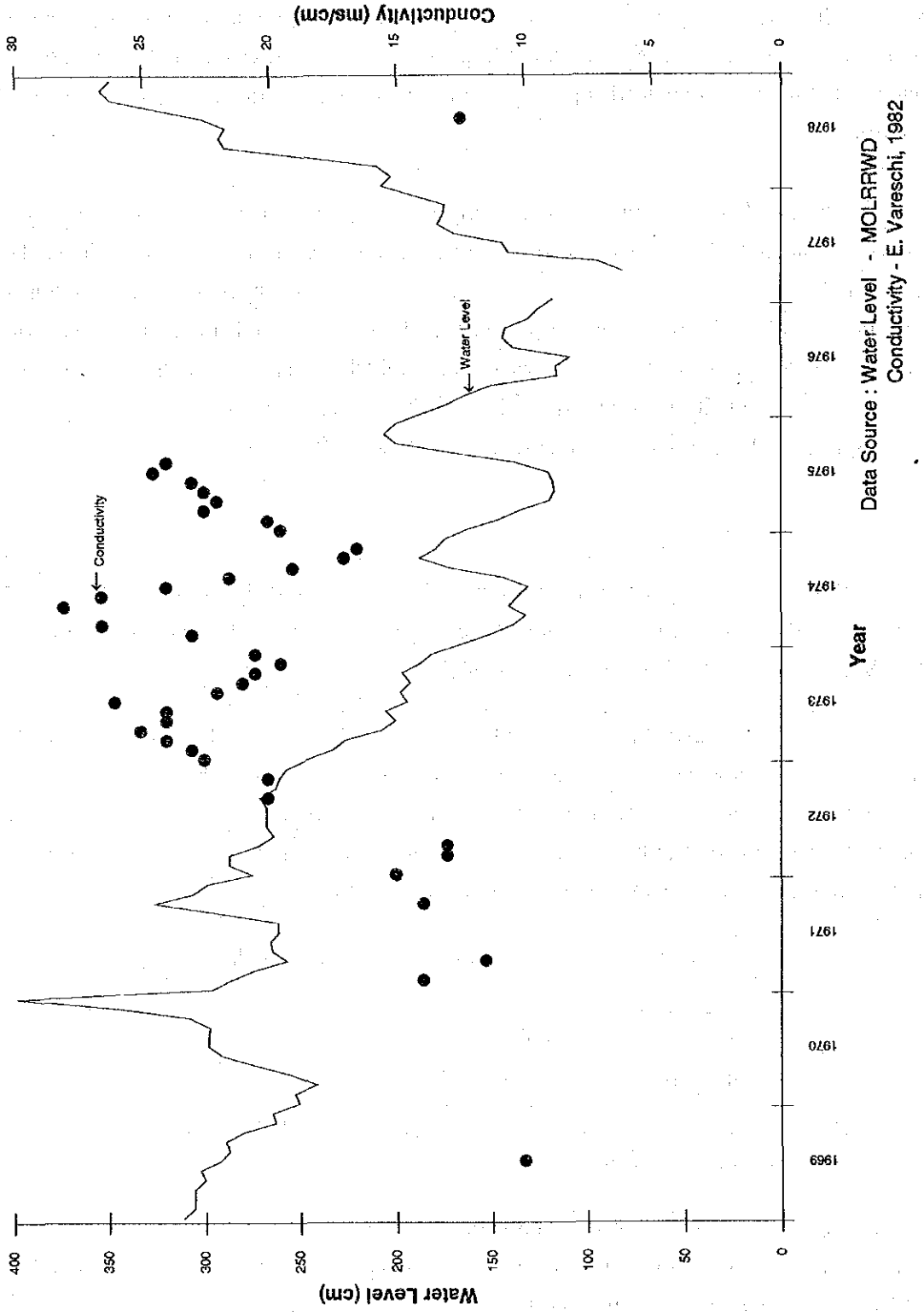
**Table L-4 Typical Water Quality Data**

| Item | Lake Nakuru | Sea water | Fresh water |
|---|---|---|---|
| Conductivity (sm/cm) | 10 - 60 | 57 | 0.1 |
| pH | 10.5 | 8 | 7 |

(Data source :JICA Study Team)

Figs. L-7 and L-8 show a relationship between the lake level and the conductivity. As shown in the figures the conductivity increases with the lake level decrease, and the conductivity decrease with the lake level increase. It appears that in a closed lake such as Lake Nakuru, an increase in the lake water volume causes a decrease in the density of any material. It could be said that lake water quality varies depending on the lake water level. For example, COD value in the lake was measured at 568 mg/l at the lake level of about 0.5 m in 1993, while it was 179 -372 mg/l at the lake level of about 2.0 m in 1990.

Fig. L - 7

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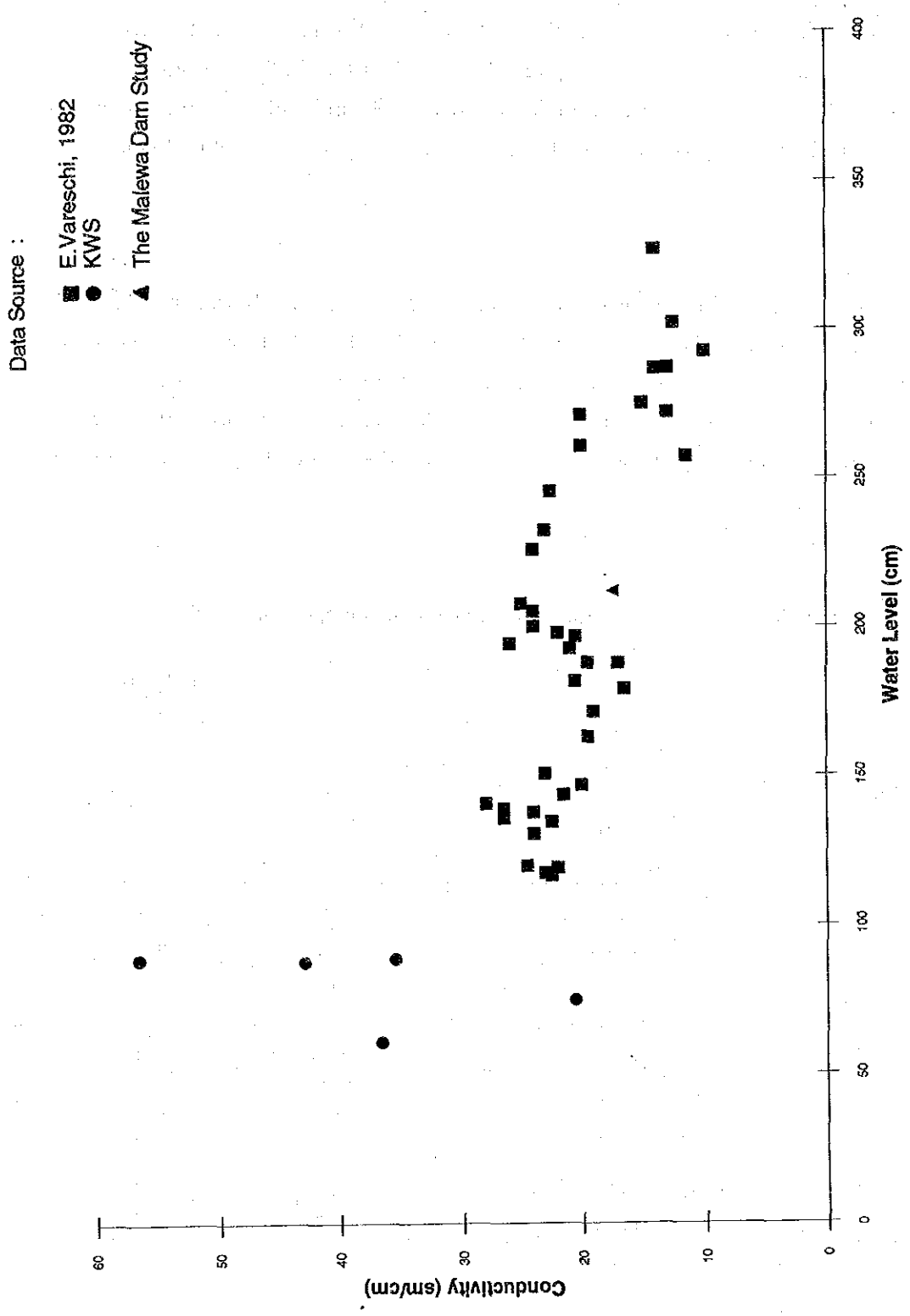
| *THE REPUBLIC OF KENYA*<br>MINISTRY OF LOCAL GOVERNMENT | THE STUDY<br>ON<br>THE NAKURU SEWAGE WORKS<br>REHABILITATION AND EXPANSION PROJECT<br>JAPAN INTERNATIONAL COOPERATION AGENCY | TITLE<br>Records of Water Level and Conductivity in Lake Nakuru |

Fig. L - 8

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Distribution of DO value is as shown in Fig. L-9, which is being quoted from the Malewa Dam Study. The figure indicates that the northern part of the lake is in anaerobic condition, which means that the large portion of organic pollution load into the lake concentrates on that area. This could be explained by the fact that in the said area. Njoro river, town's drainage channel and the drain from Town STW and gathered and discharge there. The Nakuru Municipality is presumed to be a major source of the pollution load.

L3.3.5 Vegetation

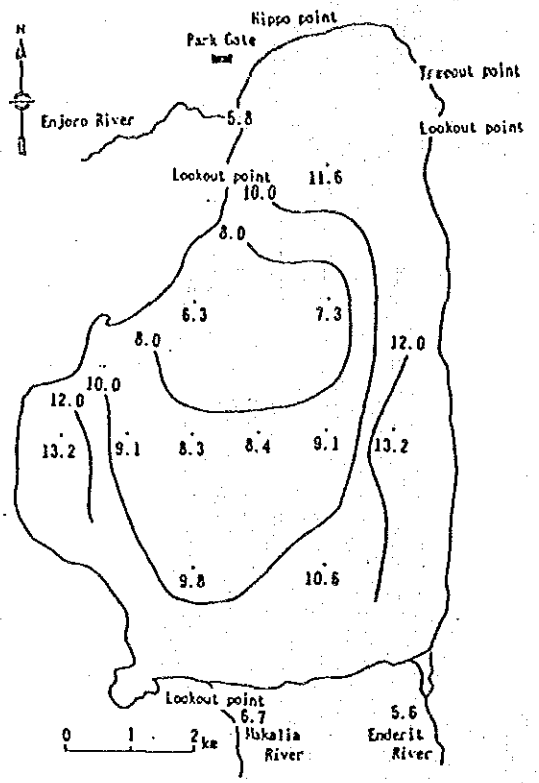
A vegetation map of he national park is presented in Fig. L-10 and the types of vegetation present are given in Table L-5. The data shows that 46.7 % of the area is covered with bush land and only about 23.1 % is covered with grasses. The foreshore only contributes 11.7 % while woodlands make up 18.7 %. This vegetation distribution pattern is likely to influence the abundance and special distribution of the mammals to be found within the park.

**Table L-5 Area by Vegetation in Lake Nakuru National Park**

| Classification by Vegetation | | Area ($km^2$) | % of Total Area |
|---|---|---|---|
| Foreshore | Littoral zone | 7.19 | 4.5 |
| Vegetation | Shore Line | 5.65 | 3.5 |
| | Sand-mud flats | 2.75 | 1.7 |
| | Swamps | 3.08 | 1.9 |
| Grasslands | Open Grassland | 29.93 | 18.8 |
| | Shrub Grassland | 6.85 | 4.3 |
| Bush land | Escarpment Vegetation | 27.08 | 17.0 |
| | Tarconanthus Bush land | 23.85 | 14.9 |
| | Mixed Bush / Shrubland | 23.72 | 14.8 |
| Woodlands | Open Acacia Woodland | 5.48 | 3.4 |
| | Dense Acacia Woodland | 6.94 | 4.3 |
| | Olive - Teclea Forest | 14.73 | 9.2 |
| | Euphobia Forest | 2.73 | 1.7 |

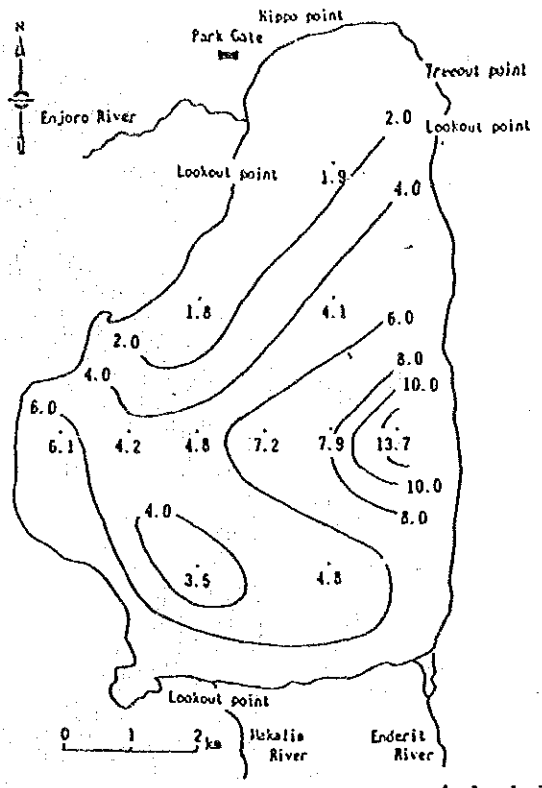
(Data source : JICA Study Team)

Fig. L - 9



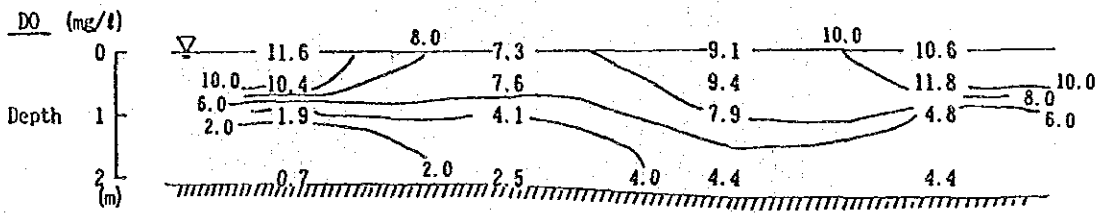

Photic Layer

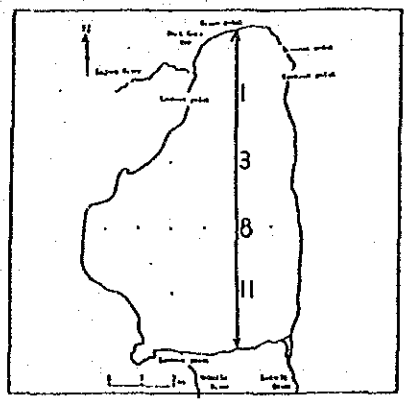
DO (mg/ℓ)




Aphotic Layer

DO (mg/ℓ)




Data Source : The Malewa Dam Study Team

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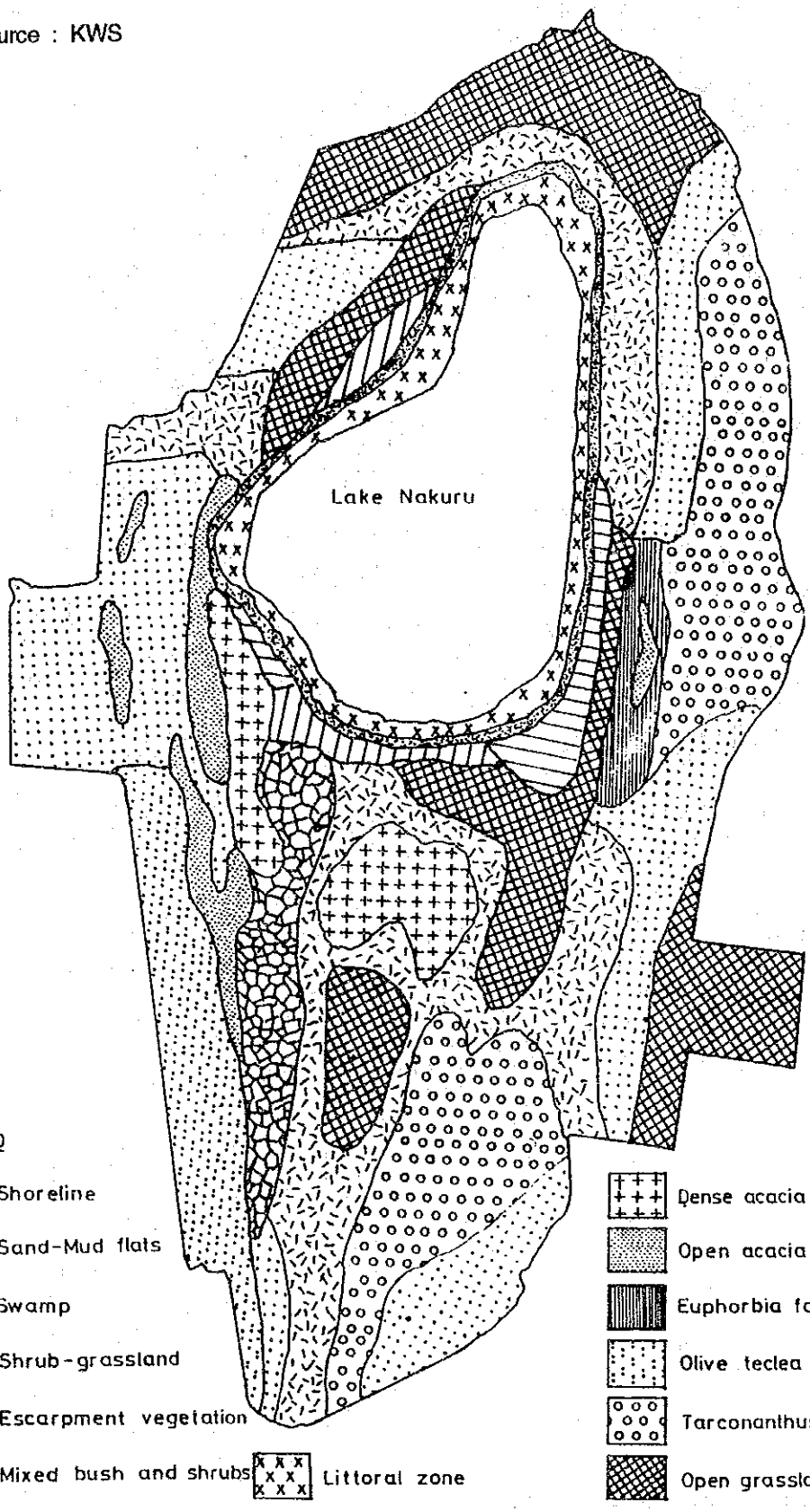
| *THE REPUBLIC OF KENYA* | THE STUDY ON THE NAKURU SEWAGE WORKS REHABILITATION AND EXPANSION PROJECT | TITLE |
| MINISTRY OF LOCAL GOVERNMENT | JAPAN INTERNATIONAL COOPERATION AGENCY | Distribution of DO value in Lake Nakuru |

Fig. L - 10

Data Source : KWS

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| *THE REPUBLIC OF KENYA*<br>MINISTRY OF LOCAL GOVERNMENT | THE STUDY<br>ON<br>THE NAKURU SEWAGE WORKS<br>REHABILITATION AND EXPANSION PROJECT<br>JAPAN INTERNATIONAL COOPERATION AGENCY | TITLE<br>Vegetation Map of Lake Nakuru National Park |

L3.3.6 Animal Activities

(1) Birds

KWS staff in cooperation with volunteers have been carrying out a birds census twice a year (July & January) since July 1990. As a result information an fluctuations of numbers and kinds of birds have been obtained. Table L-6 presents the observation records in January 1992 and January 1993 for the six most abundant birds.

