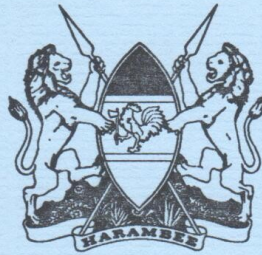


DRAFT

REPUBLIC OF KENYA



MINISTRY OF LOCAL GOVERNMENT
ON BEHALF OF
NYERI MUNICIPAL COUNCIL

KfW Kreditanstalt
für Wiederaufbau
(KfW ASSISTED)

**NYERI WATER SUPPLY
FEASIBILITY STUDY
PRE-FEASIBILITY
REPORT**

**Volume II :
Annexes**

**Gauff
JBG Ingenieure**

FRANKFURT AM MAIN, GERMANY
AND
NAIROBI, KENYA

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VOLUME II
ANNEXES

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ANNEX 1
TERMS OF REFERENCE

NYERI WATER SUPPLY FEASIBILITY STUDYI. INTRODUCTION

Nyeri town is the Provincial Capital of Central Province and the Municipality is one of the six administrative divisions of the Nyeri District. The Municipality covers an area of 176 sq.km and has 14 elected wards with 21 councillors representing the Government as a nominated councillor.

Nyeri can be described as an urban/rural town as more than 60 % of its present area is rural in nature with rich agricultural hinterland owned and managed by small scale farmers growing tea, coffee as cash crops etc..

The Municipality operates two water supplies one serving the Town centre and the surrounding areas at Kamakwa and the other Kiganjo. The two water supplies with daily productions of 5.5 million litres and 1.1 million litres respectively are only able to meet some of the town's daily water demands estimated at 11.0 million litres for Nyeri and 3.0 million litres for Kamakwa. The most recent study on Nyeri Water Supply was prepared in 1982 by Sir Alexander Gibbs and partners.

Nyeri town and Kiganjo are served by two recently commissioned sewage treatment works which are currently under-utilized due to the inadequate water supply in the areas. Some densely populated areas e.g. Kangemi, Kamakwa and parts of Ruringu might require sewer extensions once an adequate water supply is available.

A full scale feasibility study shall be elaborated for the extension of the Nyeri water supply system while part A of the ToR shall also include the existing facilities in Kiganjo.

II. TERMS OF REFERENCE

A. Assessment of Situation

Collect, review and summarize information on development and present situation of water supply covering technical, financial, organizational and socio-economic aspects, i.e.:

1. Raw water source, water works facilities, distribution network, number of yard/house connections and of public taps; urgent rehabilitation requirements by components (production, storage, transmission).
2. Water consumption by various consumer groups (households, by living standards and income groups, public taps, industries, schools, hospitals, administration etc.).
3. Theoretical water demand (according to supply standards) compared to present water supply capacity; assessment of suppressed demand, if any.
4. Raw and clear water production over the last 3 years, sales (m³), billing (m³; KShs), revenue collection (KShs), metering, physical and administrative water losses, necessity for block mapping and consumer survey.
5. Present cost of water supply (running, maintenance, depreciation), required cost-covering tariff versus existing tariff.

6. Overall budget of the Municipality (description and interpretation), indebtedness (total amount and yearly budgeted vs. effective debt service), budget for water supply and sewerage, effective payments for water supply and sewerage.
7. Organization chart for Council's administration, Engineer's Department, Water and Sewerage Section; establishment for Water and Sewerage Section incl. vacant positions; qualification of personnel.
8. Brief description of sanitary facilities (solid and liquid waste disposal, on-lot systems, percentage of households connected to sewers, responsibilities for operation and maintenance, necessity for expansion of sewer network and sewage treatment plant, if any).

B. P R E - F E A S I B I L I T Y

1. Determine water consumption and project future demand of the various consumer groups to the years 2010 and 2015. Apply using minimum, average and maximum assumptions. Discuss in detail the need for a project (major problems and bottlenecks of the existing supply situation, main objectives to be achieved by a project).
2. Define suitable alternatives for individual and integrated systems for the 2 design periods. Pay special attention to the raw water source(s) and consider possibilities how to optimize the use of existing system components.
3. Prepare engineering layouts and preliminary quantities and cost estimates for all works proposed.
4. Recommend optimum solutions for the two specified periods by technical and economical evaluations of investments and operation costs.

5. Review possible implications of the water supply proposals on sanitation and outline possible solutions. Include details in feasibility study.
6. Assess environmental and socio-economic impacts of the project (on health, standard of living, women, urban poor etc.).
7. Identify project objectives and objectively verifiable indicators to measure project achievements. Justify proposed measures and their relevance to the intended achievements. Prepare a logical framework matrix.

C. FEASIBILITY

The technical alternative selected by Client and KfW shall be investigated to feasibility level:

1. Elaborate engineering preliminary designs including preliminary quantities and cost estimates (by years of construction/investment) with breakdown of
 - construction cost based on unit rates and preliminary quantities
 - equipment and material
 - consulting services
 - physical and price contingencies
 - local and foreign currency components.
2. Elaborate in detail on annual operation and maintenance costs up to the final stage of the project, specify foreign currency component.
3. Prepare economic and financial analysis of the project including present value (unit water cost method), cash-flow and sensitivity analysis; effects on the population regarding health, social benefits, income, women, etc.).

4. Propose tariff structure (assuming realistic collection rate) to achieve operating cost coverage, total cost coverage (real and nominal calculations); elaborate on affordability and willingness to pay.
5. Give guidelines for staffing and qualification of operation and maintenance services, propose necessary establishment (Water and Sanitation Department/autonomous Water and Sanitation Company) and compare with the present situation, elaborate on additional costs involved.
6. Make detailed proposals for improved meter reading, billing and collection, for minimization of technical and administrative water losses.
7. Make proposal for new organisational set up (e.g. water and sewerage department). Assess necessity for training programme and elaborate terms of reference, man-month input and cost estimate for such programme.

D. R E P O R T I N G

The following reports are to be submitted to ministries/authorities involved and to KfW for comments and approval prior to the start of the next study stage:

- inception report (8 copies)
- pre-feasibility report (8 copies)
- feasibility report (10 copies).

	Indicators	Assumptions	Indicators
I Goal:			
II Objectives:			
III Results:			
IV Activities:			

ANNEX 2
SOCIO-ECONOMIC REVIEW

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1. BACKGROUND

1.1. Scope of Study

The terms of reference for this socio-economic impact study are given in Appendix 1.

The Study forms a part of the Pre-Feasibility stage, sub-category vi) environmental and socio-economic impacts of the proposed project. The Pre-Feasibility Study follows the preparation of the inception report, *Assessment of the Situation*.

The terms were elaborated and limitations in availability of detailed quantitative data sources discussed. In elaborating the terms for this study it was decided to concentrate on a literature review and on the collection of readily available data. The problems resulting from a lack of detailed socio-economic information and in particular that from the 1989 population census was discussed in the earlier report, *Assessment of Situation*.

Economic and financial analysis of the project is part of the third stage, Feasibility. It is suggested that it may be useful to obtain additional resources to facilitate the collection of primary economic and sociological data, over and above the usual data normally required for economic and financial feasibility.

1.2. Project Area

The project area is the administrative capital of Central Province situated about 150 kilometres North of the national capital, Nairobi. It is located in a valley between the land massifs of Mount Kenya and the Nyandarua (Aberdare) Range.

The zoned municipality area has changed over the past few years to include areas which are essentially rural. This is typical of many small towns in the country whose boundaries have been expanded without changes in land law allowing them to raise rates. The project area, rather than being a continuous urban area, is, therefore, a series of small urbanised pockets tied together by rural areas. The key urban areas are the old town (Mukaro), Ruringu to the south east, Kamakwa to the west, Kiganjo to the north-east and the institutional area of Mathari to the west.

Nyeri is linked to Nairobi, Kenya's capital, to the south-east through Karatina. Leading to the north and then to the west is the Nyahururu road. The main trunk road to the north passes through Kiganjo. A rail road to Nanyuki, though Kiganjo was built in 1927. Kiganjo therefore has better communication and its environs are more than likely to develop as the industrial site of Nyeri.

There is an airstrip at Nyaribo. Access to it is limited since the road is not tarmacked.

The characteristic topography is of a series of ridges divided by deep valleys in most of the zoned municipal area. This has serious implications for internal communication as well as for construction. The ecological implications if the water pipeline is to be constructed to feed Kiganjo from the same treatment works as for the rest of the municipality is discussed in the Environmental Assessment Report..

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In the long term, the better communication structures in Kiganjo to the north-west, the relatively flat physical features to its west, and the fact that the larger plots of land are to the north and west is likely to lead those services which need large spaces dragging the municipality north and westwards.

Nyeri and its environs has an average annual rainfall of more than 900 millimetres spread over two seasons. Temperature is moderated by altitude and rarely rises above 25°C.

1.3. Historical Background of Nyeri Town

1.3.1 Establishment

Nyeri town is located on land which in pre-colonial times was the interface between the Laikipiak and Kikuyu. It traces its creation to the colonial wars of conquest as discussed by Dutton in *Nyeri Townsmen: Kenya*. A fort was established in 1902 to act as a base for controlling the Tetu section of the Kikuyu. From this war related origin, Nyeri became the administrative and trade centre for the local area first.

Africans, as labourers, were not participants in its evolution, although they were always the majority as Zwanenberg shows in *Colonial Capitalism and Labour in Kenya* discusses. Administrators and settlers were European. The traders were Asian. They had arrived by 1905. Administrators, settler farmers and traders determined the socio-economic processes of the town. These origins still influence the structure of urban infrastructure and land holding today, 1995.

Catholic missionaries arrived and settled at Munungaini, in Tetu, around 1903. They later moved to the base of Nyeri Hill at Mathari. Today, the mission centre forms one of the core areas of the town with its varied institutions. Their work in education explains the fantastic literacy rate of the district compared to other areas of Kenya.

1.3.2. Physical and Racial Zoning

By 1910, Nyeri town, then defined as the land between the Honi {Lookout} river (corrupted as Amboni in colonial cartography) and the Chania River, got embroiled in the colonial government's intrigues of finding land for white settlers as discussed in Elliot's *East African Protectorate* and Norman Leys's *Kenya*. The Kikuyu living north of the town were forced to return to the south and east of the town, areas designated as native reserves. The land abutting the town to the north and west was zoned for settlers and for the production of coffee. The land across the Honi river was zoned for ranching by the same settlers. Consequently, the Laikipiak were removed to Narok in 1912 to make way for the European Settlers in what is today Kiari East and West divisions of Nyeri District as well as Laikipia District.

The topography determined settlement. The central ridge carried both the administrative and commercial areas. The initial buildings were on what is today the upper part of Kimathi Way. The second major building effort was on what is today Kenyatta Way - the road to Nairobi. To serve the settlement area to the north, a bridge was built across the Chania. The white official residential area developed on another ridge to the west which also incorporated the Outspan

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Hotel and the Golf Course. This is called Ring Road today and has remained as the most exclusive and expensive real estate in the town. The Asian quarters were to the south of the administrative ridge. African servants were initially housed where Ministry of Works is now located, west of the Chania. Since this interfered with European settlement, they were moved to Majengo by 1913. They were not allowed to buy land in town. This was to remain so until 1958.

1.3.3. Administrative Evolution Administrative Evolution

In 1911 Nyeri was carved out of the native reserve and proclaimed a township. This meant that Africans could only be in the town as servants and with formal permission from a European. As a result, Ruringu initially, and Kamakwa later, emerged as the African towns.

In 1912 Nyeri was made both the administrative capital of Nyeri district which included what is now Laikipia, and became the administrative capital of the Province of Kenya which covered Nanyuki and Laikipia. By 1933, Nyeri was administering what is today Central Province and parts of Eastern Province.

Between 1918 and 1950, Nyeri became one of the major settler towns rivaling Kitale and Nakuru as Huxley discusses in *White Man's Country*. In colonial folklore it, and its environs up to Nanyuki, was the supreme Khaki town - reflecting the fact that most of the settlers were ex-army.

During the Mau Mau years, 1952-1955, it grew significantly as the main base for counterinsurgency for the main battles were in the Nyandarua Range and Mount Kenya, its hinterland as discussed by Tabitha Kanongo in *Squatters and the Rise of Mau Mau*.

In 1954 Nyeri Urban District Council was created. It was zoned an Urban Town in 1961 when the boundary was established as constituting 8 square kilometres. It became a municipality in 1971, and the boundaries were then expanded to cover 72 square kilometres. In 1983 it was to be expanded again to cover 176 square kilometres.

At independence, in 1963, Nyeri was confirmed as the administrative headquarters of Central Province, defined as Kiambu, Muranga, Nyandarua and Kirinyaga districts. This situation obtains to date, 1995.

1.3.4. Economic Evolution since 1963 Economic Evolution since 1963

During the first decade of independence, Nyeri lost its settler character as most of them left. It also lost a significant number of Asian traders. Newcomers to the town were primarily African administrators from other parts of the country and locals seeking economic opportunity as discussed by Dutto in *Nyeri Townsmen*.

In terms of economic infrastructure, the first decade of independence was extremely significant. First, the national and local governments spent a lot of money in the town, building offices and residential quarters for the expanding bureaucracy. The local co-operative movement was organised and invested significant amounts of money in the town in buildings and services. Most important initially was the Tetu Co-operative Union. It was to be joined by other divisional co-operative unions in making investments in the town.

National organisations which had served settlers, like the Kenya Farmers Association, expanded operations. The Kenya Co-operative Creameries, also founded to serve settlers in colonial times, expanded operations and built the Kiganjo milk plant. As bureaucrats from Nyeri rose in the national government, they ensured that key national programmes included Nyeri district and town. Coffee was expanded in the smallholder sector. Tea was started for the same sector. Dairy farming was expanded. The banking sector was expanded. Pressure for expanding the urban and rural water supplies was generated by both bureaucrats and politicians. The result was that since independence, Nyeri district has had more water and sanitation projects funded by Government and Harambee than any other district.

The bureaucrats from the area also ensured that the national banking institutions did locate in the town.