**Table L-6 Observation Records of Birds in Lake Nakuru National Park**

| Birds | January 1992 | January 1993 |
|---|---|---|
| Greater Flamingo | 4,323 | 612 |
| Lesser Flamingo | 320,300 | 750,169 |
| White Pelican | 14,426 | 4,607 |
| Gray Headed Gull | 8,145 | 1,207 |
| Great Cormorant | 3,238 | 578 |
| Little Grebe | 6,708 | 1,232 |

(Data source : KWS)

Lesser Flamingo is identified as the most predominant bird in Lake Nakuru, but it number change from time to time. As shown in Table L-6, the number of lessor flamingoes in Lake Nakuru in 1993 was more than two times that shown for 1992. However the total number of flamingoes in Lake Nakuru, Bogoria and Elementaita remained almost unchanged as shown in Table L-7.

**Table L-7 Distribution of Lesser Flamingo**

| Lake | Jan. 1992 | Jan. 1993 |
|---|---|---|
| Nakuru | 320,300 | 750,169 |
| Bogolia | 754,200 | 268,139 |
| Elementaita | 94,080 | 2,497 |
| Total | 1,168,580 | 1,021,805 |

(Data source : National Museum of Kenya)

This fact indicates that flamingoes move from one lake to another from time to time. The departure of flamingoes is believed to be related to food availability in these lakes and for breeding purpose. Only Lake Natron, which is located in Tanzania, is identified in the Rift Valley as a breeding environment. It is said that this is attributed to the soil type which is suitable for nest building.

A relation between the number of flamingoes and the lake level is as shown in Fig. L-11. According to the available data, the number of lesser flamingoes was ranging between 4,239 and 1,404,000, and there were no flamingoes in dried up period in Lake Nakuru. The availability of food for flamingo, which is blue-green algae, ***Spirulina,*** is believed to be related to the lake level fluctuation but this relationship has yet to be investigated fully and clarified.

Before introduction of Tilapia in 1960 from Lake Magadi, the bird life of the lake was poor compared to the present situation. Except for flamingoes, there were few other birds. Since the introduction, more than 50 species of fish eating birds have been recorded, and the number and variety of birds have become abundant in the lake. The great white pelican, which is the dominant fish predator, takes about 80 % of the fish biomass predicted upon. It breeds mainly in Lake Elementaita, 14 km east of Lake Nakuru.

Little Stint, Blackwinged Stint, Gray Handed Gull etc. come to Lake Nakuru seasonally. The number of Pelican and many kinds of fish eating birds vary from time to time and their number are said to be related to the availability of Tilapia in the lake.

(2) Mammals

Also KWS staff in cooperation with volunteers have carried out monitoring of the number of mammals monthly and/or quarterly since 1978. The monitoring results in 1990 and 1991 are as presented in Table L-8

Fig. L - 11

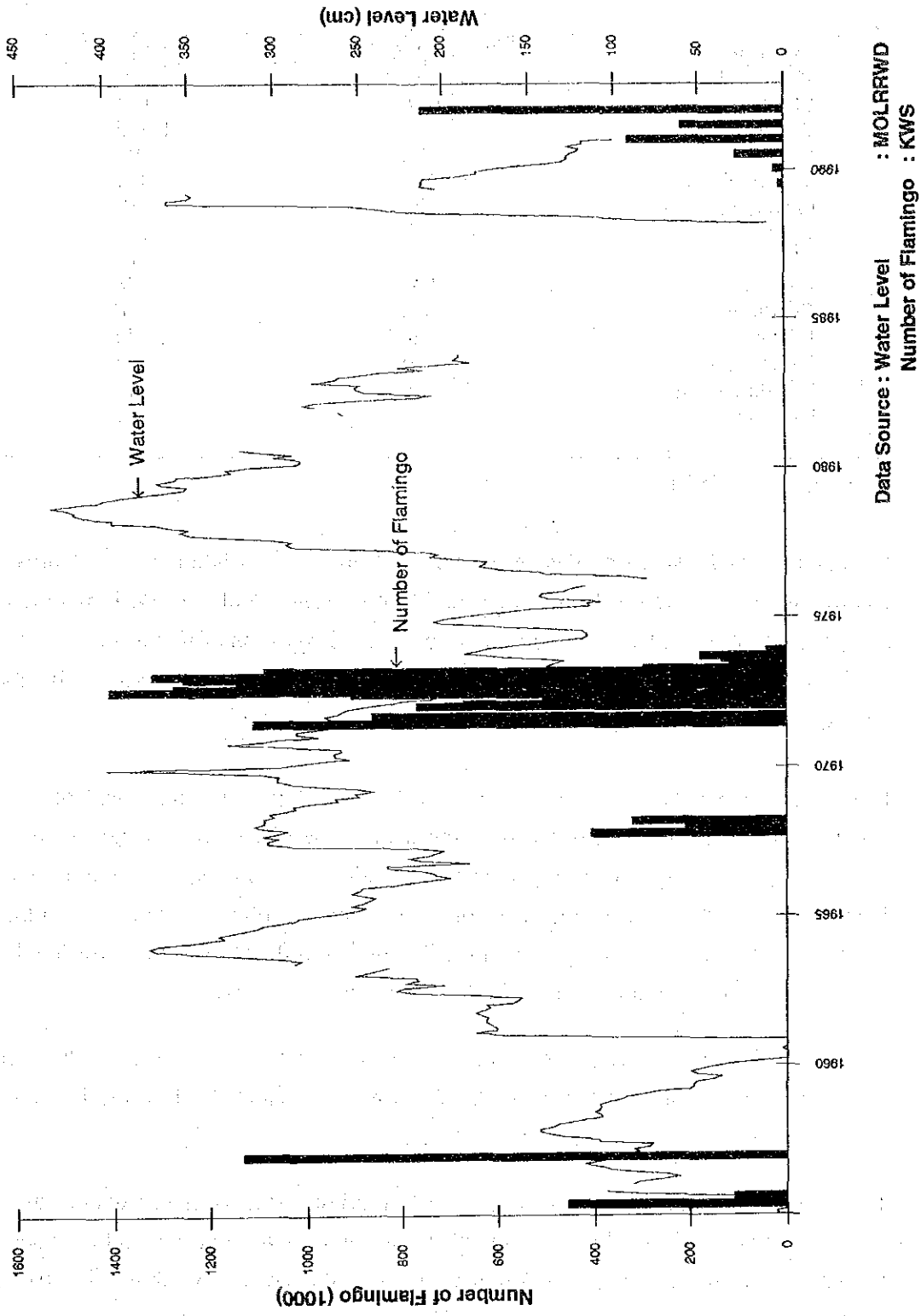


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**Table L-8 Mammal Monitoring Record in 1991**

| Mammal | Number in 1990 | Number in 1991 |
|---|---|---|
| Waterbuck | 4,979 | 4,649 |
| Impala | 4,658 | 4,147 |
| Warthog | 1,181 | 1,339 |
| Buffalo | 406 | 392 |
| Thomson's Gazelle | 405 | 1,301 |
| Grants Gazelle | 192 | 589 |
| Zebra | 252 | 162 |
| Eland | 58 | 75 |
| Giraffe | 105 | 98 |
| Redbuck | 24 | 70 |
| Dikdik | 28 | 24 |
| Bush buck | 16 | 5 |
| Hippopotamus | 10 | 35 |
| Rhinoceros | 7 | 19 |

(Data source : KWS)

Both electric and chain fences have been erected around the National Park to prevent any mammals moving out from the park. Therefore the number of each mammal is more accurately recorded than the number of birds. Migration of mammals in and out of the park is therefore not possible. Distribution of mammals within the park however varies from time to time.

Lake Nakuru National Park has a large diversity of grasses, ranging from soda resistant and salt tolerant species near the lake to the ***Cynodon*** star grass and the mead grass. These type of grasses support a variety of animals, for example, water buck, Bohor Redbuck, Impala, Warthog, Zebra and Gazelles. Important mammals form a conservation point of view include the rhino and the Rothchild's Giraffe which were transferred from outside the park for conservation purposes.

These herbivores are eaten by Lions which normally roams free on the open grasslands to the south of the lake. Other carnivores which feed on the herbivores above are the Leopard and the Spotted Hyena

Lake Nakuru can not be used as a source of drinking water for mammals because of its water quality. Only Hippopotamus lives in the lake in daytime, and depends on the lake. Almost all kinds of mammals live in herds and are distributed in different ecotypes in the park. For example, the rhino is to be found in the acacia woodland and escarpment vegetation to the south of the lake while the waterbuk occurs in the grasslands close to the lake.

L3.3.7 Food Chain in Lake Nakuru

Lake Nakuru usually maintains an exceptionally high standing crop of the cyanophyte ***Spirulina platensis***. ***Spirulina*** is not only the main food for the large population of the lesser flamingoes, but also the basis of the food chain in Lake Nakuru as the predominant primary producer. Under normal condition of Lake Nakuru, ***Spirulina*** is estimated to contribute to about 95 % of the lake's total biomass. But other kinds of "primary producers" sometimes become dominant. The animals and plankton which depend on the lake are divided into three groups from the view point of ecological food chain as given in Table L-9 and Fig. L-12.

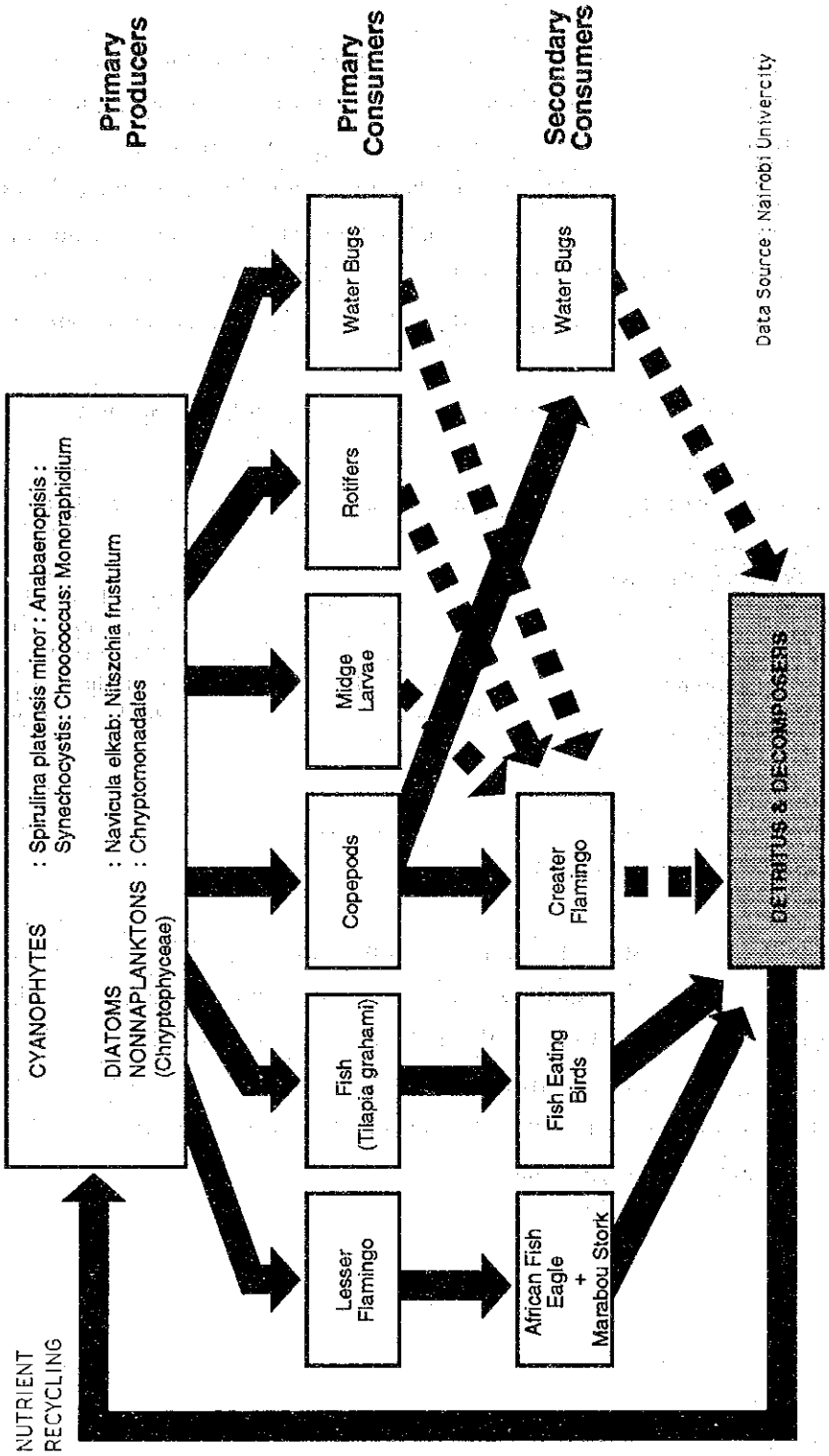
**Table L-9 Classification of Animals in Lake Nakuru**

| 1) Primary Producers | 2) Primary Consumers | 3) Secondary Consumers |
|---|---|---|
| Cyanophytes | | |
| - Spirulina Platensis minor | | |
| - Anabaenopsis | Lesser Flamingo | White Pelican |
| - Synechocystis | Tilapia Grahami | Greater Flamingo |
| - Chroococcus | Copepods | Africa Fish Eagle |
| - Monoraphidium | Midge Larvae | Marabou Stork |
| Diatom | Rotifers | Other Fish Eating Birds |
| - Navicula elkab | Water Bugs | |
| - Nitzschia | | |
| Nonnaplankton | | |

(Data Source : Nairobi University)

It is considered that a change in the dominant kind of "Primary Producer" affects "Primary consumers" and "Secondary consumers", and numbers and kinds of animals vary under the food chains law. One of the limiting factors in the food chain is the rate of nutrients recycling which in turn influences the rate of growth of the primary producers. The water level and therefore conductivity also influences nutrients concentration and osmolarity which may also affect primary productivity.

Fig. L - 12

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## L4. PROJECT EVALUATION ON POLLUTANT LOAD REDUCTION

With implementation of the proposed rehabilitation and expansion of the sewage treatment works and the construction of the storm water retention pond, pollution loads into Lake Nakuru will be reduced greatly. Especially a great reduction is anticipated to be derived from the sewage treatment works. The reduction of BOD and nutrient pollutant load is estimated as described below:

(1) BOD load reduction

BOD pollutant loads into Lake Nakuru estimated for the following five cases:

| | |
|---|---|
| Case-1 | Present conditions |
| Case-2 | After additional water supply of 13,300 $m^3$/day by Greater Nakuru Water Supply Project |
| Case-3 | After implementation of Nakuru Sewerage Project (capacity: 6,000 $m^3$/day) |
| Case-4 | After proposed rehabilitation and expansion of the sewage treatment works |
| Case-5 | After implementation of the rehabilitation and expansion, and enforcement of Trade Effluent By-Laws |

The calculation condition of the respective cases is shown in Table L-10.