While the economic base was being established for a thriving regional town, the old structure of the town continued to haunt it. The key was the historic segregation into ethnic areas. As the local elite began to claim a stake in the town in the fifties, they could only operate in Ruringu. The County Council (initially African District Council) was and still is located there. This is where the initial African investors located. After independence many shifted to the former section of the White and Brown town. Ruringu stagnated. So did Kamakwa which was the bedroom satellite, as some say, Soweto, to the European residential area.

The former White Highlands, areas of farming to the west and north of the town, also attracted both the local and national elite. The major investments were made on this land rather than urban land or industries as ably discussed by Gary Wassermann's *The Politics of Decolonisation*, Colin Leys' *Underdevelopment in Kenya*, M.P.K. Sorrenson's *Origins of European Settlement in Kenya* and Nicola Swainson's *The Development of Corporate Capitalism in Kenya*. It is generally known that even the traders who moved to town commerce invested most of their profits in land acquisition in the former White highlands as Raphael Kaplinsky discusses in *Readings on Multinational Corporations in Kenya*. The poor were not left out in this process.

By 1966, when it had become clear that the Kenyatta government was not going to give away land in the former White highlands, in spite of its Programme of Settlement and Haraka Schemes, land buying companies were created ostensibly to buy land for the poor for ultimate distribution. It is one of the ironies of Kenyan structure of accumulation that the local elite, who bought the White highlands cheaply during the first ten years of independence when the leaving Europeans were desperate, turned around and sold the less productive land to their poor kinsman at fantastic profit. The sales were often made years later when the same elite, who were often the directors of the land buying companies, had used the same land as collateral to finance other individual operations.

Ranches to the north of the town, and most of Laikipia, were sold to the poor this way. It is there that most of the poor households in the district are to be found as shown by Ayako in *Nyeri Dry Areas Community Development Project: Baseline Survey*.

By 1980, the Moi government was faced with the crisis of rural unrest amongst the poor. The crisis was driven by the fact that they had invested in the land buying companies with a hope of being allocated a piece of land there so as to leave the overcrowded former reserves. The crises was solved by ordering the immediate subdivision of land buying company farms.

For Nyeri town, the presidential proclamation for subdivision had the impact of settling a lot of people in its northern areas, the Kieny's. This settlement and its subsequent evolution is one of the major socio-economic variables impacting on the evolution of Nyeri town. Its effects are felt particularly in the area of owner occupier housing construction and on the long term use of water from both the Nyandarua and Mount Kenya catchments.

1.3.5. Africanisation of Nyeri Town

The Africanisation of Nyeri Town can specifically be dated to 1967 for up to then, it was mainly local elite moving into the town in a trickle. In 1967, the Trade Act was passed. It provided, inter alia, that Asians were to be confined to the large towns. Although Nyeri qualified as a large town, the act generated so much insecurity among the Asian traders that many left.

In the African portion of society, the act opened opportunities for getting into commerce for institutions were created at the national level to assist them in getting into trade. The key institutions were the Industrial and Commercial Development Corporation and the Kenya National Trading Company. Both were created with the express purpose of enabling African traders to take over Asian businesses as ably discussed by Kaplinsky and Swainson. The movement into trade in the town accelerated at all levels. The town became the new frontier, a character it held up to the nineties.

The economic fortunes of Nyeri Town have been tied to national economic developments. Generally, the national economy grew significantly for the first twenty five years after independence. However by the nineties, the national economy had slackened. This is shown in Table 1: Long-term Inflation and Real Growth, 1963-1995.

Real growth averaged 6.5% between 1964 and 1971. Between 1972 and 1975, it was below 4% basically because of the impact of the first oil crisis. During 1976 and 1977 it averaged 7.5% because of the coffee boom. The year 1979 brought the second oil crisis and the ancillary inflation. Growth was minimal. It barely kept up with population growth. Between 1980-1985 it was below 4%, in 1984 being 0.9% because of drought. From 1986 to 1989 it was around 5%. The decade of the nineties has so far been an economic disaster. GDP slid from 4.2% in 1990 to 2.1% in 1991 to 0.5% in 1992 and eventually to a meaningless 0.1% in 1993 and 0.3% in 1994. Up to June 1995, real growth was 4.5% but given the subsequent inflationary pressure it is doubtful whether the rate will be maintained for the year.

Since the slide is coupled with inflationary pressure, towns, Nyeri included, are no longer attractive places to be in. Consequently the poor have begun to exit from towns as shown in the Kimani case in Chapter 7. Terms of trade have changed in favour of farmers, particularly those producing food. This means that the poor are attracted to the rural areas where they can at least produce survival food.

TABLE 1: LONG TERM INFLATION AND REAL GROWTH, 1963-1995

YEAR	ANNUAL CHANGE IN CPI	REAL GROWTH RATE	YEAR	ANNUAL CHANGE IN CPI	REAL GROWTH RATE
1963	0.4	6.1	1980	12.6	3.3
1964	-0.4	5.9	1981	20.9	5.9
1965	6.6	3.6	1982	16.3	2.4
1966	2.3	11.9	1983	10.1	3.1
1967	1.9	4.0	1984	9.8	0.9
1968	0.8	7.8	1985	10.1	4.8
1969	0.6	6.7	1986	4.6	5.6
1970	1.9	6.7	1987	8.6	4.9
1971	6.9	6.3	1988	11.2	5.1
1972	2.6	6.4	1989	10.7	5.1
1973	14.5	6.9	1990	18.3	4.2
1974	13.6	2.0	1991	10.5	2.1
1975	18.7	1.2	1992	33.7	0.5
1976	6.7	6.1	1993	54.7	0.1
1977	16.1	8.8	1994	6.6	0.3
1978	10.0	6.7	June 1995	0.2	4.8

Source: Central Bank of Kenya and Development Plan 1994-1996.

2. DOCUMENTATION AND REVIEW

2.1. Introduction

As far as can be ascertained, Nyeri town socio-economics have not been studied comprehensively recently. Instead, data on the municipality is found in a few scattered studies of the district.

The municipality on its part does not seem to have collected any socio-economic data on the population it serves for, as was explained, it is totally depended on data provided by the Central Bureau of Statistics. To the extent the later deals with aggregated national data mainly, it may be a good idea for the Municipality to seek data specific to itself from the CBS, and to keep it for planning purposes.

2.2. Documentation

Among the key documents consulted were the following:

1. Dutto, Carl A. Nyeri Townsmen: Kenya. Nairobi: EALB, 1975.
2. Environment and Urban Development Training Project and Nyeri Municipality, Nyeri Environmental Development Plan and Action Plans. Nyeri: Municipal Council, 1994.
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2.3. Review of Documentation Review of Documentation

Nyeri town was studied by Dutto in 1971. The study was published as *Nyeri Townsmen: Kenya*, in 1975. Its focus, like many other anthropological studies of the period, was mainly on how Africans were taking to town living. Some of the historical material about the growth of the town and the dynamics of trade and land has been extensively used is the relevant part of this report.

Perhaps the single most important source in the production of this report is data collected by H. P. Gauff in *Nyeri Water Supply Feasibility Study: Situation Assessment Report: Volumes 1 and 2*. July, 1995. It is relied upon extensively especially the data on demography for it focused extensively on determining the probable population in the town given the recent boundary changes. It has also been extensively drawn on for socio-economic characteristics. This is so since H.P. Gauff was able to get from CBS the yet to be published socio-economic analysis of the 1989 census data pertaining to Nyeri Town.

The Housing Research and Development Unit of the University of Nairobi has over the years produced studies on both rural housing or urban housing. Some studies which touch on Nyeri District or the Municipality are drawn on especially in the section on the disadvantaged populations. Their limitations are the limited samples and the lack of relating the conclusions from such limited samples to the wider surveyed CBS data.

Three thesis looked promising on the outset. These were:

Nyeri Town: A Case Study of Land Use Conflicts in Urban Areas. BA Thesis. University of Nairobi, 1987:

A Criteria for Urban Boundary Extension for Kenya Towns: A Case of Nyeri Municipality. MA Thesis, 1982: and,

Evaluation of Infrastructural Development in Nyeri Town with Emphasis To Enhance Environmental Quality. University of Nairobi, 1994.

They were useful in terms of sensitising the consultant to some problems but not in providing useful hard data.

Details on other sources are found in the bibliography in Appendix 2.

3. POPULATION GROWTH

3.1. Introduction

The following is a summary of key national demographic indicators based on the most recent census. They are offered here as the backdrop to the subsequent discussion of Nyeri town data.

TABLE 2: KEY DEMOGRAPHIC INDICATORS

LAND AREA		582,646 Sq Km		
POPULATION				
1989 (1989 Census)		21,397,000		
Growth Rate (1979-1989)		3.34% pa		
Distribution:				
	Population		Proportion (%)	
	1979	1989	1979	1989
Urban	2,312,576	3,735,900	14.34	17.46
Rural	13,814,400	17,661,100	85.66	82.54
HEALTH				
Infant mortality (per 1,000 live births 1990)			68.7	
Life expectancy birth: years (1990)			59	
Access to safe water (1990) %:Urban			61.0	
Rural			21.0	
Daily calorie intake per person (1990)			1973.0	
Per capita protein intake (g/day)			55.0	
	1989	1990	1991	
Population per doctor	7,140	7,246	6,622	
Population per dentist	50,000	41,667	35,714	
Pop. per hospital bed and cots	724	735	676	
EDUCATION				
School enrolment ('000)		1989	1990	1991
Primary:	Male	2,766	2,766	2,797
	Female	2,623	2,626	2,659
Secondary:	Male	383	354	346
	Female	258	265	268
University:	Male	19.5	28.4	41,674
	Female	8.1	11.3	NA
Adult literacy (1990)				59.2%
Sources: 1. World Bank, World Development Report, 1991				
2. World Bank, World Bank Reporting System.				
3. Government of Kenya, Economic Survey, Central Bureau of Statistics (CBS), Office of the Vice- President and Ministry of Planning and National Development (OVPMPND). 1991, 1992.				
4. GOK Statistical Abstract CBS, OVPMPND. 1990, 1991.				

3.2. National Population Growth

Kenya's national population grew from 5,506,000 in 1948 to 8,636,000 in 1962. It jumped to 10,942,705 in 1969 and grew to 15,327,061 by 1979. The last census in 1989 showed that there were 21,443,636 people organised into 4,352,751 households. There are controversies about the last census. However Kenya's population growth rate has been above 3% for the past fifty or so years and is one of the highest in the world.

According to the National Council for Population and Development (NCPD), *Kenya Demographic and Health Survey 1989 and 1993*, the national fertility rates since 1948 were as follows:

TABLE 3: NATIONAL FERTILITY RATES SINCE 1948

1962	1969	1977	1978	1979	1984	1989	1993
5.3	6.6	8.0	7.9	7.9	7.7	6.9	5.4

Sources: *Kenya Demographic and Health Surveys 1989 and 1993.*

Within these national averages, rural women generally have more children than urban women. For the 1993 figure, it is important to note that the urban women fertility rate is 3.4 whilst the rural women fertility rate is 5.8. Discussions with NCPD and Pathfinder professionals, who have monitored family planning activities in Central Province for many years, lead one to conclude that the small towns like Nyeri do not show different fertility patterns to their rural hinterlands for they are still part of the rural environment as shown in G-C. M. Mutiso *Development of National Community Based Distribution Plan and Community Based Distribution Program Manual*.

According to the CBS *Kenya Contraceptive Prevalence Survey 1984*, and the CBS and UNICEF *Children and Women in Kenya: Situation Analysis 1992*, the mortality indicators from 1948 to 1989 census are as follows:

TABLE 4: MORTALITY INDICTORS FROM 1948 TO 1989

Year	Crude Death Rate	Infant Mortality Rate	Life Expectancy at Birth
1948	25	184	35
1962	20	NA	44
1969	17	119	49
1979	14	104	54
1989	12	74	59

Sources: *Kenya Contraceptive Prevalence Survey 1984*
Children and Women in Kenya: Situation Analysis 1992.

This data is provided to show that Nyeri has been doing better on most indicators of well-being than the national averages. Part of the explanation is the favourable climate, and a tradition of education and natural resource endowment which make the district not only highly productive but also extremely innovative.

3.3. Nyeri District Population Growth

At the outset, it should be noted that the problems outlined in the Gauff *Assessment of Situation* report are pertinent to this section.

In summary first is the problem of changes in the administrative division, location and sub-location levels areas. Sixty three divisions, 395 locations and 509 sub-locations were created nationally. Some of these were in Nyeri district. Maps for these are not available to the consultant. Second, the area of the district is given as 3,284 and 3,266 square kilometres in 1979 and 1989 respectively. Third, there seems to be a numerical error on the population of Magutu location, in Mathira Division in the 1979 census.

Fourth, the *Nyeri District Development Plan 1994-1996*, using provisional 1989 census figures of 613,000 for Nyeri District and assuming a growth rate of 2.32% calculated that there will be 718,440 people in Nyeri District by 1996. These figure are higher than the actual from the 1989 Census, as is shown in Table 5: 'Comparison between 1979 and 1989 Census for Nyeri District Down to Locational Level.'

In 1969, the Nyeri district population was 360,845 forming 3.3% of the then national population. By the 1979 census it was 486,477 and formed only 3.2% of the national population. In 1989, the district population was 607,292.

Nyeri population is highly homogeneous. In 1979, 96.76% of the District population was indigenous. In 1989, the district population was 607,292 of which Kikuyu people formed 96.57%, whilst Meru people, neighbours to the north, formed 0.71% of the district population. None of the other tribes formed more than 0.5% of the district population.

Between the 1979 and 1989 census, the growth rate of the district population was 2.24%. This is lower than the national growth rate which is higher than 3% and reflects the district's good environment, education and adoption of family planning.