**Table L-10 Pollutant Load Forecast Criteria**

| | Case (1) | Case(2) | Case(3) | Case(4) | Case(5) |
|---|---|---|---|---|---|
| Quantity of Sewage Generation ($m^3$/d) | 8,185 | 16,200 | 16,200 | 16,200 | 16,200 |
| BOD concentration of Raw sewage (mg/L) | 800 | 800 | 800 | 800 | 500 |
| Effluent BOD Concentration (mg/L) | | | | | |
| Njoro 3,600 | 200 | 200 | 200 | 15 | 10 |
| Njoro 6,000 | - | - | 30 | 15 | 10 |
| Town 3,400 | 220 | 220 | 220 | 15 | 10 |
| Town 3,200 | - | - | - | 15 | 10 |
| Total Capacity of STWs ($m^3$/d) | 7,000 | 7,000 | 13,000 | 16,200 | 16,200 |
| Pollutant Load from Storm water | Same as present | Same as present | Same as present | 30 % reduction | 30 % reduction |

The estimate for each cases is reported in Supporting Report (G) and the results of the estimate are as presented in Table L-11.

**Table L-11 Pollutant Load Forecast (BOD) into Lake Nakuru**

(Unit: ton/year)

| Route of Pollutant Load | Case-1 | Case-2 | Case-3 | Case-4 | Case-5 |
|---|---|---|---|---|---|
| 1. Sewage Treatment Works | 626 | 2,964 | 1,450 | 89 | 59 |
| 2. Storm water drainage | 161 | 161 | 161 | 113 | 113 |
| 3. Rivers and Springs | | | | | |
| - Njoro River | 356 | 356 | 356 | 356 | 356 |
| - Makalia River | 122 | 122 | 122 | 122 | 122 |
| - Nderit River | 152 | 152 | 152 | 152 | 152 |
| - Springs | 54 | 54 | 54 | 54 | 54 |
| Total | 1,471 | 3,809 | 2,295 | 886 | 856 |

(Data source: Study Team)

It is clear that pollutant (BOD) load into Lake Nakuru decreases greatly, 1,514 ton/year by Nakuru Sewerage Project and 1,409 ton /year by the contemplated Project, 2,953 ton/year in total corresponding to 78% of the forecast value after the additional water supply. When compared to the present condition, pollutant load decreases to 58% so that a great contribution is expected for conservation of environment of Lake Nakuru.

(2) Nutrient Load Forecast

T-N and T-P concentrations are forecast only for Cases 1 and 5 based on typical values that could be achieved when industrial wastes are properly controlled and sewage are properly treated. Such value is 8 mg/L for T-N and 6 mg/L for T-P. The T-N and T-P loads for Case-1 are derived from the results of the water quality investigation.

**Table L-12 Pollutant Load Forecast (Nutrient) into Lake Nakuru**

(Unit: ton/year)

| | T-N | | T-P | |
|---|---|---|---|---|
| | Case (1) | Case (5) | Case (1) | Case (5) |
| Sewage Treatment Works | 491 | 47 | 151 | 35 |
| Storm water Drainage | 12 | 12 | 13 | 13 |
| River & other | 44 | 44 | 3 | 3 |
| Total | 547 | 103 | 167 | 51 |

(Data source: Study Team)

## L5. ENVIRONMENTAL IMPACT ASSESSMENT

### L5.1 Sewage Treatment Works Sites

There are two areas to be objective of the environmental impact assessment. One is the sites of both Njoro and Town STWs, where the actual construction works take place for installation of sewage treatment facilities, and the other is Lake Nakuru, being beneficiary of the Project. The environmental impact assessment was conducted for two conditions: one is the construction period and the other is the operation period.

#### L5.1.1 Construction Period

*There are seven objective items to be assessed as follows:*

(1) Erosion and slope protection

Soil erosion may occur on the slope of excavation and embankment especially when occurring heavy storm rainfall, and soil materials will be carried down into the Lake Nakuru National Work with storm rainfall. It is necessary to make sodding as promptly as possible on finished slope surface and to take necessary precautions on excavation/embankment under construction.

(2) Muddy water

Muddy water may be generated from construction works, especially concrete works, and construction area during storm rainfall. Sedimentation pond and drainage ditch should be prepared to prevent the above problems.

It is necessary to make dry the existing ponds by means of pumping of retained water for the purpose of remodeling and construction of new ponds. It is recommended that pumping plan be arranged so that all the water be discharged into the ponds located nearby. It must not be discharged into river/channel blowing into Lake Nakuru.

(3) Surplus soil & sludge disposal

In the earthwork, the excavation is planned to be balanced with the fill required for the embankments. No surplus soil is expected to be generated from the construction site.

The sludge removal is expected to be taken place at the existing ponds at the 3,400 $m^3$/day line at Njoro STW and 3,400 $m^3$/day line at Town STW to facilitate the subsequent construction works. It is absolutely required to construct a tentative dry space at the sites, which should be designed to prevent the water running into directly Lake Nakuru. It is recommended that the dried sludge be taken to either the new disposal area or existing disposal area depending on quality. If such measure is properly executed, the dried sludge is considered to be not pollution into Lake Nakuru.

(4) Land acquisition

It is required to acquire the lands of 9.3 ha and 42.0 ha for Njoro and Town STWs respectively. Majority of the required lands extends to the Lake Nakuru National Park. The land acquisition will therefore cause any negative impacts on the surrounding communities.

(5) Fauna and flora

With expansion of the areas of the sewage treatment works, it is necessary to relocate the existing fences along the national park boundary. It is recommended that the relocation works be done under supervision of the KWS staff to protect the working people from animals and to prevent the animals running out of the park.

(6) Safety and working environment

It is anticipated that a certain amount of wastewater and solid waste will be generated by people working at the sites. They are considered to be pollution into the Lake Nakuru National Park including Lake Nakuru. It is necessary to provide and operate suitable toilet and garbage facilities at the site throughout the construction period.

A number of working people will be employed for the construction of the proposed Project. The construction supervision should be directed not only to progress and quality control of the construction works but also to working amenity and safety of the working people.

(7) Noise, nuisance etc.

It is forecast that there will be no serious traffic disturbance on public road due to transportation of construction materials and equipment into and from the sites. The proposed sites are located from built-up area and major construction activity is earth works. No particular impact and nuisance are expected to be created owing to vibration and noise.

L5.1.2 Operation Period

Four major items are evaluated as described below:

(1) Offensive odour

Offensive odour is generated under anaerobic condition. Fortunately the proposed sites are is orated from densely populated area and are under the favor of climate logical condition. The wind direction and speed area, in particular, are unlikely to create odour problem as reported in Section 2.2 of this report.

The tree belt planting around the anaerobic pond is however recommendable for not only offensive odour protection but also for land scope improvement.

(2) Sludge treatment and disposal

The sludge treatment and disposal is one of the concerns in view of conservation and preservation of ecology of Lake Nakuru and environment of areas surrounding the sewage treatment works in along run. Mal-handling and management would result in adverse effects on natural and human environments. It is concluded that the WSD is to bring into effect the sludge treatment and disposal recommended in Section 4.4 of this report.

(3) Vector borne disease and groundwater contamination

At the proposed sites, the groundwater is not encountered within a depth of 15 m below the ground surface according to the geological investigation and bottom of the ponds has been proposed to be designed with leakage protection. It is therefore unlikely to occur the contamination of the groundwater.

Slow moving streams, such as the ponds, are considered to be the major breeding sites of mosquitoes, which are major transmitters of malaria. But there is no records that the existing both treatment works cause serious problem on mosquito breeding. The project is considered not to cause such serious problem on that.

(4) Soil erosion

The slopes of waste stabilization ponds are very gently and their external surface are designed with sodding for slope protection. The grass plots are to be covered densely by sod for the purpose of additional treatment of sewage. Open spaces of the sites are expected to be regreened soon after completion of the construction works. Accordingly there will be no serious soil erosion within the proposed sites.

## L5.2 Downstream of the Sites

The environmental impact is assessed only for the condition of operation period.

(1) Pollutant Load

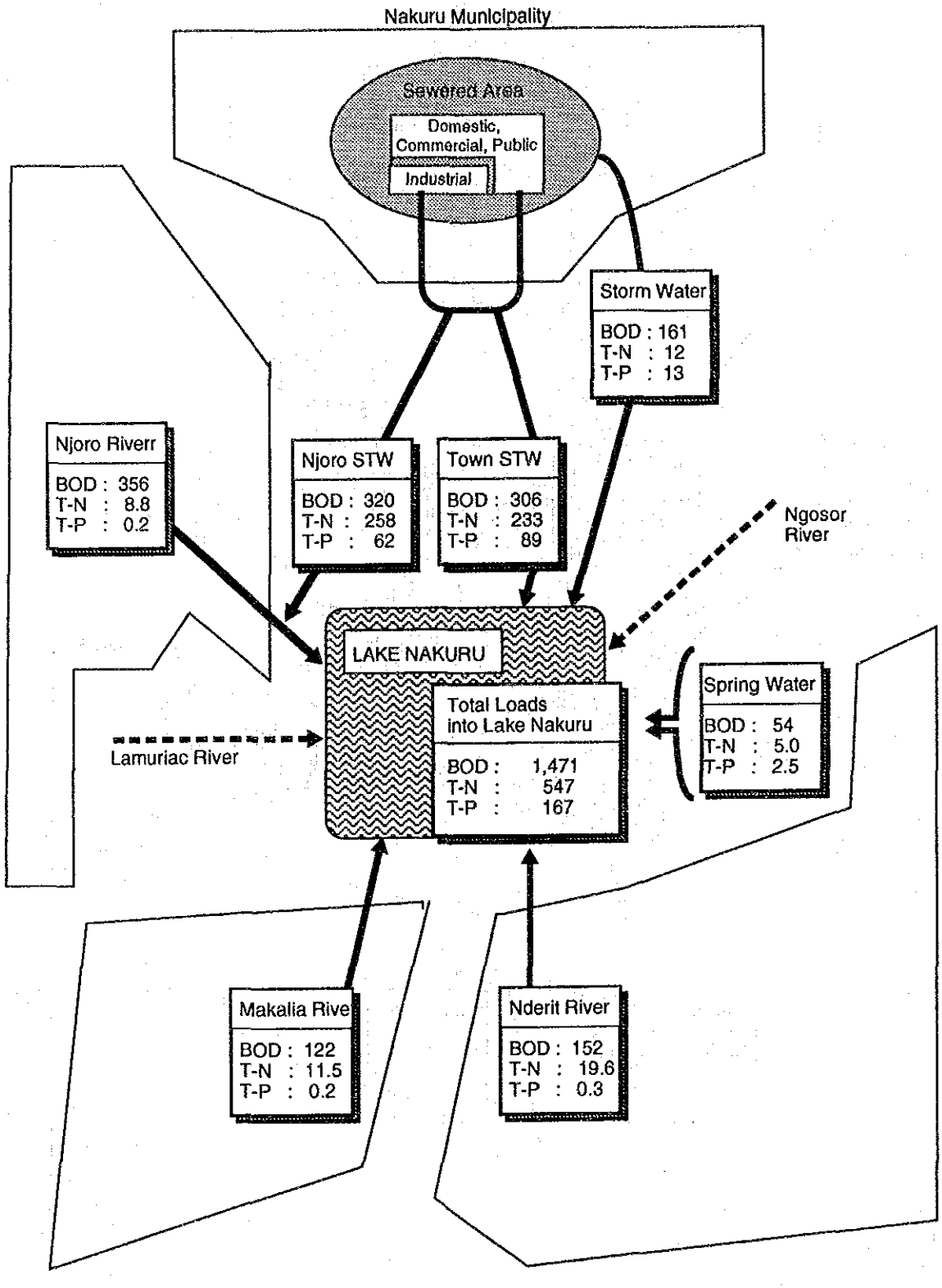
Present pollutant load condition into Lake Nakuru is shown in Fig. L-13, and the forecast after implementation of the project is shown in Fig. L-14 as preliminary estimate. As comparing the above two cases, the Project is estimated to greatly contributes to alleviate pollution load into Lake Nakuru.

(2) Fauna and flora

The project will reduce pollutant load into Lake Nakuru. It is not considered the Project has any negative impact on the founa and flora in the down stream of the sites during operation period.

Fig. L - 13

**Present Condition**

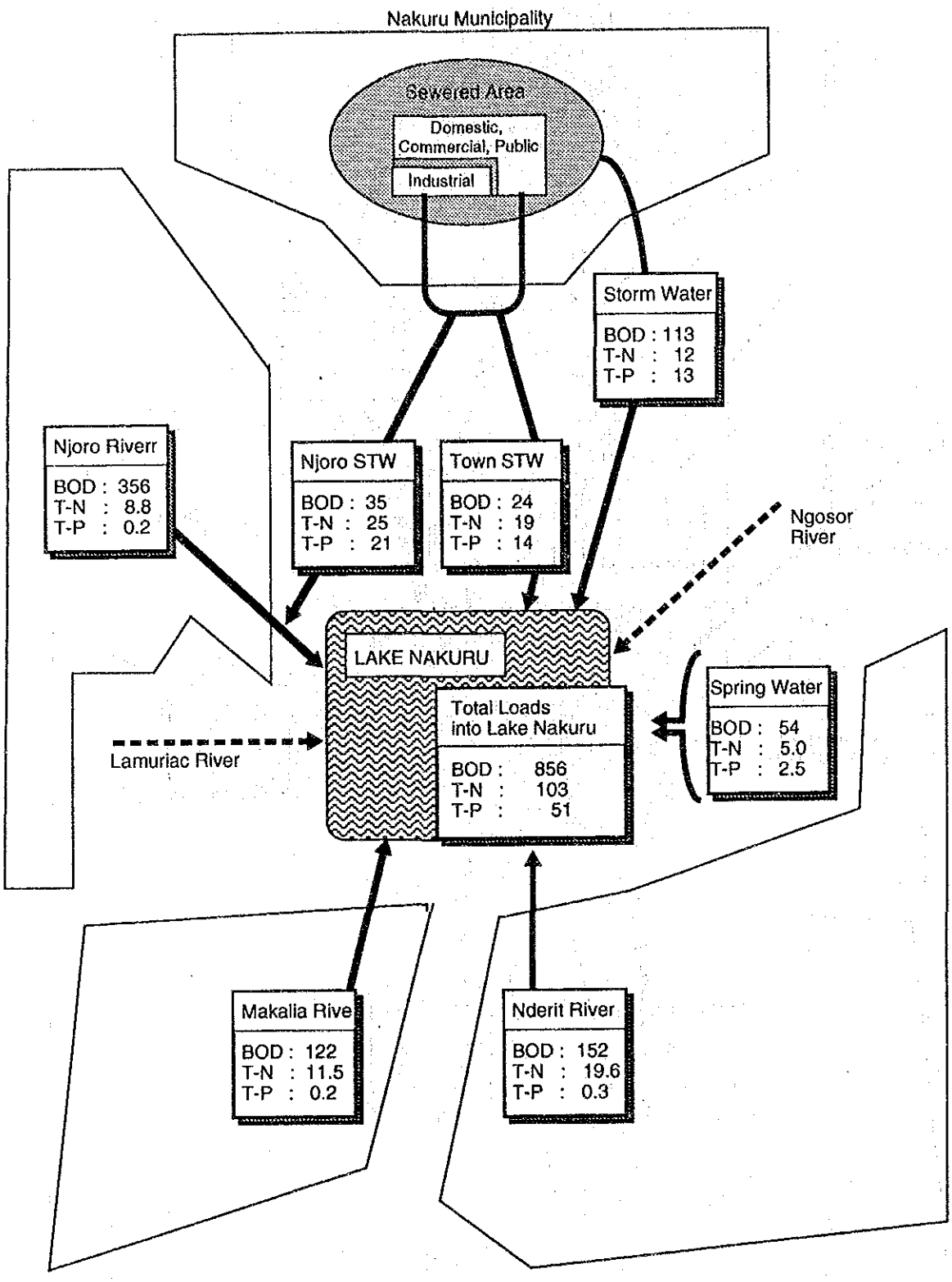



Unit : ton / year

| | | |
|---|---|---|
| *THE REPUBLIC OF KENYA*<br>MINISTRY OF LOCAL GOVERNMENT | THE STUDY<br>ON<br>THE NAKURU SEWAGE WORKS<br>REHABILITATION AND EXPANSION PROJECT<br>JAPAN INTERNATIONAL COOPERATION AGENCY | TITLE<br>POLLUTANT LOAD CONDITION<br>INTO LAKE NAKURU (PRESENT) |

Fig. L - 14

After Implementation of the Project
(with Enforcement Trade Effluent By-Laws)




Unit : ton / year

| | | |
|---|---|---|
| *THE REPUBLIC OF KENYA*<br>MINISTRY OF LOCAL GOVERNMENT | THE STUDY ON THE NAKURU SEWAGE WORKS REHABILITATION AND EXPANSION PROJECT<br>JAPAN INTERNATIONAL COOPERATION AGENCY | TITLE<br>POLLUTANT LOAD CONDITION INTO LAKE NAKURU (FORECAST) |

## L.5.3 Conclusion and Recommendation

The summary of environmental impact assessment are shown in Table L-10. The contemplated Project contributes not only to alleviate pollution loads into Lake Nakuru but also make it possible to commence the additional water supply of 13,300 $m^3$/day to the Nakuru Municipality. It is foreseeable that adverse environmental impacts resulting from the installation of a waste stabilization pond system will be kept minimal, and the positive impacts, such as alleviation of water pollution, will greatly outweigh any potential negative impacts such as odour nuisance or sludge generation. Some items are forecast to be subject to minor impact. The mitigation method is studied and proposed for the respective item as below;

### (1) Drainage Pit & Sedimentation Pond

Muddy water flow may cause the impact on the downstream water body. As the mitigation measure of muddy water treatment, drainage pit and sedimentation ponds should be constructed at the construction sites during the construction period. Even the short retention period in the sedimentation pond shall improve the quality of muddy water.