**TABLE 5: COMPARISON BETWEEN 1979 & 1989 CENSUS FOR NYERI DISTRICT
DOWN TO LOCATION LEVEL**

ADMINISTRATIVE AREA	1979 CENSUS SITUATION				1989 CENSUS SITUATION				GROWTH RATES %
	TOTAL No. no.	H'OLDS no.	AREA km2	DENSITY p/km2	TOTAL No. no.	H'OLDS no.	AREA km2	DENSITY p/km2	
NYERI DISTRICT	488,477	98,222	*2,092	**233	607,292	130,541	3,265	186	2.24%
KIENI EAST	38,893	8,856	488	80	55,584	12,510	727	76	
NAROMORU	24,313	5,843	332	73	19,381	4,103	232	84	
KABARU	14,580	3,013	156	93	18,280	3,966	240	76	
GAKAWA					17,923	4,441	255	70	
KIENI WEST	41,411	8,091	548	78	57,636	11,844	1,051	55	3.36%
MWEIGA	26,731	5,347	282	95	22,666	5,095	625	36	
GATARAKWA	14,680	2,744	264	56	13,544	2,637	79	171	
ENDARASHA					21,426	4,112	347	62	
MUKURWEINI	72,288	14,590	180	402	88,838	18,370	180	494	2.08%
GKONDI	16,967	3,476	38	445	20,710	4,154	39	531	2.01%
GITHII	21,481	4,225	61	353	26,899	5,548	58	464	2.27%
MUHITO	27,651	5,625	49	562	17,380	3,725	28	621	
LOWER MUHITO	6,189	1,234	32	196					
RUTUNE					8,912	1,726	32	279	
GAKINDU					14,937	3,217	23	649	
MATHIRA	127,369	24,763	325	392	145,802	31,637	389	375	1.38%
IRIAINI	21,022	4,039	49	431	25,779	5,442	49	528	2.06%
KONYU	32,181	6,596	58	556	35,411	7,746	55	644	0.96%
KIRIMIKUYU	26,939	5,031	56	485	30,778	6,219	55	560	1.34%
RUGURU	26,408	4,969	90	295	11,590	2,455	65	178	
MAGUTU	20,809	4,118	73	285	24,216	5,237	131	185	
NGORANO					12,436	2,462	32	389	1.32%
KARATINA					5,582	1,976	2	2,796	
TETU (exc. Nyeri Town)	102,273	19,710	311	329	81,391	16,279	279	282	
AGUTHI	32,622	6,427	74	442	27,865	5,313	48	581	
TETU	21,049	3,949	64	328	11,659	2,231	29	402	
MUHOYA'S	13,679	2,642	73	187	10,686	2,252	93	115	
THEGENGE	34,923	6,692	100	349	31,181	6,483	109	286	
MUNICIPALITY	35,753	9,527	72	497	91,539	22,290	167	548	
NYERI TOWNSHIP	35,753	9,527	72	497					
MUKARO					78,880	19,366	135	584	
KIGANJO					12,659	2,924	32	396	
OTHAYA	68,500	12,726	171	402	86,141	17,398	171	499	2.20%
CHINGA	16,691	2,920	51	330	20,215	3,943	51	400	1.93%
MAHIGA	18,523	3,516	43	431	22,814	4,633	42	543	2.11%
OTHAYA	33,286	6,289	77	432					
IRIAINI					22,147	4,495	45	492	2.38%
KARIMA					19,965	4,327	33	605	
MT. KENYA F./N. P/K					1,109	249	111	10	
ABERDARE F./N. P/K					252	64	191	1	

Notes: * 3284 km2 in 1979 Census ** 148 p/km2 in 1979 Census
Sources: Assessment of Situation Report

3.4. Nyeri Municipal Population Nyeri Municipal Population

3.4.1. Growth

As Dutto points out and as shown in Table 6: 'Nyeri Town Population Growth by Ethnic Group up to 1969', the town has always had a majority African population although they were not the rulers or the controllers of the town.

TABLE 6: NYERI TOWN POPULATION GROWTH BY ETHNIC GROUP

	1921	1931	1948	1969
Africans	675	620	1,930	8,915
Asians	82	215	604	866
Europeans	24	68	220	191
Others	-	-	2	32
Total	781	903	2,777	10,004

Source: Dutto Table 6.

In 1948 the population of Nyeri town was 2,777. In 1962, it reached 7,857 and rose to 10,004 by 1969. By 1979, the population was 35,753 living in a municipal area of 72 square kilometres. The 1989 census indicates a jump to 91,258. This data suggests a 9.37% annual growth between 1979 and 1989.

3.4.2. Growth Rate

For purposes of planning this project, it is important that the growth rate be determined systematically. The annual growth rate for the years between 1979 and 1989 is estimated by the consultant to be about a third of this. The reason is simply that the populations of the rural areas involved in the expansion of the intercensal municipal boundary, which saw the inclusion of an extra 95 square kilometres, were not included in establishing the 1979 base population for the 1989 Municipal Boundaries.

Between 1979 and 1989, the municipal boundary expanded to the south-east and east primarily, and to the south-west, north-west and central northern secondarily. The sub-locations involved are shown in Tables 7: 'Results of 1979 Census for Nyeri Municipality' and Table 8: 'Results of 1989 Census for Nyeri Municipality'.

In the south and south-west, the sub-locations of Tetu Location involved were Muthuani, Kiritu and Unjiru. To the south, the sub-locations of Aguthi location involved were Gatitu, Githiri, Marua, Gaaki and Muruguru. In the south-east, the sub-locations of Ruguru location, in Mathira Division, involved were Gachika and Karuthi. In the north-east Muhoya location's Kihuyo sub-location was involved. Finally, in the northern central area, a small part of Kiganjo sub-location of Kaburu location was involved.

Thus by 1989 Census time, Nyeri Municipal area consisted of the newly named locations of Mukaro and Kiganjo. Mukaro consists of the former municipal area save former Kiganjo Ward and all areas acquired from Tetu location. Kiganjo, on its part, by 1989, was made up of the former Municipal Kiganjo Ward, the former sub-location of Kericho (renamed Kirichu in the 1989 Census), and Gachika transferred from Mathira Location.

TABLE 7: RESULTS OF 1979 CENSUS FOR NYERI MUNICIPALITY

ADMINISTRATIVE AREA	MALE	FEMALE	TOTAL	HOUSE- HOLDS	AREA in sq. kms.	DENSITY
NYERI TOWN	19,247	16,506	35,753	9,527	72	497
MAJENGO WARD	2,489	2,155	4,644	1,646	0.60	7,740
RURINGU WARD	2,214	2,138	4,352	1,161	4.36	998
NGANGARITHI WARD	1,350	1,409	2,759	649	4.16	663
MOUNT KENYA WARD	870	827	1,697	442	2.72	623
CHANIA WARD	2,148	1,071	3,219	928	3.44	935
BLUE VALLEY WARD	1,535	1,645	3,180	775	1.92	1,656
CENTRAL WARD	300	171	471	201	0.96	490
NYARIBO WARD	2,702	1,822	4,524	939	26.15	173
KERICHO WARD	191	202	393	77	1.08	363
KIMATHI WARD	772	708	1,480	458	-	-
KAMAKWA WARD	1,435	1,384	2,819	804	2.72	1,036
MATHARI WARD	1,851	2,130	3,981	740	18.35	217
KIGANJO WARD	1,390	844	2,234	707	5.45	410

Source: Table 6.3 Assessment of Situation Report

TABLE 8: RESULTS OF 1989 CENSUS FOR NYERI MUNICIPALITY

ADMINISTRATIVE AREA	MALE	FEMALE	TOTAL	HOUSE- HOLDS	AREA in sq. kms.	DENSITY
NYERI MUNICIPALITY	46,405	45,134	91,539	22,290	167	548
MUKARO	39,632	39,248	78,880	19,366	135	584
MAJENGO	10,194	8,284	18,478	5,575	7	2,640
RURINGU/THUNGUMA	5,373	5,236	10,609	3,206	20	530
KIHUYO	1,063	1,198	2,261	444	5	452
GITHIRI	1,084	1,289	2,373	473	5	475
MURUGURU	1,154	1,434	2,588	548	6	431
KIHATHA	866	944	1,810	355	4	453
MUNUNGA-INI	1,227	1,302	2,529	530	5	506
GATITU	882	885	1,767	419	5	353
KARIA	1,094	1,158	2,252	459	4	563
RIAMUKURWE	1,339	1,434	2,773	530	6	462
MARUA	1,071	1,050	2,121	461	5	424
KAMAKWA	4,594	4,536	9,130	2,432	7	1,304
MUTHUA-INI	1,727	1,925	3,652	711	6	609
MATHARI	3,847	3,964	7,811	1,480	37	211
GATATHINI	1,196	1,250	2,446	496	3	815
KINUNGA	606	681	1,287	302	2	644
CHORONGI	2,315	2,678	4,993	945	8	624
KIGANJO	6,773	5,886	12,659	2,924	32	396
KIRICHU	1,978	2,154	4,132	868	10	413
KIGANJO	2,284	1,093	3,377	969	5	675
NYARIBO	1,245	1,220	2,465	581	10	247
GACHIKA	1,266	1,419	2,685	506	7	384

Source: Table 6.4 Assessment of Situation Report

TABLE 9: SUB-DIVISIONS & WARDS INVOLVED IN MUNICIPAL BOUNDARY CHANGES BETWEEN 1979 & 1989

ADMINISTRATIVE AREA	1979 CENSUS SITUATION				1989 CENSUS SITUATION				GROWTH RATES %
	TOTAL No. no.	HHOLDS no.	AREA km ²	DENSITY p/km ²	TOTAL No. no.	HHOLDS no.	AREA km ²	DENSITY p/km ²	
KIEN EAST	38,868	8,866	488.6	80	55,584	12,510	727	76	
NAROMORU	24,313	5,843	332	73	19,381	4,103	232	84	
KABARU	14,580	3,013	157	93	18,280	3,988	240	76	
WARAZO	3,310	665	45	74	4,083	865	61	67	
WARAZO JET	2,583	440	9	298	3,538	673	19	185	
ISLAND FARMS	2,846	469	13	217					
KABARU NDATH	2,543	669	55	46	2,232	578	99	23	
KIMAHURI					3,925	802	13	302	
KIGANJO	3,288	707	35	94					
NGONDE					4,524	1,048	48	94	
GAKAWA					17,923	4,441	255	70	
MATHIRA	153,767	28,722	414.3	371	157,392	33,982	464	347	
IRAIWI	21,022	4,039	49	431	25,779	5,442	49	528	
KONYU	32,181	6,586	58	558	35,411	7,746	55	644	
KIRIMIKUYU	28,939	5,031	58	485	30,778	6,219	55	560	
RUGURU	28,408	4,989	90	265	11,580	2,455	65	178	
KARUTH	3,200	691	10	307					
GACHIKA	2,167	402	8	265					
RUTURU	3,474	610	8	414					
KIAMARIGA	3,669	703	8	437	4,003	868	8	500	
IRURI	2,385	401	7	328	3,242	649	7	463	
HOMBE	2,403	463	7	332	2,158	520	42	51	
SAGANA	1,943	333	9	221	2,189	418	8	274	
CHEN	1,805	267	7	245					
GATUNGANGA	2,286	432	7	340					
KERICHO	3,275	627	18	185					
MAGUTU	20,809	4,118	73	285	24,218	5,237	131	185	
NGORANO					12,438	2,462	32	389	
KARATINA					5,582	1,978	2	2,758	
TETU (exc. Nyeri Town)	169,623	32,728	521.3	325	131,601	26,075	449	288	
AGUTHI	32,622	6,427	74	442	27,865	5,313	48	581	
GATITITU A	1,822	307	5	304					
GATITITU B	2,416	475	5	460					
GITHRI	1,940	377	6	338					
MURUGURU	2,638	462	5	470					
MAPUA	1,550	313	4	417					
GAKA A	3,024	550	6	504					
GAKA B	4,903	830	13	384	5,775	1,084	10	578	
MUNGARIA	1,851	360	3	580	2,258	462	4	594	
GICHRA	2,507	507	5	489	3,089	582	6	515	
GITITU	2,904	581	5	558	3,658	715	7	523	
GATHITHI	3,363	678	6	523	4,121	831	6	687	
ITHEKALINDO	4,114	829	9	457	5,029	964	9	559	
MUTATHINI					3,837	665	6	688	
TETU	21,049	3,949	65	325	11,859	2,231	29	402	
KARAIHUA	1,381	284	4	368					
KARAIHUB	1,865	325	5	328	1,865	380	5	379	
MUTHUANI A	2,685	540	4	688					
MUTHUANI B	2,322	424	6	415					
UNURU A	2,682	481	6	468					
UNURU B	2,514	488	5	462					
ICHAGACHRU A	1,582	283	5	335	1,864	377	5	367	
ICHAGACHRU B	2,317	391	6	384					
KIRITI A	1,762	362	3	568					
KIRITI B	1,661	314	4	469					
GAKANGA	518	97	18	29					
KIRURUMI					2,857	553	10	287	
KIGOGGIN					3,367	633	6	553	
GATUMBEIRO					1,518	288	3	505	
MUHOYAS	13,679	2,942	72	180	10,688	2,252	93	115	0.23%
KIHUJO	2,222	407	5	463					
THATHA A	1,581	280	3	459	1,534	311	4	384	
THATHA B	1,876	362	3	575					
KABAGE A	1,282	209	3	365					
KABAGE B	1,587	318	5	340	787	177	34	23	
KABAGE FOREST	1,407	238	34	41					
ZAINA (FOREST)	1,075	208	13	81	1,118	228	40	28	
NGOORU					1,544	304	4	388	
IKURURU	2,849	562	5	530	2,563	577	5	511	
KANUCRA					1,807	376	3	602	
KARUNAIN					1,345	281	3	448	
THEGENGE	34,923	6,862	100	349	31,181	6,483	109	285	2.08%

Notes: In 1979 census, all decimal places in measured areas were rounded down.

Source: Table 6.2 Assessment of Situation Report

TABLE 10: SUB-LOCATIONS INVOLVED IN MUNICIPAL BOUNDARY CHANGES BETWEEN 1979 & 1989

DIVISION	ADMINISTRATIVE AREAS		1979 CENSUS SITUATION		MUNICIPAL WARDS IN 1989		APPROX. AREA IN MUNICIPALITY IN 1989				
	LOCATION	SUB-LOCATION	TOTAL No. no.	H'OLDS no.	AREA km ²	DENSITY p/km ²	TOTAL No. no.	H'OLDS no.	AREA km ²	DENSITY p/km ²	
KIENI EAST	KABARU	KIGANJO	3,286	707	34.9	94	394	99	4.19	94	
MATHIRA	RUGURU	GACHIKA KERICHO	2,167 3,275	402 627	8.2 17.6	265 186	2,167 3,275	402 627	8.17 17.60	265 186	
											sub-total
TETU	AGUTHI	GATITITU A GATITITU B GITHIRI MURUGURU MARUA GAAKI A GAAKI B	1,522 2,416 1,940 2,538 1,550 3,024 4,903	307 475 377 492 313 550 930	5.0 5.4 5.7 5.4 3.7 6.0 13.5	304 450 339 470 417 504 364	1,522 2,416 1,940 2,538 1,550 2,208 2,844	307 475 377 492 313 550 930	5.00 5.37 5.72 5.40 3.72 4.38 7.81	304 450 339 470 417 504 364	
											sub-total
MUHOYA'S	TETU	MUTHUANI A MUTHUANI B UNJIRU A UNJIRU B	2,685 2,322 2,682 2,514	540 424 481 488	3.9 5.6 5.9 5.4	688 415 456 462	2,067 2,322 2,172 2,514	540 424 481 488	3.00 5.59 4.76 5.44	688 415 456 462	
											sub-total
TOTAL NYERI TOWN (1979) GRAND TOTAL	KIHUYO		2,222	407	4.9	453	2,222	407	4.90	453	
		TOTAL		94.3		32,151		5,040		353	
		NYERI TOWN (1979)		72.0		35,735		9,527		497	
		GRAND TOTAL		165.3		67,886		14,567		416	

Source: Table 6.5 Assessment of Situation Report

Table 9, shows the Divisions, Locations, Sub-locations and Wards involved in the Municipal boundary changes between 1979 and 1989.

The populations of the involved areas are also detailed in Table 10: 'Sub-locations Involved in Municipal Boundary Changes Between 1979 and 1989'.

Table 10 is an attempt to marry the 1979 sub-location names and areas of the 1989 ward names and areas. From these approximations it is estimated that 32,000 people living in an area of approximately 91-94 square kilometres were counted in the rural areas surrounding the municipality in 1979 but were living in the area designated as part of Nyeri Municipality by the time of the 1989 census. The growth rate applicable to them is the district average of 2.24%.

It is therefore possible to then estimate that the 1989 Nyeri Municipal area had in 1979 a total population of 67,900. Thus a feasible annual increase between 1979 and 1989 is 3.0% and not the 9.37% suggested in the *1989 Census Report Vol. 2*. This is not just in line with the district growth rate of 2.24% but is realistic given that Nyeri town is primarily administrative and commercial and not industrial. The derived and projected population is shown in Table 11. 'Derivation of Municipality Population Projections'.

TABLE 11: DERIVATION OF MUNICIPALITY POPULATION PROJECTIONS

GROWTH RATE		POPULATIONS	
		1979 CENSUS	1989 CENSUS
3.70%	Urban	35,753	51,415
2.24%	Rural	32,151	40,124
3.03%	Total	67,886	91,539
Source: Table 6.6. Inception Report.			

Taking the 3% growth rate, Table 12 shows population projections up to the ultimate horizon for the whole Municipal area based on the derived 1989 population.

In 1992, some 3.4 square kilometres were removed from the municipality and another 32 square kilometres added. Thus at the end of 1995 the municipality constitutes of 195.6 square kilometres. Lack of census enumeration maps makes impossible the projecting of this data to the current and future horizons in terms of specific neighbourhoods in the Municipality.

TABLE 12: DERIVED 1989 POPULATION AND PROJECTIONS TO 2020

YEAR	POPULATION	YEAR	POPULATION
1989	91,539	2005	146,892
1990	94,285	2006	151,299
1991	97,113	2007	155,838
1992	100,027	2008	160,513
1993	103,027	2009	165,329
1994	106,118	2010	170,288
1995	109,302	2011	175,397
1996	112,281	2012	180,659
1997	115,958	2013	186,079
1998	119,437	2014	191,661
1999	123,020	2015	197,411
2000	126,710	2016	203,333
2001	130,512	2017	209,432
2002	134,427	2018	215,715
2003	138,460	2019	222,187
2004	142,614	2020	228,853

Source: Inception Report and Fieldwork.

3.4.3. Structure of the Municipal Population in 1989

The structure of a population has implications for infrastructure planning. The 1989 census showed a total population of 91,258, of whom 46,211 were male and 45,047 were female organised in 22,290 households. The sex ratio was 1.026 to 1

Table 13 shows the structure of the 1989 municipality population. Several conclusions, which have implications for planning the demand for water and sewerage, stem from the data in this table.

First, it can be noted that the population in 1989 showed a significant dependent ratio, for those in the dependent ages (Groups A and D) form 53.99% of the population. It is not anticipated that within the project's future horizon, year 2010 and ultimate horizon, year 2020 this dependency ratio will exist for Nyeri District and, by implication, Nyeri Town for a variety of reasons.

It is expected that a detailed analysis of the 1989 Census would show that fertility rates have dropped drastically from 7.0010 in 1979. The Contraceptive Prevalence Rate for the district has increased from 41% in 1989 to 64.2% in 1993 according to the Demographic and Health Survey 1993. A non-dependent population will be a producing population and thus putting demands on services.

TABLE 13: STRUCTURE OF 1989 MUNICIPAL POPULATION

Age	Population	Percentage
All Ages	91,258	100
Group A	51.10	
1-4	12,440	13.63
5-9	12,585	13.76
10-14	11,363	12.45
15-19	10,284	11.26
Group B	37.62	
20-24	11,422	12.51
25-29	9,477	10.38
30-34	5,638	6.17
35-39	4,359	4.77
40-44	3,466	3.79
Group C	7.80	
45-49	2,688	2.94
50-54	1,986	2.17
55-59	1,328	1.45
60-64	1,132	1.24
Group D	2.89	
65-69	883	0.96
70-74	637	0.69
75-79	597	0.65
80+	542	0.59

Source: Census 1989

Second, the majority of the 1989 population, who will stay in town, (for Kenyans do not out-migrate from towns in significant numbers), will demand better services and also consume more of such services. In the two horizons, practically all of Nyeri's population will be second generation urban dwellers since most of the population will have arrived in the town in the 1969 and 1979 intercensal period. Dutto (p. 63) points out that there was a major male in-migration between 1967 and 1969 as a result of the Trade Licensing Act. These were followed by women as soon as the men had established their economic bases.

Third, the population is likely to be well educated compared to the rest of the country. The 1979 census showed Nyeri District as the most educated district. Significantly, only 2% of both sexes, in the 10-14 age group were without schooling. Nationally the figures are 12% of males and 15% of females. By 1989, this figure had dropped to 0.35% for Nyeri District. These district literacy figures can stand as proxy for the town which logically should have higher educational levels. Such a literate population is more likely to be in a position to demand more and better water and sewerage services.

It is clear then that provision of more water will be not only have positive impacts on this educated population but also be in keeping with their expected standards of living.

4. RATE OF URBANISATION

4.1. Urbanisation in the National Context

In 1948, the population of Nyeri town was 2,705 and ranked ninth nationally. In 1962, the population was 7,857 and ranked eighth nationally. In 1969, the population was 10,004 and ranked tenth nationally. In 1979, the population was 35,753 and ranked ninth nationally. By the 1989 census, the population had jumped to 91,258, mainly because of boundary changes and the town was ranked ninth nationally. Of the total population, 46,211 were male and 45,047 were female organised in 22,290 households. It can then be seen that the sex ratio was almost 1.0 unlike the national urban sex ratio of 1.18 for all towns with more than 2,000 people.

4.2. Urbanisation in the District Context

In the town classification system introduced in the 1989 Census, only Nyeri town is classified in the towns above 10,000 in the district. Towns of between 5,000 and 10,000 in the district are Enderasha and Othaya. The towns below 2,000 are Naro Moru and Mweiga. It is clear then that Nyeri town plays a primary or city role in the district. This is of crucial importance for investors, employment, generation of urban commerce and housing and thus the demand for infrastructural services, water and sewerage included.

In *Characteristics of Urban Housing in Nyeri as Compared to Other Towns in Kenya*, Rafael Tuts, (HRDU 1991), using 1983 data points other salient features of Nyeri urbanisation. Among these are:

- That the national average for owner occupier is 22% whilst Nyeri's is 25%.
- That the low and middle income groups spend about 15% of their expenses on housing.
- That the higher income groups spend more than 25% of their income on housing.
- That Nyeri has a median construction cost of ksh. 60,000 which is low compared to other towns.
- That housing related services of water, bath, toilet, and electricity are well above national urban averages
- That Nyeri dwellings have a disproportionate number of timber walls compared to national averages.

Extrapolating from this study, it can be anticipated that the owner occupier rate will increase in the future for many more people are retiring to the areas recently incorporated into the town. At the same time those who work and trade in the town are generating their own owner occupier housing. As the dependent population decreases in the district and by extension the town, it is anticipated that there will be many more people constructing own houses.

5. ECONOMIC GROWTH AND AVAILABILITY OF EMPLOYMENT

5.1. Employment in Business

No systematic economic study of Nyeri town exists for the period before 1971. In 1971, Dutto studied the town and established that there were 397 businesses as shown in Table 14: 'Registered Business 1971, 1993 and 1994'. The current District Development Plan was prepared in 1993 and during its preparation, data on businesses in the Municipality was collected. It showed that there were a total of 1,257 businesses registered in the town as extracted from Table 2:10 to 2:16 of the current District Development Plan. Data on registrations was also collected during field work. These various sources of data are synthesised in Table 14.

On the face of it, it is clear that the number of businesses had expanded at least three fold over a period of twenty five years. This statistic is fairly reliable for the business registration regime was rigorous nationally during this period. The second major point is that the businesses in the municipality are a large portion of the businesses in the district. The last column shows the district percentage of the particular type of business in the town in 1993 when comparative data is available.

Overall, businesses registered in the town are 29% of all businesses registered in the district.

Of the total of licensed businesses in the district, some types are only found in the town. For example, computer training and optical sales businesses, which form 4% of the types of business registered in the district, all are in the town. For another 21% of the types of businesses in the district, 50 - 99% are found in the town. For another 41 % of the types of business in the district, 30-49% are found in the town. These figures show the primary nature of the town in district business.

It should also be noted that over the past 25 years or so, there has been an evolution in the type of businesses with services increasing more than industries. It is also worth noting that even between 1993 and 1994, there appears to be some change with the entry of specialised service businesses in the consumption sectors like chemists, music stores and electrical accessories and repairs. This may be an indicator of the general uplift in the standard of living across the population and availability of resources for leisure consumption.

If it is assumed that each of the licences granted was for a business employing 5 people on the average, an assumption derived out the district consultation process discussed in Chapter Six, it can then be argued that by 1993 about 6,285 persons were employed in commerce and industry. This employment figure rose marginally to 6,305 in 1994. This is of course, a conservative assumption about employment in the town for there are very many jua kali traders who are not licensed and who employ a significant number of people. Similarly most hawkers are not licensed.

TABLE 14: REGISTERED BUSINESSES 1971, 1993 and 1994

Type	No.1971	No.1993	No.1995	Dist.% 1993
1. Whole sellers	40	93	45	48%
2. Retail Shops	229	528	506	24%
3. Hotels	39	133	140	31%
4. Bars and Restaurants	26	51	54	18%
5. Boarding and Lodging	16	34	33	42%
6. Garages/Motor & Bike	13	12	14	32%
7. Small Industries	16			
8. Petrol Stations	8	12	12	15%
9. Butcheries	10	38	37	20%
10. Dry Cleaners	0	18	18	31%
11. Insurance/l. Brokers	0	10	10	63%
12. Security Guards	0	3	4	43%
13. Agency/Distributors	0	15	13	52%
14. Transporters	0	4	6	20%
15. Computer Training	0	1	2	100%
16. Optical Sales	0	1	1	100%
17. Photographic	0	10	8	37%
18. Auctioneers	0	4	4	45%
19. Produce Store	0	2	5	20%
20. Video/Cinematography	0	8	7	45%
21. Printing Press	0	4	4	67%
22. Import/Export	0	6	6	60%
23. Music Stores	0	2	6	50%
24. Hire Purchase	0	5	6	50%
25. Carpentry/Timber Yard	0	32	35	36%
26. Hardware and Spares	0	48	43	50%
27. Shoe Making	0	16	13	25%
28. Knit./Tailor./Drapers	0	49	68	33%
29. Electrical Acc&Repair	0	8	13	38%
30. Metal Workshop	0	11	11	33%
31. Hairdressing /Barbers	0	33	34	40%
32. Hides and Skins	0	2	2	13%
33. Slaughter Houses	0	1	1	25%
34. Posho Mills	0	7	12	10%
35. Manufacturers	0	10	11	38%
36. Saw mills	0	6	6	35%
37. Bakeries	0	2	2	50%
38. Block making	0	2	2	67%
39. Building Contractors	0	3	3	75%
40. Green Grocers	0	8	9	36%
41. Animal Feed & Drugs	0	6	7	43%
42. Shoe Shops	0	10	12	32%
43. Curio Shops	0	1	1	20%
44. Bookshops	0	6	12	21%
45. Tyre Shops	0	2	3	33%
46. Chemists	0	0	10	?
TOTAL	397	1,257	1,261	29%
5 EMPLOYEES AVERAGE	1,985	6,285	6,305	

Source: Dutto 1975 and DDP 1974.

5.2. Other Employment

The current District Development Plan (Table 2.19), shows the Employment Profile of the District.

This data is not dis-aggregated for the Municipality. Second, the categories are lumped implying double counting. Third, the 1994 data column is strictly for data collected in 1993. The consultant discussed aspects of the data with officials at the Municipal, District and Provincial levels to get background data to make informed estimates.