### (2) Sludge Disposal System

Existing garbage disposal site is located at the points about 8 km from Lake Nakuru. Pollution released from the garbage site may discharge into Lake Nakuru through the groundwater aquifer. The suitable garbage disposal site should be required.

The sludge accumulated in the existing waste stabilization ponds, and the sludge generated from anaerobic pond during operation period should be treated properly. Suitable sludge disposal site and sludge convey system are required. The sludge disposal site is preferred to be identified away from Lake Nakuru in the view point of Lake Nakuru conservation.

### (3) Regreening on Excavation Area

The major construction work of this project is earth works such as stripping, excavation and embankment. Open grass land which cover the construction sites will be destroyed. As counter measure for slope erosion, "vegetation restoration" and deterioration of landscape, regreening on the embankment and excavated area is required.

(4) Tree Belt Planting

At present offensive odour is not considered to be problem. Nobody complain such issue at present. But actually offensive odour is generated from existing anaerobic ponds. Tree planting around the anaerobic pond is recommendable not only for offensive odour mitigation, but for landscape improvement.

(5) Cooperation with KWS

The construction schedule and method should be discussed with KWS prior to commencement of the construction works in order to minimize the impact of the construction work on fauna and flora in the park. The meeting and discussion should be continued with KWS throughout the construction period in order to assess the impact and to feed back such impact for construction work.

(6) Working Environmental

Infrastructure for working persons at the construction site should be established properly, especially wastewater and garbage treatment facilities. Wastewater and garbage generated from working persons may cause the impact on downstream waterbody.

## Table L-13 Summary of Environmental Impact Assessment (1/2)

| | Check Items | Impact | Problems | Action & Counter Measure |
|---|---|---|---|---|
| Project Site (Construction Period) | 1. Erosion & Slope protection | 1-b | The construction works includes a great deal of earthworks. | At the construction stage, proper embankment and slope protection works are required. |
| | 2. Muddy Water | 1-b | Muddy water will cause impact to downstream. | Sedimentation pond and drainage ditch should be prepared. |
| | 3. Noise, vibration, dust pollution | 1-a | There are no resident houses near the construction sites. | |
| | 4. Traffic situation | 1-a | The traffic volume will not be increased. The construction work need not many material to be conveyed from outside. | |
| | 5. Excess soil disposal | 1-a | Earthwork balance has been considered. Excess soil will not be generated so much. | |
| | 6. Sludge Disposal | 2 | The construction work includes de-sludging from existing WSP. These sludge may cause impact on downstream water body, if not treated properly. | Dry space will be prepared in the sites. The accumulated sludge is discharged into the space, and the dried sludge will be taken to disposal site. |
| | 7. Land acquisition | 1-b | The area of Lake Nakuru National Park should be used for the STWs construction sites. | Appropriate measure should be taken up by the Government. |
| | 8. Flora | 2 | The project sites are covered with open grass land. The stripping of grass will be taken place over the entire area. | Regreening should be done on excavated area. |
| | 9. Fauna | 1-b | Relocation of the fence should be done. It may cause impact on Fauna in the National Park. | The works should be done under the supervision of KWS |
| | 10. Safety & Working Environment | 1-b | | Wastewater and garbage from working persons should be treated properly. Safety and working environment precaution should be managed. |

Level of Impact

1-a : No Impact by the Project
1-b : No Impact after Counter Measure
2 : Minor Impact
3 : Major Impact

## Table L-13 Summary of Environmental Impact Assessment (2/2)

| | Check Items | Impact | Problems | Action & Counter Measure |
|---|---|---|---|---|
| Project Site (Operation Period) | 1. Offensive Odour | 2 | Offensive odour will be generated from anaerobic ponds. But it will not be serious because of wind direction and location of STW. | Tree belt around the anaerobic pond is recommendable. |
| | 2. Sludge Disposal | 2 | Sludge should be taken out from anaerobic pond. The sludge may become to be pollution source. | Sludge treatment system including new disposal sites should be established as soon as possible (Refer to 4.4.1). |
| | 3. Noise | 1-a | Proposed facilities have no major mechanical equipment. | |
| | 4. Effect on Landscape | 1-a | STWs sites look like natural ponds and natural open grass land. | Regreening will be done, and tree belt will be planted around anaerobic ponds. |
| Downstream of Proposed Works (Operation Period) | 1. Water Pollution | 1-a | Main purpose of the project is to reduce the water pollutant load. | The situation shall be improved (Refer to 4.5). |
| | 2. Fauna & Flora | Not Clear | Impact of water pollution on ecological condition will be mitigated. | Long term monitoring program and detail ecological study is required. |

Level of Impact

1-a : No Impact by the Project
1-b : No Impact after Counter Measure
2 : Minor Impact
3 : Major Impact

# ANNEX

## ANNEX ENVIRONMENTAL IMPACT ASSESSMENT FORMAT

Environmental impact assessment format has been established through a number of discussions among the NES, MOLG and JICA Study Team and is attached hereto.

**EIA Format**

**on**

**Nakuru Sewerage Works Rehabilitation and Expansion Project**

## 1. Background of the Project

### 1.1 Water Supply and Sewerage

- To explain historical process of water supply and sewerage development in Nakuru Municipality
- Above explanation includes following issues;
  - Water sources
  - Water supply amount and water quality
  - Current sewerage works (processes and capacity)
  - Types of the pollution sources
  - Sewage quantity and quality
  - Institutional framework

### 1.2 Lake Nakuru

- To describe the special characteristics of Lake Nakuru
- To describe pollution load into Lake Nakuru

## 2. Description of the Proposed Project

- To describe main objective of the Project and rationale to improve the present effluent system into Lake Nakuru

## 3. Present Environmental Condition in the Study Area

### 3.1 Project Area

- To define project area and describe general area condition

3.2 Basin of Lake Nakuru

- To explain development activity
- To describe major pollution sources , including following information;
  - Types of pollutants
  - Quality and quantity of pollutants
- To describe the condition around proposed construction site

3.3 Lake Nakuru National Park

- To describe physical condition in Nakuru National Park
- To describe ecological condition in Nakuru National Park
- To describe institutional management of Nakuru National Park by the government , and kinds of support by NGO, and International Organization.

3.4 Lake Nakuru

- To explain the physical condition of Lake Nakuru
- To explain the ecology of Lake Nakuru
- Above explanation includes following also;
  - Discharge sources into the lake
  - Lake level fluctuation
  - Water quality
  - Ecology (Food Chain, Plankton, Flamingo & Other Birds)
  - Any special characteristics

**4. Project Evaluation on Pollution Load Reduction**

- To describe present pollution load into Lake Nakuru
- To estimate expected pollution load reduction by the project

## 5. Environmental Impact Assessment

5.1 Results of Scooping and Screening

- To review Environmental Preliminary Study

5.2 Project Site (construction site)

a) Construction period

To assess following issues;
- Erosion & slope protection
- Noise, vibration, dust pollution
- Traffic situation
- Excess soil disposal
- Land acquisition
- Flora
- Fauna
- Safety and working environment

b) Operation Period

To assess following issues;
- Offensive Odour (sources and expected circumstances)
- Sludge Disposal (treatment and reuse method)
- Any special operation consideration

5.3 Downstream of Proposed Works

- Water Pollution
  (expected improvements after project and possible negative effects)
- Fauna
- Flora

5.4 Recommendation for 5.2 and 5.3

## 6. Proposed Monitoring Program

- To recommend monitoring program, including following issues;
  - Object
  - Parameters
  - Periodicity
  - Institutional issue

# M : FINANCIAL AND ECONOMIC EVALUATION

# M: FINANCIAL AND ECONOMIC EVALUATION

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## M1. INTRODUCTION

This study aims at presenting the evaluation from three points of view for the proposed project, i.e., financial viability, economic feasibility and assessment of the socio-economic impacts. This evaluation composes a part of the total project evaluation which consists of technical and environmental aspects in addition to the above aspects.

Financial evaluation usually consists of both the financial viability of the proposed project and the impacts of the proposed project on the financial soundness of both the executing body (NMC) and beneficiaries. The former point will be evaluated on the basis of the two balances, capital balance and revenue balance. In the capital balance, the constraints and recommendations will be discussed in the fields of procurement of investment capitals and sources for repayment of loans on consideration of the Municipal financial conditions. In the revenue balance, the revenues and expenses of sewerage undertaking will be analyzed considering the rate of charges to sewage treatment services for beneficiaries. The charges will also be examined from the point of beneficiary's capacity to pay.

The economic aspect of the project is evaluated by indices such as Economic Internal Rate of Return (EIRR), Net Present Value (NPV) and Benefit-Cost Ratio (B/C). The evaluation components comprise measurement of economic costs, identification and estimation of benefits, and finally calculation of evaluation indices. The economic cost of the project is obtained by converting the financial cost with some adjustments.

In economic evaluation, it is a key issue to identify the economic benefits accruing from the proposed project. Major benefit will be estimated as a sum of willingness to pay for sewage treatment services. The beneficiaries are broken down into two categories, i.e., direct beneficiaries and indirect beneficiaries. The direct ones consists of residents and enterprises in the areas covered by the sewerage system. The indirect ones are typified by tourists to Lake Nakuru National Park, who enjoy the tourism resources and natural environment, since the sewage system is essential for enhancing better environment in the Park. To quantify the these benefit, the questionnaire interview survey is conducted for residents in the Municipality and for tourists in Lake Nakuru National Park. The survey is being conducted from September 6 and through September 10, 1993.

Socio-economic impacts of the project will be examined focusing on the impacts for low income households and on the regional economy. They also include both tangible and intangible benefits such as public hygiene and improved amenities.

This evaluation study has been completed with co-operation of Mr. K. K. Yegon, a Kenyan Counterpart for the financial and economic evaluation. The study also has had

constant assistance and valuable advice from Mr. F. N. Mwaura, Deputy Director of MOLG, Mr. C. G. Kamau, General Manager of WSD in NMC, Mr. R. Ndetei, Head of LNNP. A heartfelt thanks is also to be extended to Mr. B. G. Kibetu from MOLRRWD and Mr. H. G. Kigenyi from MOLRRWD, who had worked together for the field survey in Nakuru Municipality and Lake Nakuru National Park.

## M2. FINANCIAL EVALUATION

### M2.1 Financial Status of Sewerage Management

#### M2.1.1 Sewerage Works in Nakuru Municipality

In most of major towns and municipalities, sewerage works are operated with water supply works and refuse services. These service works are managed by Local Authorities. The Authorities, however, are not always operated all these services by themselves. By service level, they are grouped into three categories as follows:

- Category A (Full Water Undertakers): They operate water supply, water distribution, sewerage and refuse services.
- Category B (Water Undertakers): They operate water distribution, sewerage and refuse services whereby the water supply is managed by MOLRRWD.
- Category C (Other Municipalities): They operate sewerage and refuse facilities only, whereby water supply and distribution is managed by MOLRRWD.

Nakuru is classified into Category A, i.e., a Full Undertaker. The Municipal Council of Nakuru (NMC) is managing and operating water works and refuse services as well as sewerage works. Thus, NMC holds the strings of the managing purse of these utility services in Nakuru Municipality. Table M-1 shows annual balance of these utility services for the latest six fiscal years, 1988/89 to 1993/94. Although the balances for 1988/89 to 1991/92 are actual figures, the balance in 1992/93 is probable figures and that in 1993/94 is estimates.

#### M2.1.2 Financial Condition of Sewage System

The municipal revenue for sewage treatment services was actually K£355,600 in the 1991/92 fiscal year, accounting for 6.9% of the total revenue of K£5,178 thousand. Owing to the revision of the tariff for sewage treatment services, that will be expected to increase to K£874,600 or 9.3% of the total revenue in 1993/94. On the other hand, the municipal expenditure for the services was K£212,800 in 1991/92 or 3.8% of the municipal total expenditure of K£5,647 thousand. That will somewhat increase to K£296,300 in 1993/94, but it accounts for only 3.3% of the total. Thus, the sewage system accounts contribute to the municipal financial management, although its total amount is comparatively small to the total figure.

## Table M-1 Annual Financial Balance of Utility Services in Nakuru

(Unit : K£ thousand)

| Item | 1988/89 (Actual) | | 1989/90 (Actual) | | 1990/91 (Actual) | |
|---|---|---|---|---|---|---|
| | Amount | Share(%) | Amount | Share(%) | Amount | Share(%) |
| 1. Whole Council | | | | | | |
| a. Income | 3,885.1 | 100.0 | 4,891.8 | 100.0 | 4,593.1 | 100.0 |
| b. Expenditure | 3,555.9 | 100.0 | 4,144.8 | 100.0 | 5,182.1 | 100.0 |
| c. Balance | 329.3 | 100.0 | 747.0 | 100.0 | -588.9 | 100.0 |
| 2. Water Supply and Distribution | | | | | | |
| a. Income | 715.6 | 18.4 | 749.8 | 15.3 | 608.9 | 13.3 |
| b. Expenditure | 648.0 | 18.2 | 700.3 | 16.9 | 859.2 | 16.6 |
| c. Balance | 67.6 | 20.5 | 49.5 | 6.6 | -250.3 | 42.5 |
| 3. Sewerage | | | | | | |
| a. Income | 418.7 | 10.8 | 386.6 | 7.9 | 314.7 | 6.9 |
| b. Expenditure | 146.7 | 4.1 | 167.1 | 4.0 | 253.0 | 4.9 |
| c. Balance | 272.1 | 82.6 | 219.4 | 29.4 | 61.7 | -10.5 |
| 4. Refuse Services*1 | | | | | | |
| a. Income | 161.1 | 4.1 | 137.4 | 2.8 | 111.5 | 2.4 |
| b. Expenditure | 162.7 | 4.6 | 198.8 | 4.8 | 251.3 | 4.8 |
| c. Balance | -1.6 | -0.5 | -61.4 | -8.2 | -139.8 | 23.7 |

| Item | 1991/92 (Actual) | | 1992/93 (Probable) | | 1993/94 (Estimate) | |
|---|---|---|---|---|---|---|
| | Amount | Share(%) | Amount | Share(%) | Amount | Share(%) |
| 1. Whole Council | | | | | | |
| a. Income | 5,177.8 | 100.0 | 7,367.7 | 100.0 | 9,423.3 | 100.0 |
| b. Expenditure | 5,647.3 | 100.0 | 7,250.1 | 100.0 | 9,097.8 | 100.0 |
| c. Balance | -469.5 | 100.0 | 117.7 | 100.0 | 325.5 | 100.0 |
| 2. Water Supply and Distribution | | | | | | |
| a. Income | 151.0 | 2.9 | 1,075.1 | 14.6 | 1,700.8 | 18.0 |
| b. Expenditure | 932.7 | 16.5 | 1,040.6 | 14.4 | 1,761.2 | 19.4 |
| c. Balance | -781.7 | 166.5 | 34.5 | 29.3 | -60.5 | -18.6 |
| 3. Sewerage | | | | | | |
| a. Income | 355.6 | 6.9 | 644.5 | 8.7 | 874.6 | 9.3 |
| b. Expenditure | 212.8 | 3.8 | 246.9 | 3.4 | 296.3 | 3.3 |
| c. Balance | 142.8 | -30.4 | 397.5 | 337.8 | 578.3 | 177.6 |
| 4. Refuse Services*1 | | | | | | |
| a. Income | 174.3 | 3.4 | 279.4 | 3.8 | 335.2 | 3.6 |
| b. Expenditure | 225.0 | 4.0 | 335.7 | 4.6 | 339.5 | 3.7 |
| c. Balance | -50.7 | 10.8 | -56.3 | -47.9 | -4.3 | -1.3 |

Source: Ref.M-06 to M-10
Remark: *1 Including conservancy, refuse removal and refuse disposal