TABLE 15: EMPLOYMENT PROFILE OF THE DISTRICT

SECTOR	1989	1994	1996
LABOUR FORCE (15-59)	286,148	299,579	
1. AGRICULTURAL LABOUR			
Small Farms	28,233	59,294	97,518
Large Farms	5,000	11,270	20,160
Pastoral	1,680	2,800	3,388
2. RURAL SELF-EMPLOYED			
Fishing	280	397	562
Mining	1,600	2,268	3,216
(Stone Quarry) Sand Harvesting	1,900	32,144	4,895
3. WAGE EMPLOYMENT			
Public Sector	20,115	32,636	52,950
Private Sector	11,243	13,940	16,558
4. URBAN SELF-EMPLOYMENT			14,295
Commercial/Business	10,570	12,660	
Informal Sector	14,333	24,257	36,955
5. SERVICE			
Hotels	4,230	5,998	8,505
Transport	7,890	10,860	13,893
Co-operatives	2,377	3,370	4,778
Security Services	2,650	3,265	5,391
TOTAL	112,101	215,159	283,064

Source: District Development Plan Table 2.19.

One way of treating this district wide data is to impute that the Municipality given its primary town role in the district employs about 30% of all district employees. This will imply that out of the estimated 215,159 people employed in 1993, about 64,547 were employed in the municipality. This is probably an over estimate given the structure of the population in 1989 which showed only about 45.% of the population in the labour force ages.

Another way of estimating the possible employment in the municipality is to take the percentage of employees by category who are posted in Nyeri town out of the district total. This was done with locally based officials who know each sector.

It was estimated that 50% of all District informal sector employees are in the municipality. So are 50% of all civil service employees and parastatal and national private sector employees.

For the category of services, including tourist hotel employees, matatatu employees and co-operatives employees, it was estimated 70% are employed within the municipality.

The results of these estimations, plus the derived employment in commerce and industry, are shown in Table 16: 'Derived Municipality Employment 1993'.

The total figure of 56,390 is considered realistic for it approximates the figure of 51,500 which is approximately fifty percent of the derived population as shown in Table 10: 'Derived 1989 Population and Projections to 2020'.

The higher figure is however realistic as a basis for calculating future employment for as the impacts of family planning, improvements in mortality rates and thus reduced population growth rates are felt, the dependency rate will drop, thereby allowing about 55% of the total population to be in the labour force ages.

TABLE 16: DERIVED MUNICIPAL EMPLOYMENT 1993

Category	Number
Commerce and Industry	6,285
Informal Sector 50% District Total	12,129
Civil Service 50% District Total	16,846
Parastatals/Nat. Private Sect. 50% Dist.Tot.	6,970
Services 70% of Distr. Total	<u>14,160</u>
Total	56,390

Source: Dutto 1975, DDP 1994 and Fieldwork

5.3. Prospects for Municipal Economic Growth

As discussed in Section 1.3.5., the national economy has not been performing well in the nineties especially with regard to growth and inflation. Current wariness on the part of donors, expected elections in 1997 and the marginalisation of Nyeri district elite from the bureaucratic and political roles which earlier enabled them to commandeer national resources for the district, leads one to expect little new major investment in the Municipality in the immediate future.

The municipality's economic performance is therefore very much tied to the performance of Dairy, Coffee and Tea primarily and tourism, horticulture and more recently floriculture.

Table 17: 'Key Commodities by Gross Sale Value', shows the range of the cash crop economy in the District.

Without going into details, the current situation is poor.

The dairy industry has been bedevilled by the management problems of the Kenya Co-operative Creameries and return to producers has dropped.

Although tea has performed well in the eighties lately there appears to be a world glut.

Coffee prices were dismal in the eighties and nobody expects a boom soon. Tourism is stagnating.

Horticulture and floriculture has become important for the district in the dry divisions of Kieni East and Kieni West but currently there is a limitation on irrigation and on marketing infrastructure for these are former ranch areas. Although the immediate outlook is poor, in the next five years there could be dramatic changes.

TABLE 17: KEY COMMODITIES BY GROSS VALUE

Commodity	Value Ksh.m.	Year
Milk	113	1989
	147	1990
	135	1991
	122	1992
	217	1993
Coffee	?	1989
	419	1990
	314	1991
	321	1992
	743	1993
	912	1994
Tea	212	1990
	?	1991
	437	1992

Source: Ministry of Co-operative Development

Key national macro-economic activities towards privatisation and the general global economic recovery ought to make the cash crops profitable in the long term. There are projects investing in irrigation infrastructure. There is private sector investment in the horticulture and floriculture sector, especially with coolers being built. Consequently, an improvement in the economy of the Municipal catchment area is foreseen by the time of the future and ultimate planning horizons of this project. Such stable hinterland ought to support the economy of the town.

Banking infrastructure is an important contributor to economic activities. The following Banks operate in the municipality:

Kenya Commercial Bank, Standard Chartered Bank, Barclays Bank, National Bank, Consolidated Bank, Co-operative Bank, Nyeri District Co-operative Bank and Agricultural Finance Corporation. It was not possible to obtain estimates of amounts lent in the municipality, such data being treated as more confidential than state secrets in Kenya banking. However all the banks argued that there was adequate business in the municipality.

Therefore, a very conservative 3% annual growth in employment is used in Table 18: 'Future and Ultimate Horizons Urban Employment Estimates', which also gives the projected population estimates. Such employment growth will just keep pace with population growth. Its productivity will be greatly aided by an improved water provision system which should facilitate better health also.

TABLE 18: FUTURE AND ULTIMATE HORIZON URBAN EMPLOYMENT ESTIMATES

Year	Projected Pop.	No. Employed
1993	103,027	56,390
1994	106,118	58,081
1995	109,302	59,823
1996	112,281	61,618
1997	115,958	63,466
1998	119,437	65,369
1999	123,020	67,331
2000	126,710	69,351
2001	130,512	71,431
2002	134,427	73,574
2003	138,460	75,781
2004	142,614	78,055
2005	146,892	80,396
2006	151,299	82,808
2007	155,838	85,292
2008	160,513	87,851
2009	165,329	90,487
2010	170,288	93,201
2011	175,397	95,998
2012	180,659	98,877
2013	186,079	101,844
2014	191,661	104,899
2015	197,411	108,046
2016	203,333	111,287
2017	209,432	114,626
2018	215,715	118,065
2019	222,187	121,607
2020	228,853	125,255

6. LABOUR PRODUCTIVITY INCOMES AND INCOME DISPOSAL PATTERNS

6.1. Methodology for Deriving Labour Productivity and Incomes

In Kenya, even at the national level, labour productivity studies are rare. During field work in Nyeri, and after extensively interviewing officials deemed informed about this and failing to make headway, the problem of Nyeri municipality labour productivity was discussed with the District Development Officer. Since no district wide, leave alone municipal data existed, it was decided to call a two day meeting of key district officials to generate some estimates about levels of labour productivity.

The officers involved were the District Development Officer, Assistant District Programme Officer (IFAD), District Water Engineer, Assistant District Development Officer, District Labour Officer, Senior Labour Inspector, District Trade Development Officer, District Programme Officer (IFAD), District Agricultural Officer, District Employment Officer and District Jua Kali Officer. This list did not include senior staff of the Municipality for the methodology demands that another set of officials act as the check on the accuracy of the estimates developed by one group. The meetings were called and chaired by the District Development Officer in his office.

The first day was used to brief the individual officers and to ask them to refer to their official records and to work out estimates of levels of productivity in their sectors. To simplify the data collection and analysis, as well as to generate data for use in the next District Development Plan, data was to be prepared overnight by departments based on the administrative divisions. The data was to be reviewed during the second day on a divisional basis and then aggregated to the district and municipality averages by the whole panel. For example, the District Agricultural Officer was to prepare incomes data based on average farm sizes in the various divisions, cropping patterns, farmers in co-operatives and any other relevant variables. During the second day, each officer presented the departmental estimates for review by colleagues. There were very informative and blunt discussions of the departmental proposals and consensus reached on what were rational estimates by the panel.

The officers agreed to refine this data for their own use after this exercise. The key refinement will be to attribute number of persons in each category so as to derive a district average. This should be available for the next District Development Plan and it could be useful for the design stage of this project.

The results of this exercise were put to a meeting of e Municipal officials; Clerk, Engineer, Welfare Officer and Chief Accountant. On the whole there were no objections to the derived conclusions and figures.

Improvements in levels of productivity, was defined as improvements in per capita net monetised value of work done on land, business or employment on monthly basis. Thus it is contemporaneous with net incomes per month. Where employed people had incomes from non-employment sources these were considered. Average family size was taken as 6.

The broad conclusions were that improvements in water supply would have positive impacts for the following reasons:

1. Reduce the numbers using contaminated water and thus reducing the cost of disease. The Environmental Impact Assessment discusses this in some detail, it is however worth noting from Table 27 that about 30% of the population does not get piped water. One should also note that a significant number uses raw piped water.

2. Enable local hotel investors to expand their operations and thus employ more labour.

3. Enable businesses which have installed large plants, which are operating sub-optimally, to improve their throughput and thus increase direct labour productivity.

3. The third point was that some industries have stayed away from the town for lack of adequate supply. This was corroborated by records at the District Development Centre where six businesses had carried out feasibility studies for industries but they could not start them for lack of water. The industries were grain milling (3), chemicals (2) and fertilisers (1). It should also be noted that the largest national brewery decided not to locate a plant in Nyeri in the 1980s because of water problems.

4. Some fairly large existing businesses, some employing more than 100 people, currently do not get water and have to buy it from the municipality as discussed in Chapter Seven. This increases their cost of operations over and above reducing labour productivity.

5. Parts of the population are not using enough water for maintenance of cleanliness and this has a bearing on health. One officer put it this way: "You would not know these are urban people for they are as dirty as rural people who have to collect water".

6.2. Incomes

The main income categories in the district are shown in Table 19: 'Monthly Net Per Capita Incomes'. They are provisional estimates only and should be refined in later stages. They should be compared with the current (December 1995) Central Bank figure that the National Per Capita Income is Ksh. 14,850.

TABLE 19: MONTHLY NET PER CAPITA INCOMES IN KENYA SHILLINGS

Occupation	Monthly Net Income (K.shs)
Wholesaler	100,000
Large-scale Farmer	75,000
Retailer	10,000
Industry Non-Labour	6,600
Smallholder Farmer	5,700
Civil Servant	5,000
Jua Kali Artisan	4,500
Jua Kali Trader	4,000
Industrial Worker	2,000
Labourers	1,800
Domestic Workers	1,500

To firm up this data will require basic survey research throughout the whole district including questions on how the incomes are used to establish which portion comes to the municipality.

The bulk of the categories, which can be imputed as the significant population of the municipality, have incomes above Ksh. 4,000.

This data should be compared with the derived urban employment found in Table 16: 'Derived Urban Employment 1993'. It is clear then that the bulk of the employment categories earn incomes which allow them to pay for the water service, a point made by the District Team.

However, there are categories of employed whose water situation is unsatisfactory in the opinion of the district team. Industrial workers, labourers and domestic workers generally live in housing where individual connections are not available. Water is either provided and paid for by the landlords or the tenants are forced to either buy it from vendors or public standpipes, or collect it from contaminated sources. One should note that improved water supply would be significant for these groups for it would reduce price hikes driven by shortage or the use of contaminated water from other sources when prices escalate.

6.3. Income Disposal Patterns

Data on income disposal as determined by the District Team is shown in Table 20: 'Income Disposal Patterns Percentages'.

TABLE 20: INCOME DISPOSAL PATTERNS PERCENTAGES

CATEGORY	PERCENTAGE
Education	50
Housing	25
Food	20
General	3
Utilities	2

It should be noted that there are no savings. The argument was made forcefully by many participants that since 1991, when the national economy began to deteriorate, it has not been possible for Nyeri municipal dwellers to save. There is also the impact of cost sharing where individuals and families are spending large amounts of funds on education. Food is particularly expensive.

There is no national data to evaluate these derived income disposal patterns. However, it is probable, for anecdotal data shows that many Kenyans are selling assets to finance present costs. Land and animal sales are major sources of finance particularly for education. Ironically, the figure for education is close to government expenditure on education, which since independence, has been between 30 and 50 percent of central government expenditure.

7. PROPERTY VALUES

7.1. Valuation of Old Urban Area.

Table 21: 'Land Valuation 1971 and 1995', shows data from Dutto's 1971 study and the current valuation roll which was made in 1991 and subsequently amended by the relevant valuation courts according to the Municipal Clerk.

TABLE 21: LAND VALUATION 1971 AND 1995

Owner	Ksh. Value 1971	Ksh. Value 1995
1. Private Owners	4,580,608	115,995,000
2. GOK Ministries	3,214,930	91,204,000
3. Local Authorities	212,810	12,827,000
4. Parastatals	119,800	9,843,000
5. Co-operatives	-	3,026,000
Total	8,128,148	232,895,000

Sources: Dutto 1975 and Fieldwork

It should be noted that the valuation rolls used by Dutto for 1971 and in the 1991 valuation refer to the original 8,000 hectares of the original land grant and not the expanded municipal area. This is the land which is under Commissioner of Lands and for which rates are paid.

The land value is currently just under twenty nine times what it was in 1971. The value of land in the town doubles every year practically. This reflects partly the development of the town since then, the demand for land in the town and also the investments made in the town both in terms of infrastructure and other structures and services. Provision of water is probably the leading factor in improving the value of land.

From Table 21, it is clear that major land owner is the government. Forty eight percent of all land is owned by government related institutions. These are government ministries, with the largest share, followed by the local authorities and parastatals in descending order. Government frequently defaults on rates. As at June 30, 1995, of the Ksh. 34,818,858 rate payments owed, Government owed Ksh. 17,215,722 or 49.44%. The fact that government owns so much land in the town is a weakness in the financial base of the town for rates are a major source of revenue.

The Municipality's revenue vulnerability is made worse by the fact that the area of its service provision is close to 200 sq. kilometres whilst in law it can only raise land rates on the old eight square kilometres. This is a national problem. It may well be that the law will be changed to allow the enlarged municipalities and towns to levy land rates on land recently incorporated into them. These lands are freehold and it is expected that there will be a demand for services for their owners are politically powerful unlike the peasant farmers who are selling these lands to local elite.

7.2. Current Land Values

Other than land valuation for purposes of raising rates, land transaction values are important in indicating what the private sector thinks of investing in a town. They, also, are important indicators in terms of zoning of the demand for desired services.