## Table M-2 Annual Income and Expenditure of Sewerage Sector

(Unit : K£)

| Item | 1988/89 Actual | 1989/90 Actual | 1990/91 Actual | 1991/92 Actual | 1992/93 Probable | 1993/94 Estimate |
|---|---|---|---|---|---|---|
| I. Income | | | | | | |
| 1. Sewer Connection Fees | 1,026 | 1,362 | 1,969 | 2,085 | 1,280 | 2,095 |
| 2. Sewerage Charges | 417,398 | 384,926 | 312,468 | 352,815 | 641,775 | 870,246 |
| 3. Cleaning Blockages | 39 | 40 | 300 | 102 | 281 | 457 |
| 4. Sales of Sludge | 268 | 268 | 0 | 626 | 1,127 | 1,846 |
| Total | 418,731 | 386,596 | 314,737 | 355,628 | 644,463 | 874,644 |
| II. Expenditure | | | | | | |
| 1. Sewage Treatment Works | | | | | | |
| 1 Salaries and wages | 31,333 | 36,470 | 57,028 | 48,588 | 48,270 | 55,243 |
| 2 Superannuation fund | 803 | 940 | 1,604 | 1,236 | 1,483 | 1,886 |
| 3 Provident fund | 1,085 | 1,208 | 1,917 | 900 | 1,172 | 1,200 |
| 4 Subsistence allowance | 106 | 64 | 112 | 99 | 1,000 | 1,000 |
| 5 Uniforms | 445 | 1,723 | 2,746 | 984 | 2,750 | 3,000 |
| 6 Rented staff housing | 979 | 870 | 1,131 | 0 | 0 | 0 |
| 7 Maintenance of building | 1,020 | 1,147 | 649 | 0 | 2,000 | 3,000 |
| 8 Electricity | 4,879 | 4,879 | 14,336 | 5,708 | 5,000 | 6,000 |
| 9 Water and conservancy | 550 | 465 | 465 | 465 | 465 | 465 |
| 10 Rates and insurance | 720 | 720 | 1,348 | 1,348 | 1,348 | 1,348 |
| 11 Laboratory equipment | 268 | 852 | 21 | 228 | 1,500 | 2,000 |
| 12 Transport | 429 | 2,403 | 22 | 10 | 350 | 250 |
| 13 Maintenance of plant | 1,017 | 3,855 | 3,331 | 1,492 | 5,000 | 5,000 |
| 14 Maintenance of lagoons | 1,929 | 765 | 1,081 | 0 | 4,750 | 3,200 |
| 15 Telephone | 281 | 281 | 253 | 1,029 | 280 | 500 |
| 16 Askari force | 2,378 | 2,808 | 4,148 | 3,290 | 3,598 | 4,634 |
| 17 Cleaning material | 37 | 121 | 1,703 | 78 | 100 | 100 |
| 18 Loan Charges | 47,094 | 47,094 | 64,053 | 64,053 | 64,053 | 64,053 |
| 19 Safety equipment | 0 | 0 | 0 | 0 | 0 | 1,000 |
| 20 Maintenance of sub-pumps | 0 | 0 | 0 | 0 | 0 | 3,750 |
| 21 Sewer Extension | 251 | 131 | 11,326 | 1,222 | 0 | 0 |
| 22 Maintenance of sludge drying bed | | 0 | 0 | 0 | 3,750 | 3,750 |
| Sub-total | 95,604 | 106,796 | 167,274 | 130,730 | 146,869 | 161,379 |
| 2. Sewer Maintenance | | | | | | |
| 1 Salaries and wages | 40,683 | 44,607 | 69,951 | 62,423 | 63,336 | 61,452 |
| 2 Superannuation fund | 372 | 383 | 591 | 660 | 717 | 707 |
| 3 Provident fund | 1,761 | 1,953 | 2,873 | 2,201 | 2,012 | 2,055 |
| 4 Subsistence allowance | 0 | 20 | 0 | 0 | 0 | 0 |
| 5 Uniforms | 327 | 1,126 | 811 | 894 | 1,500 | 2,000 |
| 6 Rented staff housing | 536 | 597 | 776 | 0 | 0 | 0 |
| 7 Repairs and maintenance | 2,296 | 2,686 | 2,425 | 1,944 | 4,500 | 6,000 |
| 8 Transport | 4,888 | 6,550 | 1,020 | 1,780 | 6,000 | 8,000 |
| 9 Maintenance of septic tank | 28 | 2,130 | 671 | 0 | 500 | 0 |
| 10 Hoses | 0 | 300 | 0 | 1,216 | 7,000 | 7,000 |
| 11 Equipment, drain rods | 170 | 0 | 17 | 0 | 800 | 3,350 |
| 12 Manhole cover | 0 | 0 | 0 | 0 | 0 | 4,388 |
| 13 Computer services | 0 | 0 | 6,620 | 10,966 | 13,685 | 40,002 |
| Sub-total | 51,061 | 60,352 | 85,755 | 82,084 | 100,050 | 134,954 |
| Total of Expenditure | 146,665 | 167,148 | 253,029 | 212,814 | 246,919 | 296,333 |

Source: Ref.M-06 to M-10

In the income of sewerage sector, the leading part is sewerage charge which accounts for more than 99% of the total income, as shown in Table M-2. Other income accrue from sewer connection fees, cleaning blockages and sales of sludge. In the 1991/92 fiscal year, the total income of this sector was K£355,628. In the same year, the quantity of sewage at inlets of both Njoro and Town STWs was about 10,159 $m^3$/day on average, i.e., 3,709 million $m^3$/annum. Thus, the average unit value of sewage treatment services was calculated at KShs.1.92/$m^3$. On the other hand, the total expenditure was K£212,814 in the same year. Then, the average unit cost of sewage treatment services was calculated at KShs.1.15/$m^3$.

Of the expenditure of sewerage sector in the 1991/92 fiscal year, the largest part was the salaries and wages which accounted for K£111 thousand or 52% of the total expenditure of K£212 thousand. The second one was the loan charges, accounting for K£64 thousand or 30%. The third one was the computer services, K£10 thousand or 5%. These three items occupied about 85% of the total expenditure. In 1993/94, however, they are expected to decrease to about 75% because the budget is allocated to other items, as seen in the table.

M2.1.3 National Expenditure for Sewage Schemes

In Kenya, major schemes of sewage works are managed by local authorities in general. Since the local authorities are under jurisdiction of Ministry of Local Government (MOLG), the national budget of major sewage schemes is provided by MOLG. On the other hand, the sewage schemes in minor towns and urban areas are mostly undertaken by Ministry of Land Reclamation, Regional and Water Development (MOLRRWD).

The national financial estimates for sewage schemes are shown in Table M-3 for the latest four fiscal years. In the 1993/94 estimates, the expenditure of MOLG is K£80.5 million or 1.0% of the national total of K£7,873 million. The development expenditure for sewage schemes is K£9.4 million or 12% of the total expenditure of MOLG. Of this amount, K£7.7 or 83% is supported by foreign assistance.

M2.1.4 Credit System for Sewage Development Scheme

The institutional framework for local borrowing is complicated in Kenya, but in most cases the Local Government Loans Authority (LGLA) functions to provide credit to local authorities. LGLA is mostly procuring its monetary sources lending to local authorities through Ministry of Finance (MOF) and MOLG. Around 80% of the original sources is provided as loan sources by the principal donors such as African Development Bank (AfDB), German Government (KfW), USAID, IDA, etc. Other sources are procured through the national financial account and also in the local financial market.

## Table M-3 Public Expenditure of Central Government for Sewerage Schemes

(Unit : K£ thousand)

| Item | 1990/92 (Approved Estimates) Gross Expenditure | A-in-A *1 | Net Expenditure | 1991/92 (Approved Estimates) Gross Expenditure | A-in-A *1 | Net Expenditure |
|---|---|---|---|---|---|---|
| 1. Government of Kenya | | | | | | |
| A) Reccurent Expenditure | 2,943,842 | 165,322 | 2,778,520 | 3,442,515 | 118,365 | 3,324,150 |
| B) Development Expenditure | 1,020,857 | 543,034 | 477,823 | 1,098,274 | 592,583 | 505,692 |
| C) Total Expenditure | 3,964,699 | 708,356 | 3,256,343 | 4,540,790 | 710,948 | 3,829,842 |
| 2. Ministry of Local Government | | | | | | |
| A) Reccurent Expenditure | 7,763 | 183 | 7,580 | 9,138 | 60 | 9,078 |
| a) General Administration & Planning | 1,813 | 99 | 1,715 | 2,400 | 60 | 2,340 |
| b) Contribution in Lieu of Rates | 5,724 | 84 | 5,640 | 6,487 | 0 | 6,487 |
| c) Grants to Local Authorities | 225 | 0 | 225 | 250 | 0 | 250 |
| B) Development Expenditure | 44,586 | 36,286 | 8,300 | 82,858 | 63,027 | 19,831 |
| a) General Administration & Planning | 1,310 | 1,050 | 260 | 1,929 | 999 | 930 |
| b) Development Schemes | 43,276 | 35,236 | 8,040 | 80,929 | 62,028 | 18,901 |
| 1) Sewerage Schemes | 15,773 | 10,423 | 5,350 | 20,757 | 15,667 | 5,090 |
| 2) Water Supply Schemes | 14,880 | 14,480 | 400 | 41,799 | 32,446 | 9,353 |
| 3) Others | 12,623 | 10,333 | 2,290 | 18,373 | 13,914 | 4,458 |
| C) Total Expenditure | 52,349 | 36,469 | 15,880 | 91,996 | 63,087 | 28,909 |
| 3. Ministry of Water Development | | | | | | |
| A) Reccurent Expenditure | 24,313 | 2,484 | 21,830 | 28,683 | 2,498 | 26,185 |
| B) Development Expenditure | 66,058 | 36,749 | 29,308 | 50,061 | 21,234 | 28,827 |
| C) Total Expenditure | 90,371 | 39,233 | 51,138 | 78,745 | 23,732 | 55,012 |

| Item | 1992/93 (Approved Estimates) Gross Expenditure | A-in-A *1 | Net Expenditure | 1993/94 (Estimates) Gross Expenditure | A-in-A *1 | Net Expenditure |
|---|---|---|---|---|---|---|
| 1. Government of Kenya | | | | | | |
| A) Reccurent Expenditure | 4,425,046 | 115,654 | 4,309,392 | 6,583,167 | 155,009 | 6,428,158 |
| B) Development Expenditure | 1,332,569 | 655,159 | 677,411 | 1,289,542 | 675,277 | 614,264 |
| C) Total Expenditure | 5,757,616 | 770,813 | 4,986,803 | 7,872,709 | 830,286 | 7,042,423 |
| 2. Ministry of Local Government | | | | | | |
| A) Reccurent Expenditure | 9,003 | 78 | 8,925 | 10,910 | 60 | 10,850 |
| a) General Administration & Planning | 2,074 | 78 | 1,996 | 2,500 | 60 | 2,441 |
| b) Contribution in Lieu of Rates | 6,679 | 0 | 6,679 | 8,109 | 0 | 8,109 |
| c) Grants to Local Authorities | 250 | 0 | 250 | 300 | 0 | 300 |
| B) Development Expenditure | 84,705 | 64,206 | 20,499 | 69,544 | 51,544 | 18,001 |
| a) General Administration & Planning | 6,023 | 3,835 | 2,188 | 4,477 | 2,634 | 1,843 |
| b) Development Schemes | 78,682 | 60,371 | 18,311 | 65,068 | 48,910 | 16,158 |
| 1) Sewerage Schemes | 7,380 | 5,200 | 2,180 | 9,365 | 7,755 | 1,610 |
| 2) Water Supply Schemes | 61,818 | 52,215 | 9,603 | 44,813 | 38,155 | 6,658 |
| 3) Others | 9,484 | 2,956 | 6,528 | 10,890 | 3,000 | 7,890 |
| C) Total Expenditure | 93,708 | 64,284 | 29,424 | 80,454 | 51,603 | 28,851 |
| 3. Ministry of Water Development *2 | | | | | | |
| A) Reccurent Expenditure | 38,018 | 3,133 | 34,885 | 53,012 | 3,606 | 49,406 |
| B) Development Expenditure | 84,043 | 50,173 | 33,870 | 93,863 | 51,224 | 42,639 |
| a) Urban Water Supply & Sewerage | 4,901 | 115 | 4,786 | 3,432 | 115 | 3,317 |
| b) Others | 79,142 | 50,058 | 29,084 | 90,431 | 51,109 | 39,322 |
| C) Total Expenditure | 122,061 | 53,306 | 68,756 | 146,875 | 54,831 | 92,045 |

Source: Ref.M-15 to M-20

Remark: *1 Appropriations in Aid

*2 Synthesized into Ministry of Land Reclamation, Regional and Water Development

The interest rate on these loans varies as follows: (1) Allocations by the MOF and/or MOLG to LGLA are lent at an interest rate of 6%; (2) Two of the major donors, AfDB and KfW, also at 6% to the national government; (3) USAID and IDA, at 11%. Reflecting these various interest rates, the national government lends these credit sources to local authorities through LGLA at the following conditions: (1) Interest rate varies from 7% to 13% in accordance with project conditions; (2) The original principal is repaid within 30 years; (3) The grace period is not provided at present.

M2.2 Constraints in Financial Aspects

The current revenue of the municipal government has increased since the fiscal year 1990/91 as shown in Table M-1. However, the water supply and refuse services were seriously in the red. Accordingly, the one year accounts of the government got into the red in the both fiscal year 1990/91 and 1991/92. After that, the government has made endeavours to collect the water charges with great patience and to revise the tariff on these services, so the water supply accounts seems to run into the normal conditions. For this period, the sewage sector has maintained in the black. Correspondingly, the overall balance of the government keeps in the surplus finance in the latest two fiscal years.

Due to the overall financial deficit of the central government, the government introduces the expenditure ceilings system and restricts the expenditure for the new projects, unless the projects have extremely high economic efficiency. Although it is not clear how long this investment programme continues, the ceilings system might be considered to continue for the time being. In addition, the government tries to improve the crowding-out conditions by reducing the excessive treasury bonds and to revitalize the financial market for private financial demands. Thus, the government has to push its fiscal restraint to improve fiscal situation and to reduce domestic borrowing at present.

Because of the high debt-service ratio in Kenya, it seems to be sensitive for the central government to increase external debt for project implementation. Succeeding to West Germany and other some lending countries, if any other lending countries offer debt write-offs, they could alleviate the excessive dependence on external debt conditions in Kenya. Otherwise, it will put the country in an awkward position to expect more external loans.

Foreign grants are another important financial source for development in Kenya. Since 1990, however, the world economy seems to grow at moderate rate after several years reasonable expansion. Thus, the international economic situation is not favourable for increasing more financial grants for Kenya. In this international scene, industrialized countries

are expected to recover in economic growth and to support the developing countries continuously in the future.

Although water supply and sewage services in Nakuru run the business on the basis of self-supporting accounts, it would be difficult for NMC to invest in new development schemes because of little capital funds. Even for this current rehabilitation and expansion of the existing systems, it might be difficult for NMC to procure investment funds without any grants and/or loans in consideration of their financial scale. Thus, it would be essential for NMC to get financial aid from the outside. MOLG supports NMC in the fields of finance as well as engineering and, then, expects foreign countries to assist this current project. Otherwise, MOLG and NMC could not put the projects into practice. Once they realize the projects, the undertaker, NMC, would be able to manage the schemes by their own accounting in cost recovering conditions, as managing the present existing schemes.

### M2.3 Charges on Sewerage Services

Rates of charge for utility services are established by NMC in every year. The rates for the recent five years are presented in Table M-4. The rate of charge for sewage treatment service is included in the water charge, as shown in the table. Thus, it is impossible to calculate an unit price of sewage, i.e., KShs. per cubic meter.

To know an average unit price of water and sewage services, typical uses are assumed, as shown in Table M-5. There are six users who are connected to water supply distribution network with appropriate water meter: domestic users (1) with and (2) without sewerage connection, commercial user (3) with and (4) without sewerage connection, (5) industrial user with sewerage connection, and (6) institutional user with sewerage connection. The table shows the total amounts and the unit prices for water and sewage services. Supposing that they consume 30 $m^3$/month of water, the respective users have to pay the following amounts for services of water and sewage treatment: (1) KShs.283.50, (2) KShs.256.50, (3) KShs.318.50, (4) KShs.297.50, (5) KShs.338.50 and (6) KShs.293.50. Then, Unit prices for the respective users are: (1) KShs.9.45/$m^3$, (2)KShs.8.55/$m^3$, (3) KShs.10.62/$m^3$, (4) KShs.9.72/$m^3$, (5) KShs.17.95/$m^3$ and (6) KShs.9.78/$m^3$. This difference comes from the meter rent charge. Once exclude the meter charge, unit price is only two levels: (1) KShs.7.95/$m^3$ for a user with sewage connection and (2) KShs.7.05/$m^3$ for a user without sewage connection.

## Table M-4 Rate of Charges for Water Supply and Sewage Treatment Services

| Item | | Approved 1989/90 | Approved 1990/91 | Approved 1991/92 | Approved 1992/93 | Proposed 1993/94 |
|---|---|---|---|---|---|---|
| 1. Water Deposits | | | | | | |
| (a) Institutions | | - | - | - | - | 1000.00 |
| (b) Industries | | - | - | - | - | 3000.00 |
| (c) Commercial users | | 660.00 | 800.00 | 800.00 | 800.00 | 2000.00 |
| (d) Domestic users per family | | 500.00 | 600.00 | 600.00 | 600.00 | 1000.00 |
| 2. Meter Rents per Month | [Classification 1993/94] | | | | | |
| (a) 1/2" and including 1" | 1/2" | 9.20 | 9.70 | 10.00 | 10.00 | 45.00 |
| (b) over 1" and Including 2" | 1" and 1.5" | 16.00 | 16.00 | 18.00 | 18.00 | 55.00 |
| (c) over 2" and Including 3" | 2" and 2.5" | 27.00 | 27.00 | 29.00 | 29.00 | 80.00 |
| (d) over 3" and Including 4" | 3" | 40.00 | 40.00 | 45.00 | 45.00 | 150.00 |
| (e) over 4" | 4" | 50.00 | 50.00 | 55.00 | 55.00 | 300.00 |
| (f) - | over 4" | - | - | - | - | 400.00 |
| 3. Reconnection Fee | | | | | | |
| (a) 1/2" | | 70.00 | 70.00 | 70.00 | 70.00 | 100.00 |
| (b) over 1" and Including 2" | | 160.00 | 160.00 | 165.00 | 165.00 | 250.00 |
| (c) over 2" to 4" | | 310.00 | 310.00 | 315.00 | 315.00 | 450.00 |
| 4. Turning Off/On Fee per Visit | | 25.00 | 25.00 | 50.00 | 50.00 | 75.00 |
| 5. Special Reading Fee per Visit | | 60.00 | 60.00 | 65.00 | 65.00 | 80.00 |
| 6. Damage to Meter - Cost Plus 25% | | +20% | +20% | +20% | +50% | +60% |
| 7. Penalty on Tampering with Council Water Supply | | 500.00 | 500.00 | 700.00 | 1,500.00 | 2,500.00 |
| 8. Meter Testing at Consumers Request Where It Is Not Found to Register Incorrectly 5% Either Way - Minimum Charge | | - | - | - | 60.00 | 60.00 |
| 9. Water Application Forms (each) | | - | - | - | 100.00 | 180.00 |
| 10. Penalty on Tempering with Meter Seals | | - | - | - | - | 600.00 |
| 11. Sewer Unblocking Vehicle (Cannon Jet) | | - | - | - | - | 2000.00 |
| 12. Water Charges - Premises Connected to Sewer | | | | | | |
| (a) Minimum charge 3000 litres | | 19.70 | 19.70 | 19.70 | 19.70 | 36.00 |
| (b) Each 1000 litres consumed in excess of 3000 litres | | 2.00 | 2.50 | 2.50 | 3.50 | 7.50 |
| 13. Water Charges - Premises Not Connected to Sewer | | | | | | |
| (a) Minimum charge 3000 litres | | 19.70 | 19.70 | 19.70 | 19.70 | 36.00 |
| (b) Each 1000 litres consumed in excess of 3000 litres | | 2.00 | 2.50 | 2.50 | 3.50 | 6.50 |
| 14. Water Charges - Outside Municipality / Peri-Urban Supply | | | | | | |
| (a) Minimum charge 3000 litres | | 105.00 | 105.00 | 105.00 | 105.00 | 200.00 |
| (b) Each 1000 litres consumed in excess of 3000 litres | | 3.35 | 4.25 | 4.25 | 4.25 | 7.50 |
| Turning off/on fee per visit | | 25.00 | 25.00 | 100.00 | 100.00 | 200.00 |
| Reconnection fee | - 1/2" | 70.00 | 70.00 | 120.00 | 120.00 | 300.00 |
| | - 1" | 160.00 | 160.00 | 200.00 | 200.00 | 400.00 |
| | - Over 1" | 310.00 | 310.00 | 350.00 | 350.00 | 550.00 |
| (c) Sale of water per drum | | - | - | - | - | 40.00 |
| (d) Water application form for areas outside Municipality | | - | - | - | - | 250.00 |
| (e) Emptying of septic into sewer line | | - | - | - | - | 100.00 |

Source : Ref. M-06

## Table M-5 Marginal Bills of Water and Sewage Services by Typical Beneficiary : 1993/94

| | Item | Domestic User (1/2") With Sewage | Domestic User (1/2") Without Sewage | Commercial User (2") With Sewage | Commercial User (2") Without Sewage | Industry (4") W/Sewage | Institution (1") W/Sewage |
|---|---|---|---|---|---|---|---|
| 1. | *Water Deposit* | 1,000.00 | 1,000.00 | 2,000.00 | 2,000.00 | 3,000.00 | 1,000.00 |
| 2. | Meter Rent (Shs./month) | 45.00 | 45.00 | 80.00 | 80.00 | 300.00 | 55.00 |
| 3. | Water Charge (Shs./month) | | | | | | |
| | (a) Minimum Charge (Less than 3000 lit) | 36.00 | 36.00 | 36.00 | 36.00 | 36.00 | 36.00 |
| | (b) Metered Charge (More than 3000 lit: Shs./1000 lit) | 7.50 | 6.50 | 7.50 | 6.50 | 7.50 | 7.50 |
| 4. | Amount Consumed (cu.m./month) | | | | | | |
| | 1 | 81.00 | 81.00 | 116.00 | 116.00 | 336.00 | 91.00 |
| | 2 | 81.00 | 81.00 | 116.00 | 116.00 | 336.00 | 91.00 |
| | 3 | 81.00 | 81.00 | 116.00 | 116.00 | 336.00 | 91.00 |
| | 4 | 88.50 | 87.50 | 123.50 | 122.50 | 343.50 | 98.50 |
| | 5 | 96.00 | 94.00 | 131.00 | 129.00 | 351.00 | 106.00 |
| | 10 | 133.50 | 126.50 | 168.50 | 161.50 | 388.50 | 143.50 |
| | 15 | 171.00 | 159.00 | 206.00 | 194.00 | 426.00 | 181.00 |
| | 20 | 208.50 | 191.50 | 243.50 | 226.50 | 463.50 | 218.50 |
| | 30 | 283.50 | 256.50 | 318.50 | 291.50 | 538.50 | 293.50 |
| | 50 | 433.50 | 386.50 | 468.50 | 421.50 | 688.50 | 443.50 |
| | 100 | 808.50 | 711.50 | 843.50 | 746.50 | 1,063.50 | 818.50 |
| | 200 | 1,558.50 | 1,361.50 | 1,593.50 | 1,396.50 | 1,813.50 | 1,568.50 |
| 5. | Unit Rate (Shs./cu.m.) | | | | | | |
| | 1 | 81.00 | 81.00 | 116.00 | 116.00 | 336.00 | 91.00 |
| | 2 | 40.50 | 40.50 | 58.00 | 58.00 | 168.00 | 45.50 |
| | 3 | 27.00 | 27.00 | 38.67 | 38.67 | 112.00 | 30.33 |
| | 4 | 22.13 | 21.88 | 30.88 | 30.63 | 85.88 | 24.63 |
| | 5 | 19.20 | 18.80 | 26.20 | 25.80 | 70.20 | 21.20 |
| | 10 | 13.35 | 12.65 | 16.85 | 16.15 | 38.85 | 14.35 |
| | 15 | 11.40 | 10.60 | 13.73 | 12.93 | 28.40 | 12.07 |
| | 20 | 10.43 | 9.58 | 12.18 | 11.33 | 23.18 | 10.93 |
| | 30 | 9.45 | 8.55 | 10.62 | 9.72 | 17.95 | 9.78 |
| | 50 | 8.67 | 7.73 | 9.37 | 8.43 | 13.77 | 8.87 |
| | 100 | 8.09 | 7.12 | 8.44 | 7.47 | 10.64 | 8.19 |
| | 200 | 7.79 | 6.81 | 7.97 | 6.98 | 9.07 | 7.84 |
| 6. | Unit Rate Excluding Meter Rent (Shs./cu.m.) | | | | | | |
| | 1 | 36.00 | 36.00 | 36.00 | 36.00 | 36.00 | 36.00 |
| | 2 | 18.00 | 18.00 | 18.00 | 18.00 | 18.00 | 18.00 |
| | 3 | 12.00 | 12.00 | 12.00 | 12.00 | 12.00 | 12.00 |
| | 4 | 10.88 | 10.63 | 10.88 | 10.63 | 10.88 | 10.88 |
| | 5 | 10.20 | 9.80 | 10.20 | 9.80 | 10.20 | 10.20 |
| | 10 | 8.85 | 8.15 | 8.85 | 8.15 | 8.85 | 8.85 |
| | 15 | 8.40 | 7.60 | 8.40 | 7.60 | 8.40 | 8.40 |
| | 20 | 8.18 | 7.33 | 8.18 | 7.33 | 8.18 | 8.18 |
| | 30 | 7.95 | 7.05 | 7.95 | 7.05 | 7.95 | 7.95 |
| | 50 | 7.77 | 6.83 | 7.77 | 6.83 | 7.77 | 7.77 |
| | 100 | 7.64 | 6.67 | 7.64 | 6.67 | 7.64 | 7.64 |
| | 200 | 7.57 | 6.58 | 7.57 | 6.58 | 7.57 | 7.57 |

## Table M-6 Flat Rate of Water Supply and Sewage Treatment

| Item | 1991/92 | 1992/93 | 1993/94 |
|---|---|---|---|
| I. Actual Record | | | |
| 1. Water Supply and Sewage Treatment Record | | *1 | *1 |
| 1) Water Supply ($m^3$/day) | 23,157 | 20,133 | 20,133 |
| (1) Metered Water Supply | 8,702 | 13,395 | 13,395 |
| a. Sewered Area | 5,974 | 8,184 | 8,184 |
| b. Unsewered Area | 2,728 | 5,211 | 5,211 |
| (2) Unaccounted Water | 14,455 | 6,739 | 6,739 |
| 2) Sewage Treatment ($m^3$/day) | 9,377 | 9,750 | 9,750 |
| (1) Sewage Inflow | 9,377 | 9,750 | 9,750 |
| 3) Annual Volume ($m^3$/year) | | | |
| (1) Source Water | 8,475,346 | 7,348,574 | 7,348,574 |
| (2) Sewage | 3,432,134 | 3,558,618 | 3,558,618 |
| 2. Municipal Accounts ( K£/year) | | | |
| 1) Water Supply | | | |
| (1) Income from Water Supply | | | |
| a. Water Charge | 86,970 | 992,600 | 1,570,293 |
| b. Total Income | 151,022 | 1,075,073 | 1,700,765 |
| (2) Expenditure for Water Supply | 932,699 | 1,043,149 | 1,761,239 |
| 2) Sewage Treatment | | | |
| (1) Income from Sewage | | | |
| a. Sewarage Charge | 352,815 | 641,775 | 870,246 |
| b. Total Income | 355,628 | 644,463 | 874,645 |
| (2) Expenditure for Sewage | 212,814 | 246,919 | 296,333 |
| 3. Unit Rate (KShs./$m^3$) | | | |
| 1) Water Supply | | | |
| (1) Unit Price of Water Supply | | | |
| a. Water Charge | 0.21 | 2.70 | 4.27 |
| b. Total Income | 0.36 | 2.93 | 4.63 |
| (2) Unit Cost of Water Supply | 2.20 | 2.84 | 4.79 |
| 2) Sewage Treatment | | | |
| (1) Unit Price of Sewage | | | |
| a. Sewarage Charge | 0.83 | 1.75 | 2.37 |
| b. Total Income | 0.84 | 1.75 | 2.38 |
| (2) Unit Cost of Sewage | 0.50 | 0.67 | 0.81 |
| II. Analytical Estimation | | | |
| 1. Estimated Volume | | | |
| 1) Daily Average ($m^3$/day) | | | |
| (1) Source Water | 23,909 | 23,909 | 23,909 |
| (2) Sewage | 8,185 | 8,185 | 8,185 |
| 2) Annual Volume ($m^3$/year) | | | |
| (1) Source Water | 8,726,785 | 8,726,785 | 8,726,785 |
| (2) Sewage | 2,987,525 | 2,987,525 | 2,987,525 |
| 2. Unit Rate (KShs./$m^3$) | | | |
| 1) Water Supply | | | |
| (1) Unit Price of Water Supply | | | |
| a. Water Charge | 0.20 | 2.27 | 3.60 |
| b. Total Income | 0.35 | 2.46 | 3.90 |
| (2) Unit Cost of Water Supply | 2.14 | 2.39 | 4.04 |
| 2) Sewage Treatment | | | |
| (1) Unit Price of Sewage | | | |
| a. Sewarage Charge | 2.36 | 4.30 | 5.83 |
| b. Total Income | 2.38 | 4.31 | 5.86 |
| (2) Unit Cost of Sewage | 1.42 | 1.65 | 1.98 |

Remark: *1 Sum of monthly records from March 1992 to February 1993 because of data availability

Since it is impossible to distinguish sewage service charge from the above unit prices, the unit price of sewage service in the 1992/93 fiscal year is estimated by means of the following processes.

(1) The total income of sewage sector in 1992/93 was K£644,463, according to the 1993/94 estimates of NMC.

(2) The total quantity of inflow into the two sewage treatment works was 9,750 $m^3$/day on average, according to the record data of WSD. Then, the total annual inflow was estimated at 3,559 $m^3$ in the same fiscal year.

(3) Thus, the average unit price of sewage service was KShs.1.75/$m^3$, as shown in Table M-6.

The above quantity of inflow into the STWs exceeds the design treatment capacity. This exceeded volume may be attributed to mixture of stromwater. On the other hand, some users do not always pay charges for utility services. According to Ref.M13, 35% of billed amounts was not collected by Nakuru municipality in 1987. Taking these conditions into consideration, the flat rate of sewage service is estimated on the basis of designed volume and actual income to the municipality. The designed volume is 8,185 $m^3$/day under the present condition. Since this volume is calculated to 2,988 $m^3$/year, the average unit price is estimated at KShs.4.31/$m^3$. In the same manner, the flat rate is estimated at KShs.5.86/$m^3$ in the 1993/94 fiscal year, as shown in the table.

## M2.4 Revenue and Expenditure

### M2.4.1 Sources for Capital Investment

In the case that a local authority procures an investment capital for sewage scheme, it usually has to get a loan through LGLA or a grant through the central government. It is possibly considered for the authority to procure capitals through issuing public bond and/or from private banks. Even in these cases, the local authority has to get a permission from MOLG, so it might be impossible to do so actually. On the other hand, if the scheme is undertaken by the central government itself, the local authority could enjoy the benefit without any financial difficulty for investment in the municipal finance. In this study, the current project is considered to be undertaken by NMC, so sources for the capital investment might be the following three alternatives taking the above situation into account:

Case 1: Procurement of a loan through LGLA, which is also divided into two cases under the terms of loan.

Case 1-A: Under the lowest interest rate of 7% per annum; and

Case 1-B Under the highest interest rate of 13% per annum.

Other terms of loan are the same as discussed in Section M2.1.4, i.e., 30 years of repayment period with no grace period.

Case 2: Procurement of a grant through the central government under the condition of foreign assistance.

M2.4.2 Revenue Balance

Revenue Balance is a concept of period of time and, therefore, shows a balance of revenue from sewerage charge and other service income and expenditure for operation and maintenance of sewerage system facilities within a definite period of time. According to the municipal estimates, the revenue of sewage service consists of four categories: (1) sewerage charges, (2) sewer connection fees, (3) cleaning blockages and (4) sales of sludge. Among them, the sewerage charges are a column of revenue, accounting for more than 99% of the total revenue. The unit price of sewage is estimated KShs.5.86/$m^3$ at 1993 price level as mentioned in the previous section. Of this price, KShs.5.83/$m^3$ is the sewerage charge as average flat rate, as shown in Table M-6. The difference of KShs.0.03 comes from the other three categories.

Expenditure for sewage works is classified into three major parts: (1) operation and maintenance (O&M) expenses of sewerage system, (2) depreciation of sewerage facilities and (3) interest of loan. In the 1993/94 fiscal year, NMC estimates the O&M cost at K£296,333 (equivalent to KShs.5.93 million) at 1993 price level. After the completion of the project, the O&M cost is estimated at KShs.6.4 million at 1993 constant prices. Depreciation of the proposed facilities is estimated at KShs.47.6 million per annum for KShs.1,427 million of the total cost of construction works. Because, the life of the facilities is considered at 30 years after the completion of construction work and a straight line depreciation is employed for public facilities in general. The payment of loan interest starts from 1994, the first year of the project.

The streams of revenue balance for Case 1-A, Case 1-B and Case 2 are shown in Tables M-7 to 9, respectively. The annual costs for O&M increase at an escalation rate of 4.2% annually. At the same time, unit prices of sewage service are also assumed to increase in proportion to the escalation rate. Just after the completion of the facilities, the income will increase to KShs.40.7 million from KShs.19.8 million. Because, the additional water supply

by Greater Nakuru Water Supply Project will be put into practical use, so its beneficiaries also become the sewerage beneficiaries. In spite of the income increase, the revenue balance becomes to the maximum deficit of KShs.107.3 million in Case 1-A, as shown in Table M-7. Although the deficit continues to the 23th year and goes into the black after the 24th year, the accumulation deficit will not be settled within the life of the sewerage facilities. In the case of Case 1-B, the revenue balance is much more serious, as shown in Table M-8. However, the financial condition of Case 2 can always keep the balance in the black as shown in Table M-9, because no investment capital is used for the construction so no interest and no depreciation costs are added in the expenditure stream. Because, an entry of the assets which is made by public grant or contribution in aid of construction should not be added up in an account book in general. These assets, therefore, are not added up to expenditures of revenue balance, so called as reduction entry. The undertaker can keep the sound management in revenue balance of Case 2.

M2.4.3 Capital Balance

Capital balance is a difference between revenue and expenditure with no relation to results of sewage service activities within a definite period of time. A capital revenue is simply a source for capital expenditure which comprises construction cost and repayment of loan. Besides loans and grants of general capital reserves, sources for capital expenditure involve depreciation and reserved capital. The depreciation is an expenditure without cash outlay and the capital reserves are accumulated profits. If the total of these sources is less than the capital expenditure, the management of undertaker would run into unsound conditions. To keep the sound condition of management, therefore, it would be indispensable to procure other funds to balance between the total of capital revenue and other sources and the capital expenditure, positively.

The streams of capital balance for Case 1-A, Case 1-B and Case 2 are shown in Tables M-7 to 9, respectively. In Case 1, the capital balance is always negative as shown in the tables. As seen in the table, the repayment of loan can compare favourably with depreciation. Then, if the revenue balance gain a profit of more than the amount of depreciation, the capital balance could be in soundness. Even in Case 1-A, however, the revenue balance is mostly in the red, so it is difficult for the capital balance to keep under sound condition. In Case 2, there might be no problems for the capital balance, as seen in Table M-9.