Current average land values were obtained from the files of the two valuation companies operating in the municipality. The valuation is an average of all the valuations done in the particular area during 1995. Since some municipal areas did not have a valuation through these companies during 1995, there is no data for those areas. Data for rural areas was collected from field interviews of farmers and is offered for contrast. The figures were presented to a meeting of the senior managers of the municipality and no major objection on their range was indicated. These prices are shown in Table 22: 'Average Land Prices for 0.10 Ha. 1995'.

TABLE 22: AVERAGE LAND PRICE FOR 0.10 HA. 1995, KSH.

Area	Mureithi	Tyson's	Average
MUNICIPALITY			
Ring Road	300,000	350,000	325,000
Skuta	280,000	300,000	290,000
Ruringu	280,000	300,000	290,000
Thunguma	200,000	250,000	225,000
Ngangarithi	200,000	250,000	225,000
Kamakwa	180,000	180,000	180,000
K. Plantations	150,000	150,000	150,000
Kingongo	100,000	100,000	100,000
Gitathini	50,000	50,000	50,000
Kangemi	-	-	-
Kiawara	-	-	-
Majengo	-	-	-
Kiganjo	25,000	25,000	25,000
RURAL			
Tetu Tea Area	37,500		
Othaya	20,000		
Naro Moru	12,500		
Kieni with Water	12,500		
Kieni without Water	4,000		

Source: Fieldwork

Ngari et. al. had surveyed land prices in some selected areas of the municipality in 1991. The data is presented below as Table 23: 'Land Prices for 0.10 Ha. 1991'.

TABLE 23: LAND PRICES FOR 0.10 HA. 1991 IN KSH.

Area	Price
Kangemi	390,000
Ngangarithi	320,000
Ruringu	240,000
Thunguma	110,000
Kamakwa	100,000

Source: Ngari et. al. 1991.

Comparing both tables, it is noticeable that prices have gone up. More specifically land prices in Thunguma have more than doubled. Those in Kamakwa have just about doubled. All this in five years! Ruringu prices have stagnated.

Although current data on land prices in Kangemi, Majengo and Kiawara could not be obtained, it is assumed that they have gone up too, perhaps even faster than in Skuta.

Those working in the district and the municipality argue that there is limited selling of land in Kangemi for it is very close to the central business area and the returns on investing in low cost housing for rental is highest there. Since the first African investors in the town latched on the provision of housing for workers in Kangemi as a very lucrative business, it is not expected that plots in Kangemi will turn over in great numbers in the future. If anything, perhaps they will be upgraded for higher incomes and thereby push the lower paid workers away from the centre of town.

This has implications for the water supply project. It ought to increase water supply in Kangemi to cater for the high income consumption patterns expected there by the future and ultimate planning horizons.

In Majengo and Kiawara, plots are small. The two neighbourhoods are located even closer to the downtown area than Kangemi. They are within reach of the existing basic infrastructure of sewers and water distribution. Although they are slums, they are being encroached on by business, church and other structures who bid for the land near downtown as shown in *Picture 1: 'Encroachment on Kiawara'*. During field work, forty-one shops, constructed with durable materials and another eleven modern structures were counted in Majengo and Kiawara. There is even a multi-storey building going up! This is the pattern for the future. The real estate is too valuable to remain a slum. Secondly, the families who own these plots, as a result of the rationalisation of land ownership during the Urban Three World Bank programme, are now interested in either selling or investing in modern structures.

7.3. Implications of Land Values on the Provision of Water & Sewerage

The Municipality will need to find ways and means of raising significant revenue from the agricultural freehold land which has been included in its new area of jurisdiction. This is under discussion by municipal officers. However, there is a legal problem for the municipality cannot raise rates on freehold land. A partial solution, which has been considered, is to charge rates on those plots which go commercial. This is not likely to significantly raise more revenue.

The way out is for all municipalities in the same position to seek changes in law to enable them to charge rates on all freehold land within their boundaries.

The second point has to do with the evolving land values and the structural obliteration of slum areas close to the central business district. This is a hot political issue. However, it is clear that market forces are such that, initially Majengo and later, Kiawara will be upgraded by the private sector, topographic arguments to the contrary.

Since Urban III, which regularised the allocation of land in Majengo, all owners have only to pay Ksh. 65 per plot to get the formal leasehold papers from the Commissioner of Lands. This has generated a land market in Majengo which used to be insecure as it was held under temporary occupancy licenses. In the last four years, there have been five applications for transfer and four applications for change of user. Given that these applications probably reflect only about 10% of actual land transactions (national average), it is clear that there is a real land market now within Majengo.

Sewers are in place and under-utilised. Water reticulation is in place but not enough water is supplied for it never really gets to the Provincial Hospital, Kangemi or the lower business sections of the town.

It therefore seems important that any water reticulation proposals pay attention to supplying the central ridge, from the government offices, through the central business district and on down to the Provincial Hospital, Kangemi and environs for this will still remain the core of the municipality.

Third, the Ruringu and Kamakwa areas have not been brought into the valuation roll for purposes of rates now. The municipality is considering this. This should be a matter of urgency for purposes of increasing revenue for significant areas of the two satellites consist of land under the Commissioner of Lands and can be charged rates. Introduction of such rates should be accompanied by improvements in water and sewerage infrastructure. The project proposals should therefore include provision of the same in the two communities.

Fourth, in Skuta and in Thuguma, there is a peculiar development which will continue. Local elite look to these freehold agricultural lands as a place for executive retirement and construct houses and allied small scale farming. The original land owners, on their part, have become some of the major investors in the drier areas of the district. This argument is not just limited to Skuta and Thunguma but extends to Ruringu rural. The proximity to the Nairobi road is seen by the investing elite as an advantage.

It is expected that the investment in and transformation of agricultural land into residential land, with limited farming, the preferred model for the first generation African urban elite, will continue thereby giving a different urban landscape in the future and ultimate horizon years. It is driven not only by the desire for such elite to build owner occupier houses but by the original land owners option for more productive land in West and East Kieni where the returns from irrigated floriculture and horticulture are more attractive than the returns they can get from patches of

coffee and subsistence agriculture on their original land.. This is illustrated in the Kimani case discussed below. If 0.10 hectare in the peri-urban areas is sold, the money obtained can purchase anywhere from 2 to 29 Ha. in the Kieni depending on the quality of land.

There is therefore a need to increase water provision in Skuta, Thuguma and parts of Ruringu.

Since most of the plots converted to residential use are above 0.10 Ha., provision of sewerage at the future and ultimate horizons may be unnecessary.

The western side of town, with large estates, albeit cheaper than some other rural areas, will have limited development for the owners do not need to sell large portions of the coffee estates. Growth as a residential area will therefore be limited. This side of town will however need more water for the Kingongo area, with its mixed high density residential and industrial operations is underserved now.

The final point and possibly the most important impact is that provision of adequate water would accelerate the growth in value of all the urban land and thereby improve the revenue base of the municipality. The planning and management challenge then is to anticipate how to use such resources. This issue should be considered in the Feasibility stage.

HOW SKUTA FINANCES THE KIENIS: THE KIMANI CASE

Kimani Uhuru is a true child of independence for he was born on 12/12/1963. He was born to peasant farmers in the area of the municipality now called Skuta. His parents had five acres freehold land. At independence, his father, a Mau Mau fighter jailed up to 1958, had yet to get into cash crops. He was an itinerant labourer. His mother, a good twenty years younger than the father, cultivated subsistence crops; maize, beans, arrow root, sugarcane and traditional vegetables. Kimani had two siblings, a brother and a sister, born in 1959 and 1961 respectively.

The house they lived in, which is still standing today and which is occupied by the brother's family, was a mud and wattle affair with a beaten earth floor and thatched with grass until 1972. That year, through the participation in Nyakinyua Mabati Women Group, Kimani's mother, Nyokabi, was given her share of ten mabati (iron roofing sheets). These were only enough for roofing one side of the house. Mutahi, Kimani's brother, completed roofing it with iron sheets in 1977. Water was, and still is, drawn from the Chania River. The plot is about a kilometre downstream from the new Sewage Treatment works for Nyeri Town.

In 1964, the family planted coffee on two acres. In 1966, the family bought a grade cow and planted bana grass on about half an acre. Another half acre which was stony was left to grow natural grass.

From 1964, Kimani's parents essentially worked the land. His father was getting on in years and was sickly most of the time. By the late sixties, when the three children were in school, times were hard for not much surplus was generated on the steep and stony land. There was hardly enough money for spraying the coffee. Consequently, the diseased plants did not yield much. Food had to be bought for the rest of the land did not produce enough. Kimani and his brother and sister worked on Saturdays and Sundays for the neighbours to supplement the money for food, clothes and school fees.

Kimani's father bought a share in a land buying company in 1968 for a thousand shillings, generated out of selling a heifer. The company was buying a ranch just beyond Munyu, in Kieni East. This was the only investment he made before dying in 1972.

In 1980, and to keep the children in school, Nyokabi sold the best two acres of the land to a relative who was working in Nairobi. This was the land with coffee. Since she had heard that the former settler farm, where her late husband had bought a share, was being subdivided, she bought more shares in it. When it was subdivided in 1983, she got twenty acres of land and moved there with her daughter who had got pregnant in school and dropped out. Kimani was left with Mutahi who by then had five children. They could not grow the crops they were used to other than maize and beans. They kept about twenty sheep and goats and two scrawny grade cows. Their major source of income was from charcoal burning from the trees they were cutting to open up the land.

In 1990, Kimani was employed as a waiter in one of the major Nyeri Town hotels, owned by a local politician, as a result of presentations made by the mother to the politician. His pay was Ksh. 1,500. For two years he worked in the hotel, walking from and to Skuta. It however became clear to him that he would never be able to live comfortably. He decided to sell his half an acre share on the land and to acquire land in Kieni which had water for irrigation.

In 1993, he sold the half acre, due to him from the Skuta land, for Ksh. 570,000 and was able to buy ten acres in Kabiruini as well as to finance building a shack, the opening of the land and laying of the irrigation pipes. He opened up an acre on which he irrigated tomatoes and cabbage. In 1993 he made Ksh. 50,000 profit. By opening more irrigated land and growing maize, which had a good price in 1994, he was able to make a profit of Ksh. 200,000. He is currently building a stone house in stages.

He has invited his mother and sister to move to his land to increase the family labour. He has found a buyer for the Munyu land bought by his father and mother. When the buyer completes payment for this land, Kimani intends to buy adjoining land to his own with the share due to him, his mother and the sister. The mother has sold off all the goats and sheep and bought two more grade animals. She tells Kimani that for her the four animals are more important than the vegetables for they produce milk and butter. After all one cannot just eat cabbages and tomatoes! Besides one always can sell the progeny.

Kimani married, late in life, in 1994 and has one girl child. He plans to have two children only even if they are girls! Mutahi on his part, already has five children. He is looking for a buyer for the remaining two and a half acres in Skuta. He has already located a good piece of land near Gatarakwa. He intends to move there and to farm as soon as the land is paid for.

8. LIVING STANDARDS

In the *Social Dimension of Development in Kenya: An Approach to Human Centred Development and Alleviation of Poverty: Conceptual Framework and Project Profiles*, published by the Office of the President, Nyeri District is not enumerated as one of the districts with extensive poor people. Conclusions of *The Welfare Monitoring Survey* by CBS in 1992, are summarised in this document on p.11 as follows:

- i) *About 30% of Kenya households are female headed of whom 53% were found to be poor.*
- ii) *The rural-poor are mainly subsistence farmers, landless and pastoralists whose incidence of poverty in 1992 was 52%, 50%, and 43% respectively.*
- iii) *Fiftyseven % of household heads who had no education lived below the absolute poverty line.*
- iv) *The poor spent 61% of their total expenditure on food as compared to 46% by the non-poor.*

Besides the above characteristics of the poor, other recent studies have shown the poor as:

- i) *having difficulty in access to reasonably priced credit;*
- ii) *being slow in adopting new seed varieties;*
- iii) *having high fertility and low contraceptive prevalence rates;*
- iv) *having high incidence of child malnutrition;*
- v) *having high morbidity;*
- vi) *not having easy access to clean water and sanitation facilities; and,*
- vii) *having difficult access to markets because of geographic isolation, poor infrastructure and high cost of transportation." (p.11-12).*

Almost none of these conditions apply to Nyeri.

The 1979 census showed Nyeri District as the most educated district for only 2%, significantly of both sexes, of the 10-14 age group were without schooling. Nationally figures for the same age group without schooling were 12% males and 15% females.

By 1989, the figure for those without schooling in Nyeri had dropped to 0.35%.

Total population school attendance was not provided for on district basis in the 1979 census. However, in the 1989 census, nationally 24.15% of the population had never attended school. For Nyeri District only 12.07%, just half of the national figure, had never attended school.

In terms of literacy, ability to read and write, in the 1989 census nationally 27.20% could not while in Nyeri District, only 12.9% were illiterate.

Access to educational facilities is also a key indicator to welfare. In 1993, Nyeri District had a total of 423 pre-primary schools with a teacher/pupil ratio of 1/40, 362 primary schools with a teacher/pupil ratio of 1/30 and 12 secondary schools with a teacher/pupil ratio of 1/15.

Over and above the general literacy, the municipality enjoyed better educational coverage for there were more facilities for a lower population. The teacher/pupil ratio for pre-primary was 1/30. For primary education it was 1/26 and for high school it was 1/17. There has been improvement since 1993 as shown in the Table 24: 'Municipality Educational Institutions, Enrolment, and Student/Teacher Ratios 1995'. For nursery schools it is 1/25, primary 1/22 and secondary 1/14. These are spectacular improvements as well as outstanding figures in the national perspective.

In 1979, Nyeri District's child (1-5 years) mortality rate per thousand was 62. Nyeri district led the nation. In comparison, the rate for South Nyanza, the worst district, was 263. Nairobi Province was 98, and Central Province was 81. It should be noted that the national average was 100 having dropped from 156 in the 1960's as shown in the 1979 Census *Analytical Report* on page 103.

Access to health facilities is also an indicator of good living standards. The district had, in 1993, 71 health facilities with 1,627 beds as shown in the current District Development Plan. This translates to one bed for every 539 people during 1993. It was also estimated that the doctor/outpatient ratio was 1/40,000. The doctor/in-patient ratio was estimated at 1/950.