## Table M-7 Financial Stream of Income and Expenditure: Case 1-A

(Unit: Shs. million)

| Year | Capital Balance | | | | | Revenue Balance | | | | | | | | Cash Balance *1 | Accumulated Cash Balance |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Income | Expenditure | | | Balance | Income | | | Expenditure | | | | Balance | | |
| | LGLA Loan | Construc-tion Cost | Repayment of Loan | Total | | Sewage Charge | Other Income | Total | Operation & Maintenance | Depreciation *2 | Interest of Loan | Total | | | |
| 1 | 316.4 | 316.4 | 0.0 | 316.4 | 0.0 | 18.1 | 0.1 | 18.2 | 6.2 | 0.0 | 22.1 | 28.3 | -10.1 | -10.1 | -10.1 |
| 2 | 957.3 | 957.3 | 10.5 | 967.9 | -10.5 | 18.9 | 0.1 | 19.0 | 6.4 | 0.0 | 88.4 | 94.8 | -75.8 | -86.4 | -96.4 |
| 3 | 153.6 | 153.6 | 42.5 | 196.1 | -42.5 | 19.7 | 0.1 | 19.8 | 6.7 | 0.0 | 96.2 | 102.9 | -83.1 | -125.5 | -222.0 |
| 4 | | | 47.6 | 47.6 | -47.6 | 40.5 | 0.2 | 40.7 | 7.6 | 47.6 | 92.9 | 148.0 | -107.3 | -107.3 | -329.3 |
| 5 | | | 47.6 | 47.6 | -47.6 | 42.2 | 0.2 | 42.4 | 7.9 | 47.6 | 89.5 | 145.0 | -102.6 | -102.6 | -431.9 |
| 6 | | | 47.6 | 47.6 | -47.6 | 44.0 | 0.2 | 44.2 | 8.2 | 47.6 | 86.2 | 142.0 | -97.8 | -97.8 | -529.7 |
| 7 | | | 47.6 | 47.6 | -47.6 | 45.8 | 0.2 | 46.0 | 8.5 | 47.6 | 82.9 | 139.0 | -92.9 | -92.9 | -622.6 |
| 8 | | | 47.6 | 47.6 | -47.6 | 47.7 | 0.2 | 48.0 | 8.9 | 47.6 | 79.6 | 136.0 | -88.0 | -88.0 | -710.6 |
| 9 | | | 47.6 | 47.6 | -47.6 | 49.7 | 0.3 | 50.0 | 9.2 | 47.6 | 76.2 | 133.0 | -83.0 | -83.0 | -793.7 |
| 10 | | | 47.6 | 47.6 | -47.6 | 51.8 | 0.3 | 52.1 | 9.6 | 47.6 | 72.9 | 130.1 | -78.0 | -78.0 | -871.7 |
| 11 | | | 47.6 | 47.6 | -47.6 | 54.0 | 0.3 | 54.3 | 10.0 | 47.6 | 69.6 | 127.1 | -72.8 | -72.8 | -944.5 |
| 12 | | | 47.6 | 47.6 | -47.6 | 56.3 | 0.3 | 56.5 | 10.4 | 47.6 | 66.2 | 124.2 | -67.6 | -67.6 | -1,012.1 |
| 13 | | | 47.6 | 47.6 | -47.6 | 58.6 | 0.3 | 58.9 | 10.8 | 47.6 | 62.9 | 121.3 | -62.4 | -62.4 | -1,074.5 |
| 14 | | | 47.6 | 47.6 | -47.6 | 61.1 | 0.3 | 61.4 | 11.2 | 47.6 | 59.6 | 118.4 | -57.0 | -57.0 | -1,131.5 |
| 15 | | | 47.6 | 47.6 | -47.6 | 63.7 | 0.3 | 64.0 | 11.7 | 47.6 | 56.2 | 115.5 | -51.5 | -51.5 | -1,183.0 |
| 16 | | | 47.6 | 47.6 | -47.6 | 66.3 | 0.3 | 66.7 | 12.2 | 47.6 | 52.9 | 112.7 | -46.0 | -46.0 | -1,229.0 |
| 17 | | | 47.6 | 47.6 | -47.6 | 69.1 | 0.4 | 69.5 | 12.7 | 47.6 | 49.6 | 109.8 | -40.3 | -40.3 | -1,269.3 |
| 18 | | | 47.6 | 47.6 | -47.6 | 72.0 | 0.4 | 72.4 | 13.2 | 47.6 | 46.2 | 107.0 | -34.6 | -34.6 | -1,304.0 |
| 19 | | | 47.6 | 47.6 | -47.6 | 75.0 | 0.4 | 75.4 | 13.7 | 47.6 | 42.9 | 104.2 | -28.8 | -28.8 | -1,332.7 |
| 20 | | | 47.6 | 47.6 | -47.6 | 78.2 | 0.4 | 78.6 | 14.3 | 47.6 | 39.6 | 101.4 | -22.8 | -22.8 | -1,355.6 |
| 21 | | | 47.6 | 47.6 | -47.6 | 81.5 | 0.4 | 81.9 | 14.8 | 47.6 | 36.3 | 98.7 | -16.8 | -16.8 | -1,372.4 |
| 22 | | | 47.6 | 47.6 | -47.6 | 84.9 | 0.4 | 85.3 | 15.4 | 47.6 | 32.9 | 96.0 | -10.6 | -10.6 | -1,383.0 |
| 23 | | | 47.6 | 47.6 | -47.6 | 88.5 | 0.5 | 88.9 | 16.1 | 47.6 | 29.6 | 93.2 | -4.3 | -4.3 | -1,387.3 |
| 24 | | | 47.6 | 47.6 | -47.6 | 92.2 | 0.5 | 92.6 | 16.7 | 47.6 | 26.3 | 90.6 | 2.1 | 2.1 | -1,385.2 |
| 25 | | | 47.6 | 47.6 | -47.6 | 96.0 | 0.5 | 96.5 | 17.4 | 47.6 | 22.9 | 87.9 | 8.6 | 8.6 | -1,376.6 |
| 26 | | | 47.6 | 47.6 | -47.6 | 100.1 | 0.5 | 100.6 | 18.1 | 47.6 | 19.6 | 85.3 | 15.3 | 15.3 | -1,361.3 |
| 27 | | | 47.6 | 47.6 | -47.6 | 104.3 | 0.5 | 104.8 | 18.9 | 47.6 | 16.3 | 82.7 | 22.1 | 22.1 | -1,339.2 |
| 28 | | | 47.6 | 47.6 | -47.6 | 108.7 | 0.6 | 109.2 | 19.6 | 47.6 | 12.9 | 80.2 | 29.1 | 29.1 | -1,310.2 |
| 29 | | | 47.6 | 47.6 | -47.6 | 113.2 | 0.6 | 113.8 | 20.4 | 47.6 | 9.6 | 77.6 | 36.2 | 36.2 | -1,274.0 |
| 30 | | | 47.6 | 47.6 | -47.6 | 118.0 | 0.6 | 118.6 | 21.3 | 47.6 | 6.3 | 75.1 | 43.5 | 43.5 | -1,230.5 |
| 31 | | | 47.6 | 47.6 | -47.6 | 122.9 | 0.6 | 123.6 | 22.1 | 47.6 | 3.0 | 72.7 | 50.9 | 50.9 | -1,179.6 |
| 32 | | | 37.0 | 37.0 | -37.0 | 128.1 | 0.7 | 128.8 | 23.0 | 47.6 | 0.4 | 71.0 | 57.8 | 68.3 | -1,111.3 |
| 33 | | | 5.1 | 5.1 | -5.1 | 133.5 | 0.7 | 134.2 | 24.0 | 47.6 | 0.0 | 71.6 | 62.6 | 105.1 | -1,006.2 |

Remark : *1 (Capital Balance)+(Revenue Balance)+(Depreciation)

*2 Loan charges of K£64,053 is assumed to be inclueded in the O&M cost till the 26th year.

## Table M-8 Financial Stream of Income and Expenditure: Case 1-B

(Unit: Shs. million)

| Year | Capital Balance | | | | | Revenue Balance | | | | | | | | Cash Balance *1 | Accumulated Cash Balance |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Income | Expenditure | | | Balance | Income | | | Expenditure | | | | Balance | | |
| | LGLA Loan | Construc-tion Cost | Repayment of Loan | Total | | Sewage Charge | Other Income | Total | Maintenance & Operation | Depreciation *2 | Interest of Loan | Total | | | |
| 1 | 316.4 | 316.4 | 0.0 | 316.4 | 0.0 | 18.1 | 0.1 | 18.2 | 6.2 | 0.0 | 41.1 | 47.3 | -29.1 | -29.1 | -29.1 |
| 2 | 957.3 | 957.3 | 10.5 | 967.9 | -10.5 | 18.9 | 0.1 | 19.0 | 6.4 | 0.0 | 164.2 | 170.6 | -151.6 | -162.2 | -191.2 |
| 3 | 153.6 | 153.6 | 42.5 | 196.1 | -42.5 | 19.7 | 0.1 | 19.8 | 6.7 | 0.0 | 178.7 | 185.3 | -165.5 | -208.0 | -399.2 |
| 4 | | | 47.6 | 47.6 | -47.6 | 40.5 | 0.2 | 40.7 | 7.6 | 47.6 | 172.5 | 227.6 | -186.9 | -186.9 | -586.1 |
| 5 | | | 47.6 | 47.6 | -47.6 | 42.2 | 0.2 | 42.4 | 7.9 | 47.6 | 166.3 | 221.7 | -179.3 | -179.3 | -765.5 |
| 6 | | | 47.6 | 47.6 | -47.6 | 44.0 | 0.2 | 44.2 | 8.2 | 47.6 | 160.1 | 215.9 | -171.7 | -171.7 | -937.2 |
| 7 | | | 47.6 | 47.6 | -47.6 | 45.8 | 0.2 | 46.0 | 8.5 | 47.6 | 153.9 | 210.0 | -164.0 | -164.0 | -1,101.2 |
| 8 | | | 47.6 | 47.6 | -47.6 | 47.7 | 0.2 | 48.0 | 8.9 | 47.6 | 147.7 | 204.2 | -156.2 | -156.2 | -1,257.4 |
| 9 | | | 47.6 | 47.6 | -47.6 | 49.7 | 0.3 | 50.0 | 9.2 | 47.6 | 141.6 | 198.3 | -148.4 | -148.4 | -1,405.7 |
| 10 | | | 47.6 | 47.6 | -47.6 | 51.8 | 0.3 | 52.1 | 9.6 | 47.6 | 135.4 | 192.5 | -140.5 | -140.5 | -1,546.2 |
| 11 | | | 47.6 | 47.6 | -47.6 | 54.0 | 0.3 | 54.3 | 10.0 | 47.6 | 129.2 | 186.7 | -132.5 | -132.5 | -1,678.6 |
| 12 | | | 47.6 | 47.6 | -47.6 | 56.3 | 0.3 | 56.5 | 10.4 | 47.6 | 123.0 | 181.0 | -124.4 | -124.4 | -1,803.1 |
| 13 | | | 47.6 | 47.6 | -47.6 | 58.6 | 0.3 | 58.9 | 10.8 | 47.6 | 116.8 | 175.2 | -116.3 | -116.3 | -1,919.3 |
| 14 | | | 47.6 | 47.6 | -47.6 | 61.1 | 0.3 | 61.4 | 11.2 | 47.6 | 110.6 | 169.4 | -108.0 | -108.0 | -2,027.4 |
| 15 | | | 47.6 | 47.6 | -47.6 | 63.7 | 0.3 | 64.0 | 11.7 | 47.6 | 104.4 | 163.7 | -99.7 | -99.7 | -2,127.1 |
| 16 | | | 47.6 | 47.6 | -47.6 | 66.3 | 0.3 | 66.7 | 12.2 | 47.6 | 98.3 | 158.0 | -91.3 | -91.3 | -2,218.4 |
| 17 | | | 47.6 | 47.6 | -47.6 | 69.1 | 0.4 | 69.5 | 12.7 | 47.6 | 92.1 | 152.3 | -82.8 | -82.8 | -2,301.3 |
| 18 | | | 47.6 | 47.6 | -47.6 | 72.0 | 0.4 | 72.4 | 13.2 | 47.6 | 85.9 | 146.6 | -74.3 | -74.3 | -2,375.5 |
| 19 | | | 47.6 | 47.6 | -47.6 | 75.0 | 0.4 | 75.4 | 13.7 | 47.6 | 79.7 | 141.0 | -65.6 | -65.6 | -2,441.1 |
| 20 | | | 47.6 | 47.6 | -47.6 | 78.2 | 0.4 | 78.6 | 14.3 | 47.6 | 73.5 | 135.4 | -56.8 | -56.8 | -2,497.9 |
| 21 | | | 47.6 | 47.6 | -47.6 | 81.5 | 0.4 | 81.9 | 14.8 | 47.6 | 67.3 | 129.8 | -47.9 | -47.9 | -2,545.7 |
| 22 | | | 47.6 | 47.6 | -47.6 | 84.9 | 0.4 | 85.3 | 15.4 | 47.6 | 61.1 | 124.2 | -38.8 | -38.8 | -2,584.6 |
| 23 | | | 47.6 | 47.6 | -47.6 | 88.5 | 0.5 | 88.9 | 16.1 | 47.6 | 55.0 | 118.6 | -29.7 | -29.7 | -2,614.3 |
| 24 | | | 47.6 | 47.6 | -47.6 | 92.2 | 0.5 | 92.6 | 16.7 | 47.6 | 48.8 | 113.1 | -20.4 | -20.4 | -2,634.7 |
| 25 | | | 47.6 | 47.6 | -47.6 | 96.0 | 0.5 | 96.5 | 17.4 | 47.6 | 42.6 | 107.6 | -11.0 | -11.0 | -2,645.8 |
| 26 | | | 47.6 | 47.6 | -47.6 | 100.1 | 0.5 | 100.6 | 18.1 | 47.6 | 36.4 | 102.1 | -1.5 | -1.5 | -2,647.3 |
| 27 | | | 47.6 | 47.6 | -47.6 | 104.3 | 0.5 | 104.8 | 18.9 | 47.6 | 30.2 | 96.7 | 8.2 | 8.2 | -2,639.1 |
| 28 | | | 47.6 | 47.6 | -47.6 | 108.7 | 0.6 | 109.2 | 19.6 | 47.6 | 24.0 | 91.2 | 18.0 | 18.0 | -2,621.1 |
| 29 | | | 47.6 | 47.6 | -47.6 | 113.2 | 0.6 | 113.8 | 20.4 | 47.6 | 17.9 | 85.9 | 27.9 | 27.9 | -2,593.2 |
| 30 | | | 47.6 | 47.6 | -47.6 | 118.0 | 0.6 | 118.6 | 21.3 | 47.6 | 11.7 | 80.5 | 38.1 | 38.1 | -2,555.1 |
| 31 | | | 47.6 | 47.6 | -47.6 | 122.9 | 0.6 | 123.6 | 22.1 | 47.6 | 5.5 | 75.2 | 48.4 | 48.4 | -2,506.7 |
| 32 | | | 37.0 | 37.0 | -37.0 | 128.1 | 0.7 | 128.8 | 23.0 | 47.6 | 0.7 | 71.3 | 57.5 | 68.0 | -2,438.7 |
| 33 | | | 5.1 | 5.1 | -5.1 | 133.5 | 0.7 | 134.2 | 24.0 | 47.6 | 0.0 | 71.6 | 62.6 | 105.1 | -2,333.6 |

Remark : *1 (Capital Balance)+(Revenue Balance)+(Depreciation)

*2 Loan charges of K£64,053 is assumed to be inclueded in the O&M cost till the 26th year.

## Table M-9 Financial Stream of Income and Expenditure: Case 2

(Unit: Shs. million)