The data on infant mortality, presented above for Nyeri District can be assumed to hold for the municipality since the National Council for Population and Development (NCPD) argues that the patterns for small rural towns are similar to their rural hinterlands.

The Central Bureau of statistics has provided hitherto unpublished household data on Nyeri Municipality. This is presented in Tables 25 to 29. Although national data was not provided for comparison, it is believed that the national averages are considerably worse than the data provided for the municipality as the district in general and the town in particular is more developed than most other districts in the country.

Table 25 shows that the out of 22,245 households in the Municipality, two thirds are headed by people between the age of 20 and 44, the most active economic age.

Construction materials are a good indicator of the standard of living. As shown in Table 26, an incredible 96% of all roofs were made of durable materials including iron sheets, tiles, concrete and asbestos sheets. Iron sheets were the largest category since they covered 87% of all roofs. Non-durable materials, grass and makuti covered only 2.5% of the roofs. The remaining 1.5% represents other materials.

TABLE 24: MUNICIPAL EDUCATIONAL INSTITUTIONS, ENROLMENT AND STUDENT/TEACHER RATIOS 1995.

NURSERY SCHOOLS - NYERI MUNICIPALITY SOUTH - 1995

NAME OF SCHOOL	ENROLMENT	NO OF TEACHERS	STUDENT/TEACHER RATIO
1. MARUA	43	2	22:1
2. MURUGURU	84	3	28:1
3. KIAMUIRU	80	2	40:1
4. GITHIRU	75	2	38:1
5. THUNGUMA	107	3	36:1
6. GATITU	8	1	8:1
7. KAMBUIRI	65	3	22:1
8. KAMOGA	95	2	48:1
9. MT. KENYA	55	2	28:1
10. CATHEDRAL	151	10	15:1
11. KAMAKWA	83	3	28:1
12. GIAMAJA	123	3	41:1
13. MUTHUAINI	94	3	31:1
14. GREENGATE	105	7	15:1
15. TETU BOYS	106	2	53:1
16. CPK EMANUEL (K/G)	17	1	17:1
17. KAMUYU I	50	2	25:1
18. STADIUM	20	4	5:1
19. RIAMUKURWE	119	3	40:1
20. CHORONGI	46	2	23:1
21. KIANDERE	61	2	31:1
22. IHWA	28	1	28:1
23. KIHATHA	52	1	52:1
24. ST. CECILIA	49	3	16:1
25. VALLEY VIEW	250	13	19:1
26. MUGA	113	12	9:1
27. KAMUYU II	50	2	25:1
28. KWANDERI	92	2	46:1
29. IHIGAINI	35	2	18:1
30. NGANGARITHI	49	2	25:1
31. ITHENGURI	92	2	46:1
32. CENTRAL	135	8	17:1
33. SKUTA	30	2	15:1
34. GITERO	106	3	35:1
35. MODERN	71	2	36:1
36. YMCA	16	1	16:1
37. NEW KIAMUIRU	12	2	6:1
38. PEFFA	28	2	14:1
TOTAL	2,795	122	23:1

NURSERY SCHOOLS - NYERI MUNICIPALITY NORTH - 1995

NAME OF SCHOOL	ENROLMENT	NO OF TEACHER	STUDENT/TEACHER RATIO
1. POLICE LINE	42	1	42:1
2. TEMPLE ROAD	80	3	27:1
3. NYAKINYUA (MUN)	50	4	13:1
4. BAPTIST	78	2	39:1
5. KANGEMI	44	1	44:1
6. P.G.H	15	2	8:1
7. M.O.W.	35	2	18:1
8. KING'ONG'O (MUN)	69	5	14:1
9. KING'ONG'O PRISON	26	2	13:1
10. GOOD SHEPHERD	109	6	18:1
11. MOI COMPLEX	20	2	10:1
12. NYERI KINDERGARTEN	163	11	15:1
13. NDERUTU	27	1	27:1
14. HILL FARM	26	1	26:1
15. ST. PATRICK KIANYANGE	21	2	11:1
16. MURINGATO	26	1	26:1
17. KIHUYO	83	2	42:1
18. NYARUGUMU	42	2	21:1
19. MATHARI	127	2	64:1
20. KAMWENJA	32	1	32:1
21. MWENJI	73	2	37:1
22. POLICE KIGANJO	53	2	27:1
23. KIGANJO	33	1	33:1
24. ELIMU	28	2	14:1
25. ST. MICHAEL (KIGANJO)	50	2	25:1
26. CHAKA ST. JOSEPH	74	2	37:1
27. THAYU	38	1	38:1
28. KIRICHU (MUN)	33	2	17:1
29. KIRICHU (COUNTY)	60	2	30:1
30. ST. AGNES	118	3	39:1
31. NDURUTU	46	1	46:1
32. GACHIKA	63	1	63:1
33. KAHIGA	52	2	26:1
34. NYARIBO	95	2	48:1
TOTAL	1,931	78	25:1

PRIMARY SCHOOLS - NYERI MUNICIPALITY 1995

NAME OF SCHOOL	WARD	ENROLMENT	TEACHERS	STUDENT/ TEACHER RATIO
1. MT. KENYA AC	NYARIBO	-	17	-0
2. ST. TERESAS	MAHARI	337	19	18:1
3. MOI COMPLEX	CHANIA	1,472	46	32:1
4. TETU GIRLS	KAMAKWA	667	27	25:1
5. CONSOLATA	BLUE VALLEY	654	22	30:1
6. KIAMBIRI	GATITU SOUTH	737	28	26:1
7. THUNGUMA	GATITU NORTH	608	22	28:1
8. NDURUTU	KERICHU	351	14	25:1
9. KIRIMARA	NYARIBO	162	12	14:1
10. TETU BOYS	KAMAKWA	531	31	17:1
11. KIHUYO	MATHARI	485	17	29:1
12. MUTHUAINI	KAMAKWA	783	23	34:1
13. MURINGATO	MATHARI	149	12	12:1
14. CHANIA	CHANIA	134	13	10:1
15. RIAMUKURWE	GATITU NORTH	657	25	26:1
16. NYAMACHAKI	BLUE VALLEY	573	38	15:1
17. MWENJI	MATHARI	564	19	30:1
18. KINGONGO	CHANIA	471	21	22:1
19. TEMPLE ROAD	KIMATHI	633	26	24:1
20. MATHARI	MATHARI	342	14	24:1
21. KIGANJO	KIGANJO	590	23	26:1
22. DEB MUSLIM	KIMATHI	767	35	22:1
23. IHWA	KAMAKWA	321	21	15:1
24. KAMUYU	KAMAKWA	398	20	20:1
25. GITHINI	KARIA	405	17	24:1
26. GIAKANJA	KARIA	569	21	27:1
27. KANUGA	KARIA	532	19	28:1
28. KWANDERI	KARIA	564	25	23:1
29. GITHIRU	MURUGURU	185	43	4:1
30. IHIGAINI	MURUGURU	256	12	21:1
31. KAHIGA	KERICHU	539	18	30:1
32. HILL FARM	MATHARI	372	20	19:1
33. GITHWARIGA	BLUE VALLEY	727	35	21:1
34. MURUGURU	MURUGURU	638	22	29:1
35. KIAMUIRU	MURUGURU	521	25	21:1
36. CHORUNGI	KARIA	342	19	18:1
37. MARUA	MURUGURU	214	13	16:1
38. KERICHU	KERICHU	706	26	27:1
39. ITHENGURI	KARIA	683	18	38:1
40. NYARIBO	NYARIBO	675	16	42:1
41. NGANGARITHI	KARIA	517	30	17:1
42. KIHATHA	KAMAKWA	474	19	25:1
43. MT. KENYA	MT. KENYA	303	16	19:1
44. THUNGUMA ACADEMY	GATITU NORTH	606	24	25:1
45. MAIRWE	KARIA	22	2	11:1
46. GOOD SHEPHERD	CHANIA	95	6	16:1
47. STADIUM	KARIA	116	9	13:1
48. ST. BENEDICT	MATHARI	82	5	16:1
TOTAL	22,529	1,005	22:1	

SECONDARY SCHOOLS - NYERI MUNICIPALITY 1995

NAME OF SCHOOL	ENROLMENT RATIO	TEACHERS	STUDENT/TEACHER
1. ST. MARYS BOYS	400	16	25:1
2. TEMPLE ROAD	396	13	30:1
3. MOI NYERI COMPLEX	255	14	18:1
4. NYERI BAPTIST	352	14	25:1
5. NYERI HIGH	216	40	5:1
6. ST. PAUL SEMINARY	209	16	13:1
7. KIHUYO	73	8	9:1
8. KAGUMO HIGH	632	39	16:1
9. SACRED HEART	158	9	18:1
10. KAHIGA	190	14	14:1
11. GACHIKA	145	9	16:1
12. KIGANJO AMBONI	231	17	14:1
13. GAKANJA	386	38	10:1
14. MURUGURU	363	27	13:1
15. THUNGUMA ACADEMY	146	18	8:1
16. MUTHUAINI	191	18	11:1
17. RIAMUKURWE	144	11	13:1
18. RURUINGU	116	10	12:1
19. IHWA	126	9	14:1
TOTAL	4,729	340	14:1

TEACHER TRAINING COLLEGES

NAME OF COLLEGE
1. KAMWENJA
2. KAGUMO

COMMERCIAL COLLEGES WITHIN NYERI MUNICIPALITY

INSTITUTION
1. Aberdare Commercial College
2. Nyeri School of Accountancy
3. Sheilaliz School of Home Economics
4. Jellas Dressmaking College
5. Hillgate Secretarial
6. Lenana Commercial
7. Central Kenya Institute of Engineering
8. St. Theresas Secretarial College
9. Nyeri School of Tailoring Designing
10. Mt. Kenya Commercial College
11. Kiganjo Commercial College
12. Githeru Institute of Metal Works
13. Grachars & Joabil Dressmaking and General Tailoring College
14. Karia Technical Training Centre
15. Rose Dressmaking College
16. Mt. Kenya Commercial College
17. Nyeri Technical Institute
18. Kimathi Institute of Technology
19. Raphester Secretarial College
20. Cathedral Secretariat
21. Judes Commercial College
22. Kerichu Youth Polytechnic
23. Nyeri Computer Centre - Computer Training
24. Kahiga Youth Polytechnic
25. Spear Commercial College
26. Benbros Commercial College
27. Jetways Secretarial College
28. Szollo Academy

TABLE 25: HOUSEHOLDS BY AGE AND SEX OF HEAD OF HOUSEHOLD

Age	<15	15-19	20-24	25-29	30-34	35-39	40-44	45-49	50-54	55-59	60-64	65+	N.R.
Male	50	299	1,516	2,708	2,208	1,757	1,502	1,158	883	586	427	1,188	13
Female	65	152	1,026	1,426	926	854	718	595	459	345	353	1,030	11
Total	115	451	2,542	4,134	3,134	2,611	2,220	1,753	1,352	931	780	2,198	24

Source: Assessment of Situation Report Table 6.8

TABLE 26: HOUSEHOLDS AND POPULATION IN HOUSEHOLDS BY TYPE OF WALL & TYPE OF ROOF

Type of WALL	Iron Sheets	Tiles	Concrete	Type of ROOF	Asbestos Sheets	Grass/ Makuti	Other	Total
STONE HHOLDS POPULN	5,136 16,591	443 2,018		384 1,033	310 1,083	10 38	73 199	8,358 20,962
BRICK/BLOCK HHOLDS POPULN	458 1,718	59 234		34 152	351 943	5 15	2 6	909 3,066
MUDWOOD HHOLDS POPULN	3,217 14,692	39 201		13 28	10 43	479 1,904	138 375	3,896 17,443
MUD/CEMENT HHOLDS POPULN	128 543	2 7		2 12	14 43	24 83	5 14	175 702
WOOD ONLY HHOLDS POPULN	9,903 40,292	92 444		5 23	16 52	29 86	71 197	10,116 41,094
IRON SHEETS HHOLDS POPULN	289 787	5 20					5 15	289 822
GRASS/REEDS HHOLDS POPULN	5 19				5 13	8 20		18 52
OTHER HHOLDS POPULN	320 1,428	2 7		1 3	2 9	15 54	138 421	478 1,920
TOTALS HHOLDS POPULN	19,458 78,266	642 2,931		439 1,251	708 2,186	570 2,300	430 1,227	22,245 86,061

Source: Table 6.9 Assessment of Situation Report

TABLE 27: HOUSEHOLDS AND POPULATION IN HOUSEHOLDS BY TYPE OF FLOOR AND TENURE/STATUS OF RESIDENTS

Type of TENURE	Cement	Type of FLOOR Earth	Wood	Tiles	Other	Total
PURCHASED						
H'OLDS	354	382	18	30	3	787
POPUL'N	1,243	1,608	94	173	20	3,138
CONSTRUCTED						
H'OLDS	1,990	7,196	119	58	18	9,381
POPUL'N	11,186	36,049	551	386	97	48,269
INHERITED						
H'OLDS	138	467	9	3	1	618
POPUL'N	565	1,856	28	12	1	2,492
GOVERNMENT						
H'OLDS	1,494	60	78	45	3	1,680
POPUL'N	4,520	174	322	196	17	5,231
LOCAL AUTH:						
H'OLDS	277	12	5	5	2	301
POPUL'N	984	34	15	24	9	1,066
PARASTATAL						
H'OLDS	122	24	2	28		176
POPUL'N	398	56	18	106		578
PRIVATE CO:						
H'OLDS	629	181	51	27	10	898
POPUL'N	1,884	594	119	74	19	2,690
INDIVIDUAL						
H'OLDS	4,494	2,575	69	68	14	7,220
POPUL'N	11,948	6,565	236	273	45	19,067
OTHER, RENTED						
H'OLDS	418	578	23	44	121	1,184
POPUL'N	1,202	1,703	78	161	386	3,530
TOTALS						
H'OLDS	9,916	11,475	374	308	172	22,245
POPUL'N	33,960	48,639	1,461	1,407	594	86,061

Source: Table 6.10 Assessment of Situation Report.