| Year | Capital Balance | | | | | Revenue Balance | | | | | | | | Cash Balance *1 | Accumulated Cash Balance |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Income | Expenditure | | | Balance | Income | | | Expenditure | | | | Balance | | |
| | Foreign Grant | Construc-tion Cost | Repayment of Loan | Total | | Sewage Charge | Other Income | Total | Maintenance & Operation | Deprecia-tion*2 | Interest of Loan | Total | | | |
| 1 | 316.4 | 316.4 | 0.0 | 316.4 | 0.0 | 18.1 | 0.1 | 18.2 | 6.2 | 0.0 | 0.0 | 6.2 | 12.1 | 12.1 | 12.1 |
| 2 | 957.3 | 957.3 | 0.0 | 957.3 | 0.0 | 18.9 | 0.1 | 19.0 | 6.4 | 0.0 | 0.0 | 6.4 | 12.6 | 12.6 | 24.7 |
| 3 | 153.6 | 153.6 | 0.0 | 153.6 | 0.0 | 19.7 | 0.1 | 19.8 | 6.7 | 0.0 | 0.0 | 6.7 | 13.1 | 13.1 | 37.8 |
| 4 | | | 0.0 | 0.0 | 0.0 | 40.5 | 0.2 | 40.7 | 7.6 | 0.0 | 0.0 | 7.6 | 33.1 | 33.1 | 70.9 |
| 5 | | | 0.0 | 0.0 | 0.0 | 42.2 | 0.2 | 42.4 | 7.9 | 0.0 | 0.0 | 7.9 | 34.5 | 34.5 | 105.5 |
| 6 | | | 0.0 | 0.0 | 0.0 | 44.0 | 0.2 | 44.2 | 8.2 | 0.0 | 0.0 | 8.2 | 36.0 | 36.0 | 141.5 |
| 7 | | | 0.0 | 0.0 | 0.0 | 45.8 | 0.2 | 46.0 | 8.5 | 0.0 | 0.0 | 8.5 | 37.5 | 37.5 | 179.0 |
| 8 | | | 0.0 | 0.0 | 0.0 | 47.7 | 0.2 | 48.0 | 8.9 | 0.0 | 0.0 | 8.9 | 39.1 | 39.1 | 218.1 |
| 9 | | | 0.0 | 0.0 | 0.0 | 49.7 | 0.3 | 50.0 | 9.2 | 0.0 | 0.0 | 9.2 | 40.8 | 40.8 | 258.8 |
| 10 | | | 0.0 | 0.0 | 0.0 | 51.8 | 0.3 | 52.1 | 9.6 | 0.0 | 0.0 | 9.6 | 42.5 | 42.5 | 301.3 |
| 11 | | | 0.0 | 0.0 | 0.0 | 54.0 | 0.3 | 54.3 | 10.0 | 0.0 | 0.0 | 10.0 | 44.3 | 44.3 | 345.6 |
| 12 | | | 0.0 | 0.0 | 0.0 | 56.3 | 0.3 | 56.5 | 10.4 | 0.0 | 0.0 | 10.4 | 46.2 | 46.2 | 391.8 |
| 13 | | | 0.0 | 0.0 | 0.0 | 58.6 | 0.3 | 58.9 | 10.8 | 0.0 | 0.0 | 10.8 | 48.1 | 48.1 | 439.9 |
| 14 | | | 0.0 | 0.0 | 0.0 | 61.1 | 0.3 | 61.4 | 11.2 | 0.0 | 0.0 | 11.2 | 50.2 | 50.2 | 490.1 |
| 15 | | | 0.0 | 0.0 | 0.0 | 63.7 | 0.3 | 64.0 | 11.7 | 0.0 | 0.0 | 11.7 | 52.3 | 52.3 | 542.4 |
| 16 | | | 0.0 | 0.0 | 0.0 | 66.3 | 0.3 | 66.7 | 12.2 | 0.0 | 0.0 | 12.2 | 54.5 | 54.5 | 596.9 |
| 17 | | | 0.0 | 0.0 | 0.0 | 69.1 | 0.4 | 69.5 | 12.7 | 0.0 | 0.0 | 12.7 | 56.8 | 56.8 | 653.7 |
| 18 | | | 0.0 | 0.0 | 0.0 | 72.0 | 0.4 | 72.4 | 13.2 | 0.0 | 0.0 | 13.2 | 59.2 | 59.2 | 712.9 |
| 19 | | | 0.0 | 0.0 | 0.0 | 75.0 | 0.4 | 75.4 | 13.7 | 0.0 | 0.0 | 13.7 | 61.7 | 61.7 | 774.6 |
| 20 | | | 0.0 | 0.0 | 0.0 | 78.2 | 0.4 | 78.6 | 14.3 | 0.0 | 0.0 | 14.3 | 64.3 | 64.3 | 838.9 |
| 21 | | | 0.0 | 0.0 | 0.0 | 81.5 | 0.4 | 81.9 | 14.8 | 0.0 | 0.0 | 14.8 | 67.0 | 67.0 | 906.0 |
| 22 | | | 0.0 | 0.0 | 0.0 | 84.9 | 0.4 | 85.3 | 15.4 | 0.0 | 0.0 | 15.4 | 69.9 | 69.9 | 975.8 |
| 23 | | | 0.0 | 0.0 | 0.0 | 88.5 | 0.5 | 88.9 | 16.1 | 0.0 | 0.0 | 16.1 | 72.8 | 72.8 | 1,048.7 |
| 24 | | | 0.0 | 0.0 | 0.0 | 92.2 | 0.5 | 92.6 | 16.7 | 0.0 | 0.0 | 16.7 | 75.9 | 75.9 | 1,124.6 |
| 25 | | | 0.0 | 0.0 | 0.0 | 96.0 | 0.5 | 96.5 | 17.4 | 0.0 | 0.0 | 17.4 | 79.1 | 79.1 | 1,203.7 |
| 26 | | | 0.0 | 0.0 | 0.0 | 100.1 | 0.5 | 100.6 | 18.1 | 0.0 | 0.0 | 18.1 | 82.5 | 82.5 | 1,286.2 |
| 27 | | | 0.0 | 0.0 | 0.0 | 104.3 | 0.5 | 104.8 | 18.9 | 0.0 | 0.0 | 18.9 | 86.0 | 86.0 | 1,372.2 |
| 28 | | | 0.0 | 0.0 | 0.0 | 108.7 | 0.6 | 109.2 | 19.6 | 0.0 | 0.0 | 19.6 | 89.6 | 89.6 | 1,461.7 |
| 29 | | | 0.0 | 0.0 | 0.0 | 113.2 | 0.6 | 113.8 | 20.4 | 0.0 | 0.0 | 20.4 | 93.4 | 93.4 | 1,555.1 |
| 30 | | | 0.0 | 0.0 | 0.0 | 118.0 | 0.6 | 118.6 | 21.3 | 0.0 | 0.0 | 21.3 | 97.3 | 97.3 | 1,652.4 |
| 31 | | | 0.0 | 0.0 | 0.0 | 122.9 | 0.6 | 123.6 | 22.1 | 0.0 | 0.0 | 22.1 | 101.4 | 101.4 | 1,753.9 |
| 32 | | | 0.0 | 0.0 | 0.0 | 128.1 | 0.7 | 128.8 | 23.0 | 0.0 | 0.0 | 23.0 | 105.7 | 105.7 | 1,859.6 |
| 33 | | | 0.0 | 0.0 | 0.0 | 133.5 | 0.7 | 134.2 | 24.0 | 0.0 | 0.0 | 24.0 | 110.2 | 110.2 | 1,969.8 |

Remark : *1 (Capital Balance)+(Revenue Balance)+(Depreciation)

*2 Depreciation is not added up because an entry of the assets granted should not be made in an account book as reduction entry.

## M2.5 Financial Evaluation

### M2.5.1 Financial Soundness of Undertaker

Financial internal rate of return (FIRR) for gross capital was 1.8%, as shown in Table M-10. This rate is far smaller than the interest rates of 7% to 13%, which LGLA applies to local authorities for capital investment. Thus, from the financial point of view, this project might be not viable as far as the undertaker procures the investment capital through LGLA. In order to make the project feasible, it would be necessary to introduce special funds and/or grants for relieve the burden of repayment and interest of loan.

In Case 1-A, the negative cash balance will continue 20 years after the completion of the project. By the end of the physical facility life, the accumulated deficit will become KShs.1,006.2 million. Accordingly, to manage the sewage service in Nakuru after the introduction of the project, the undertaker must employ the following two countermeasures: (1) to receive subsidies from the municipal finance and/or the central government finance; and (2) to increase sewage unit price to around 40% more than the present level. Applying the second measure, the accumulated balance would change into the black within the life of the facilities. In Case 1-B in the same manner, the sewage unit price must be increased to about 90% more than the present prices.

In Case 2, the both balances of capital and revenue can keep sound financial condition until the end of the facility life, as seen in Table M-9. In this case, the accumulated profits could be inserted into municipal finance. If the undertaker replace the sewage facilities at the end of their life, the accumulated profits could be useful to support it from the financial point of view. In the 30th year after the completion of the project, incidentally, the total construction costs having the same specification of the proposed project would be escalated to be KShs.5,230 million (KShs.1,427 million at 1993 prices), the accumulated profits of KShs.1,970 million accounts for 38% of the total.

### M2.5.2 Household Budget of Domestic User

An average family size of middle income class in Nakuru municipality is 5.6 persons in 1993, according to the questionnaire survey which will be discussed in the next chapter. This average family might consume domestic water of about 15.12 $m^3$/month, because each family member consumes water at the rate of 90 lpcd on average. In this case, the family must pay KShs.171.90/month for water and sewage service charge including meter rent, applying the water tariff of 1993/94 version in Table M-4.

## Table M-10 Financial Cost and Revenue Stream

(Unit: KShs. million)

| Year | Cost | | | Revenue | Balance |
|---|---|---|---|---|---|
| | Initial Construction Works | O&M Works | Total | | |
| 1 | 316.4 | 4.8 | 321.2 | 18.2 | -303.0 |
| 2 | 957.3 | 5.0 | 962.3 | 19.0 | -943.3 |
| 3 | 153.6 | 5.2 | 158.9 | 19.8 | -139.1 |
| 4 | | 7.5 | 7.5 | 40.7 | 33.2 |
| 5 | | 7.8 | 7.8 | 42.4 | 34.6 |
| 6 | | 8.2 | 8.2 | 44.2 | 36.0 |
| 7 | | 8.5 | 8.5 | 46.0 | 37.5 |
| 8 | | 8.8 | 8.8 | 48.0 | 39.1 |
| 9 | | 9.2 | 9.2 | 50.0 | 40.8 |
| 10 | | 9.6 | 9.6 | 52.1 | 42.5 |
| 11 | | 9.9 | 9.9 | 54.3 | 44.3 |
| 12 | | 10.3 | 10.3 | 56.5 | 46.2 |
| 13 | | 10.8 | 10.8 | 58.9 | 48.2 |
| 14 | | 11.2 | 11.2 | 61.4 | 50.2 |
| 15 | | 11.6 | 11.6 | 64.0 | 52.3 |
| 16 | | 12.1 | 12.1 | 66.7 | 54.5 |
| 17 | | 12.6 | 12.6 | 69.5 | 56.9 |
| 18 | | 13.1 | 13.1 | 72.4 | 59.3 |
| 19 | | 13.7 | 13.7 | 75.4 | 61.8 |
| 20 | | 14.2 | 14.2 | 78.6 | 64.4 |
| 21 | | 14.8 | 14.8 | 81.9 | 67.1 |
| 22 | | 15.4 | 15.4 | 85.3 | 69.9 |
| 23 | | 16.0 | 16.0 | 88.9 | 72.9 |
| 24 | | 16.7 | 16.7 | 92.6 | 76.0 |
| 25 | | 17.3 | 17.3 | 96.5 | 79.2 |
| 26 | | 18.1 | 18.1 | 100.6 | 82.5 |
| 27 | | 18.8 | 18.8 | 104.8 | 86.0 |
| 28 | | 19.6 | 19.6 | 109.2 | 89.7 |
| 29 | | 20.4 | 20.4 | 113.8 | 93.5 |
| 30 | | 21.2 | 21.2 | 118.6 | 97.4 |
| 31 | | 22.1 | 22.1 | 123.6 | 101.5 |
| 32 | | 23.0 | 23.0 | 128.8 | 105.8 |
| 33 | | 23.9 | 23.9 | 134.2 | 110.3 |

FIRR: 1.8%

In the same manner, if a family belongs to low income class, the average family size is 4.3 persons and they consume water at the rate of 40 lpcd on average. Then, they consumes 5.16 $m^3$ monthly in total. This family must pay KShs.52.20 for water and sewage service charge excluding meter rent.

An average household income in Nakuru is estimated at KShs.6,690 in middle income class and at KShs.5,020 in low income class in 1993, according to the survey. Therefore, the above water and sewage service charges accounts for 2.6% for middle income family and 1.0% for low income family, respectively. The below table shows variation of the percentage of water and sewage charges to household income by family size, although every family is assumed to consume the above same volume of water. That is, a middle income family consumes 90 lpcd on average and a low income family, 40 lpcd. The charges include a meter rent for middle income class and not for low income class.

| Family Income | Family Size of Middle Income Class (persons) | | | | Family Size of Low Income Class (persons) | | | |
|---|---|---|---|---|---|---|---|---|
| Level | Monthly Income | 4 | Ave. 5.6 | 7 | Monthly Income | 3 | Ave. 4.3 | 6 |
| First Quarter | KShs.3,500 | 4.0% | 4.9% | 5.7% | KShs.2,500 | 1.6% | 2.1% | 2.7% |
| Mean | KShs.4,500 | 3.1% | 3.8% | 4.5% | KShs.3,500 | 1.2% | 1.5% | 1.9% |
| Third Quarter | KShs.6,500 | 2.1% | 2.6% | 3.1% | KShs.5,500 | 0.7% | 0.9% | 1.2% |

Remark: Total charge of middle income class include a meter rent charge, but that of low income class does not include the one.

Central Bureau of Statistics (CBS) conducted "Urban Household Budget Survey" in 1983 in major municipalities and towns. Table M-11 shows a part of analysis of the survey. In Nakuru, an average family spent KShs.54/month for water charge at the survey time. An average family income was KShs.3,692/month, so the water charge accounted for 1.5% of the income. Supposing that this percentage is a standard of water charge, the above all percentages in middle income class families exceed this standard level. These families might try to curtail water for saving money or to demand a reduction of water price to the undertaker. On the other hand, the some water charges of low income families in the above table do not exceed the standard level. However, it might be difficult to install a water meter, because KShs.45/month of meter rent could be a heavy burden for them. Thus, in low income areas, the water distribution system has to be maintained at the present supply level.

These charges mentioned above, however, were based on the current water rates as of the fiscal year 1993/94. As discussed in the previous section, the water rate must be raised to approximately 40% more than the current one in Case 1-A and to 90% in Case 1-B, if the deficit of management is covered by a raising of the water rates only. In these cases, middle income people could not afford to receive water through the present system. For low income people, they will not be able to get water even through the communal system. Thus, if the undertaker implement the proposed project by means of loan, they should bring about better understanding among all the parties concerned as well as people in the municipality.

## Table M-11 Urban Household Income and Expenditure in Nakuru Municipality and Major Towns : 1983

| | Item | Nakuru | Nairobi | Mombasa | Kisumu |
|---|---|---|---|---|---|
| I. | Average Income by Income Class | | | | |
| | A) Average Income (KShs./Month) | | | | |
| | Below 2,000 | 836 | 908 | 928 | 915 |
| | 2,000 - 7,999 | 3,627 | 3,504 | 3,983 | 3,500 |
| | More than 8,000 | 12,965 | 14,020 | 16,395 | 14,078 |
| | Average of all Classes | 1,754 | 1,822 | 2,232 | 2,182 |
| | B) Distribution of Sample Frequency | | | | |
| | Below 2,000 | 1,472 | 9,480 | 4,756 | 1,355 |
| | 2,000 - 7,999 | 371 | 2,883 | 2,694 | 310 |
| | More than 8,000 | 59 | 313 | 105 | 110 |
| | Average of all Classes | 1,902 | 12,676 | 7,555 | 1,775 |
| II. | Average Expenditure by Major Expenditure Item *1 | | | | |
| | A) Income Class : Below Kshs.2,000/Month | | | | |
| | Food & Beverages | 316 | 429 | 440 | 437 |
| | Household Goods *2 | 168 | 211 | 209 | 230 |
| | Major Goods *3 | 254 | 245 | 194 | 361 |
| | Regular Expenditure *4 | 219 | 184 | 150 | 150 |
| | Total | 957 | 1,069 | 993 | 1,178 |
| | B) Income Class : KShs.2,000 - 7,999/Month | | | | |
| | Food & Beverages | 651 | 857 | 1,228 | 907 |
| | Household Goods *2 | 870 | 969 | 1,002 | 894 |
| | Major Goods *3 | 1,684 | 1,076 | 1,170 | 1,497 |
| | Regular Expenditure *4 | 885 | 776 | 705 | 479 |
| | Total | 4,090 | 3,678 | 4,105 | 3,777 |
| | C) Income Class : More Than KShs.8,000/Month | | | | |
| | Food & Beverages | 1,830 | 1,183 | 2,956 | 3,062 |
| | Household Goods *2 | 2,849 | 2,722 | 6,040 | 4,920 |
| | Major Goods *3 | 2,181 | 342 | 2,447 | - |
| | Regular Expenditure *4 | 3,593 | 2,371 | 2,569 | 5,950 |
| | Total | 10,453 | 6,618 | 14,012 | 13,932 |
| | D) All Income Classes | | | | |
| | Food & Beverages | 428 | 545 | 756 | 682 |
| | Household Goods *2 | 388 | 446 | 573 | 637 |
| | Major Goods *3 | 946 | 574 | 697 | 898 |
| | Regular Expenditure *4 | 453 | 372 | 381 | 367 |
| | Total | 2,215 | 1,937 | 2,407 | 2,584 |
| III. | Relation between Income and Water Expenditure (using efficient samples only) | | | | |
| | Number of Efficient Samples | 26 | 243 | 225 | 78 |
| | Average Income (KShs.) | 3,692 | 1,806 | 2,058 | 1,999 |
| | Average Expenditure for Potable Water(KShs.) | 54 | 25 | 36 | 15 |
| | Percentage of Water Expenditure to Income | 1.5% | 1.4% | 1.7% | 0.8% |

Source : Urban Household Budget Survey, 1983, CBS (Unpublished)

Remark : *1 Some unjustifiable figures are perceived in the table, because some problems occured in the survey.

*2 Clothing, Footwear, Fuel, Furnishing, Utensils, Transport, Communication & Recreation

*3 Furniture, Electric Appliances and Transport Equipment

*4 Education, Insurance, Water, Electricity, Telephone, House Rent and Taxes

## M3. ECONOMIC EVALUATION

### M3.1 Basic Points of Economic Evaluation

In estimating economic cost and benefit of the proposed project, the following conditions and assumptions are applied for every item related to estimation.

(1) For economic evaluation activities, the basic price level for cost and benefit estimates was set as of November, 1993. Foreign exchange rate was set at KShs.62.40 to US$1.00 and ¥1.75 to KShs.1.00 in obedience to the official exchange rate.

(2) Opportunity cost of capital represents the permissible economic rate of return for development projects. In Kenya, 10% of this opportunity cost of capital is applied as a discount rate for assessing economic viability of proposed project.

(3) In economic analysis, all goods and services value. In terms of goods and services in local market, the following points have to be considered in the case of converting their financial values to economic ones: (a) internal transfer payment and (b) shadow wage of unskilled labour in particular because of taking unemployment and underemployment conditions into account. In this study, thus, economic values are estimated as 90% of total financial values of local portions which exclude value added taxes of 18%. On the other hand, the foreign goods and services are estimated based on the international market prices, so their values reflect real economic ones.

(4) Regarding benefit of the people in the target area, the total benefit is assumed to increase in proportion to the growth of household income and the number population up to the year 2010. Regarding benefit of other facilities, the total benefit is assumed to increase in proportion to the growth of GRDP in the municipality up to the year 2010. Beyond 2010, however, it is assumed to be constant.

(5) The economic life of the projects is taken as 30 years just after completion of the construction works.