TABLE 28: HOUSEHOLDS AND POPULATION IN HOUSEHOLDS BY MAIN COOKING FUEL AND TYPE OF LIGHTING

Type of LIGHTING	Elect-ricity	Paraffin	Main cooking FUEL Gas	Fire-wood	Charcoal	Other	Total
ELECTRICITY							
H'OLDS	690	3,324	1,044	343	475	84	5,960
POPUL'N	2,726	8,411	4,170	1,696	1,898	207	19,110
PARAFFIN LAMPS							
H'OLDS	33	3,606	97	10,746	1,299	127	15,908
POPUL'N	102	8,586	437	52,141	3,997	239	65,502
FUEL WOOD							
H'OLDS	4	20	6	33	3		66
POPUL'N	17	95	21	153	10		296
CANDLE							
H'OLDS	2	21	31	46	9	18	127
POPUL'N	4	83	161	212	25	52	537
SOLAR							
H'OLDS		2	6	20	4	1	33
POPUL'N		3	21	82	14	2	122
OTHER							
H'OLDS	2	4	3	5	3	4	21
POPUL'N	14	7	20	17	8	4	70
TOTALS							
H'OLDS	731	6,977	1,187	11,193	1,793	234	22,115
POPUL'N	2,865	17,185	4,830	54,301	5,952	504	85,637

Source: Table 6.11 assessment of situation Report

TABLE 29: HOUSEHOLDS AND POPULATION IN HOUSEHOLDS BY MAIN SOURCE OF WATER AND SEWAGE DISPOSAL

Type of SEWAGE DISPOSAL	Main source of WATER									Total
	Pond	Dam	Lake	Stream/ River	Well	Borehole	Piped	Jabias	Other	
MAIN SEWER										
H'HOLDS	101	7	3	16	1		3,212	3		3,343
POPUL'N	322	21	30	49	10		9,114	9		9,555
SEPTIC TANK										
H'HOLDS	48	7	8	41	5	1	1,625	4	2	1,741
POPUL'N	203	19	27	191	25	8	6,132	17	7	6,629
PIT LATRINE										
H'HOLDS	52	35	6	4,476	26	3	11,763	115	110	16,586
POPUL'N	186	125	21	20,785	87	7	45,854	575	370	68,010
BUCKET LATRINE										
H'HOLDS	6	13	18	27			40	1		105
POPUL'N	31	78	85	89			140	2		425
CESS POOL										
H'HOLDS	4	2	1	2			243			252
POPUL'N	19	9	8	7			641			684
BUSH										
H'HOLDS			1	53			16		1	71
POPUL'N			14	190			54		1	259
OTHER										
H'HOLDS	2			3	2		25	1	114	147
POPUL'N	14			13	6		94	10	362	499
TOTALS										
H'HOLDS	213	64	37	4,618	34	4	16,924	124	227	22,245
POPUL'N	775	252	185	21,324	128	15	62,029	613	740	86,061

Source: Table 6.12 Assessment of Situation Report

**TABLE 30: BUILDING MATERIALS ACCORDING TO TYPE OF HOUSE, NYERI DISTRICT
(IN % OF HOUSES)**

BUILDING MATERIALS	MAIN HOUSE	BOY'S HOUSE	OTHER RELATIVES	OUTSIDE KITCHEN	ALL HOUSES
I: WALL TYPE MATERIAL					
Mud + Wattle	53.3	59.6	50.0	45.5	52.1
Off cut wood	30.0	32.7	35.2	44.2	34.2
Sawn timber	11.7	5.8	14.8	3.9	9.6
Quarry stone blocks	3.9	-	-	1.3	2.2
Other	1.1	1.9	-	5.7	1.9
II: ROOF TYPE MATERIAL					
Thatch	6.7	17.3	11.1	20.8	11.9
Debes	10.6	11.5	7.4	1.3	8.3
Mabati round poles	26.7	21.2	33.3	23.4	26.2
Mabati sawn timber	43.3	38.5	40.7	46.8	43.0
Mabati with ceiling	11.7	9.6	3.7	5.2	8.8
Other	1.0	1.9	3.7	2.5	1.8
III: FLOOR TYPE MATERIAL					
Earth	85.0	94.2	94.4	97.4	90.4
Wood	0.6	3.9	1.9	-	1.1
Rough concrete	3.9	-	3.7	-	1.9
Concrete + surface	-	-	-	-	-
Finish	10.5	1.9	-	2.6	6.6
IV: WALL SURFACE TREATMENT					
No treatment	35.0	46.2	42.6	58.4	43.5
Clay-dung plaster	7.2	13.5	9.3	7.8	8.4
Ash-dung plaster	30.0	25.0	29.6	15.6	26.2
Painted (Wood)	23.9	13.5	18.5	13.0	19.2
Pointings	3.9	-	-	1.3	1.6
Other	-	1.8	-	3.9	1.1
TOTAL NO. OF STRUCTURES	180	52	54	77	363
Source: Nyeri Housing Survey, 1985.					

This household data should be compared with the HRDU survey which showed Nyeri rural houses with only 6.7% thatch in 1985 as shown in the Table 30.

In the 1989 CBS data on houses, 45% of the walls were made of wood, 25% of stone and 17% of mud and wood. These figures are much lower than those of the survey of selected neighbourhoods by HRDU in 1991 and may reflect the growth of slum type housing in the past few years. On the other hand, they may reflect different methodologies. In any case, the HRDU survey showed that 67% of houses surveyed had stone walls, none had mud walls and 33% had timber walls. However in contrast to rural areas as shown the HRDU table, the municipality households had more durable walls than their country cousins whose houses were, mud and wattle on 53.3%, timber 41.7% and stone 3.9%.

In 1989, 43% of the house floors were either cemented, tiled or wooden whereas 57% of the floors were made of earth. In 1985, 85% of all rural households had earth floors.

In 1989, 72% of the households used paraffin lamps for lighting whilst 25% used electricity. The majority of households (50%) used wood fuel for cooking. Paraffin was used for cooking by 31% of the households.

The figure for those who had access to piped water in 1989 is very high. Seventyfive % of households had access to piped water and the remainder used stream/river water.

Only 21% of the households were connected to a sewer or had a septic tank. About three quarters used pit latrines.

The data presented above shows clearly that there are not many disadvantaged people in the town. There are pockets of the poor who are not connected to water. This group, roughly a quarter of the population will benefit from the project.

9. MUNICIPAL DISADVANTAGED POPULATION SECTORS

Ayako, in *Nyeri Dry Areas Community Development Project: Baseline Survey*, which was published in 1990, argues that 37% of all Nyeri District Households are female headed. The sample for this work followed the CBS clusters and therefore it is a significant study. This data compares with the data provided by C.B. Sand based on the 1989 Census for the Municipality. As shown in Table 31, one third of all households were female headed. Following the logic of *Social Dimensions..(OP94)* the implication of this is that about fifty percent of them are poor. No data could be found to test this implication.

It has been argued in Kenya scholarship that a good indicator for poverty, relatively, is the amount of self help activity. Table 32: 'Municipality Self Help Groups' shows currently registered groups.

TABLE 31: NUMBER OF HOUSEHOLDS BY SIZE & SEX OF HEAD OF HOUSEHOLD

Sex of Head of Household	Household Size												Total
	1 Person	2 Person	3 Person	4 Person	5 Person	6 Person	7 Person	8 Person	9 Person	10 Person	11 Person	12 Person	
Male	4,095	2,033	1,444	1,459	1,313	1,165	982	896	487	359	133	169	14,285
Female	1,762	1,152	1,159	1,126	911	698	492	304	169	124	39	56	7,990
Total	5,857	3,185	2,603	2,585	2,224	1,831	1,454	970	656	483	172	225	22,245

Source: Assessment of Situation Report

TABLE 32: MUNICIPAL SELF HELP GROUPS

NAME	LOCATION	MEMBERSHIP	REGISTRATION YEAR
A. KNITTING			
1. Wame Municipality SHG	Mukaro	28	1989
2. Gilchamwenge WG	Mukaro	25	1993
3. Mwitithia Kamuri	Mukaro	87	1993
Sub-Total		140	
NAME	LOCATION	MEMBERSHIP	REGISTRATION YEAR
B. FARMING			
1. Kiganjo Organic Farming	Kiganjo	24	1991
2. Nyakio Pig Feeding	Tetu	31	1990
3. Kariumba Muinyihia	Mukaro	51	1992
4. Gitio Women Group	Mukaro	52	1992
5. Kahonokio	Kiganjo	25	1986
6. Ciaralni Women Group	Mukaro	46	1981
7. Muruguru Dairy Goat SHG	Mukaro	20	1983
8. Kahiga SHG	Kiganjo	60	1979
9. Kibage Women Group	Mukaro	33	1992
10. Haraka Women Group	Kiganjo	46	1987
11. Wiyuminirie Muthuani WG	Mukaro	48	1991

12. Thinwo Women Group	Kiganjo	20	1981
13. Kinditi SHG	Mukaro	140	1976
14. Mid Town Small Scale WG	Mukaro	30	1991
15. Gitero SHG	Mukaro	15	1992
16. Kirichu Dairy Goat	Kiganjo	28	1993
Sub-Total		669	

NAME	LOCATION	MEMBERSHIP	REGISTRATION YEAR
C. REVOLVING LOAN/MERRY GO ROUND			
1. Ndaraua SHG	Mukaro	15	1993
2. Uiguano SHG	Mukaro	16	1992
3. Muyetheria Welfare Group	Mukaro	36	1985
4. Nyakio SHG	Mukaro	55	1989
5. Township SHG	Mukaro	50	1994
6. Shauri Yako	Mukaro	25	1992
7. Chiarayni SHG	Mukaro	16	1992
8. Ngarariga WG	Mukaro	68	1991
9. Gioko WG	Mukaro	32	1991
10. Shirikisho SHG	Mukaro	15	1993
11. Mageria SHG	Mukaro	17	1994
12. Thari SHG	Mukaro	36	1992
13. Wendi Mwega WG	Mukaro	40	1992
14. Kwigitia SHG	Mukaro	27	1993
15. Kima SHG	Mukaro	31	1989
16. Jishinde Ushinde	Mukaro	33	1994
17. Itwai SHG	Mukaro	31	1993
18. Kamunyu Winyitie	Mukaro	30	1990
19. Shopstall Owners SHG	Mukaro	80	1990
20. Mt. Kenya SHG	Mukaro	30	1993
21. Kamuyu Kariumba WG	Mukaro	41	1976
22. Hill Farm WG	Mukaro	31	1989
23. Karibaini Gitero SHG	Mukaro	33	1994
24. Kamakwa Kihoto SHG	Mukaro	29	1993
25. Kiganjo Young SHG	Kiganjo	26	1993
26. Mwereri WG	Mukaro	63	1991
27. Gilchamwenge WG	Mukaro	25	1993
28. Kinuna W. SHG	Kiganjo	30	1969
29. CBD SHG	Kiganjo	21	1992
30. Kayura WG	Mukaro	100	1976
31. Mima S. S.Business.	Mukaro	30	1991
32. Murireri SHG	Kiganjo	32	1994
33. Tawa WG	Kiganjo	27	1993
34. Good Hope SHG	Mukaro	29	1994
35. Ihigaini Stima SHG	Mukaro	60	1990
36. Marua Organic Farm.SHG	Mukaro	25	1992
37. Witethie WG	Mukaro	30	1994
38. Kiganjo R.Young WG	Kiganjo	20	1994
39. Ihiga SHG	Kiganjo	51	1993
40. Endana SHG	Kiganjo	28	1993

41. Maweya SHG	Kiganjo	30	1993
42. Jaribu SHG	Kiganjo	32	1994
43. Winyitie SHG	Kiganjo	29	1994
44. Kiganjo	Kiganjo	25	1989
45. Mwihoti WG	Kiganjo	30	1993
46. Wendo SHG	Kiganjo	30	1991
47. Chaka SHG	Kiganjo	17	1993
48. Umoja SHG	Kiganjo	29	1993
49. Nyekangika SHG	Mukaro	25	1994
50. Kamakwa Welfare SHG	Mukaro	25	1993
51. Green Vegetable SHG	Mukaro	25	1991
52. Ngangirithi Green Belt WG	Mukaro	30	1985
53. Munyaka WG	Mukaro	52	1991
54. Maendeleo WG Project	Mukaro	107	1994
55. Shauri Yako WG	Mukaro	50	1991
56. Witethie WG	Mukaro	32	1992
57. Umoja wa Wanawake WG	Mukaro	40	1994
58. Githwanga WG	Mukaro	36	1991
59. Kinatha Amani WG	Mukaro	28	1991
60. Mwihoti WG	Mukaro	30	1976
61. Urumiwe WSHG	Mukaro	54	1993
62. Mwiyaeri WG	Mukaro	42	1978
63. Gacuru Mereri SHG	Mukaro	25	1994
64. Kamunyu Mwireri SHG	Mukaro	28	1982
65. Mamunyu Red Cross	Mukaro	33	1988
66. Mairwa	Mukaro	30	1992
67. Kirichu Market WG	Kiganjo	24	1993
68. Ereri W SHG	Kiganjo	20	1993
69. Mariene WG	Mukaro	49	1970
70. Mwangaza	Kiganjo	35	1991
71. Gatathini WG	Mukaro	50	1993
72. Mabati No. 1 WG	Kiganjo	25	1969
73. Kigumo WG	Mukaro	22	1970
74. Amani SHG	Mukaro	34	1994
75. Gachikah Equipment	Kiganjo	26	1985
76. Githangara WG	Mukaro	40	1976
77. Gatathiini WG	Mukaro	35	1993
78. Mathari WG	Mukaro	50	1991
79. Jitegemee Jua Kali SHG	Mukaro	33	1994
80. Gitathiini SHG	Mukaro	25	1993
81. Micha WG	Mukaro	52	1991
82. Kambwe SHG	Mukaro	25	1992
83. Witethie SHG	Mukaro	32	1993
Sub-Total		2,905	

D. QUARRY

1. Mwireri WG	Mukaro	28	1994
2. Quarry Workers SHG	Kiganjo	21	1989
3. Kabiruni SHG	Kiganjo	30	1993
Sub-Total		79	

E. PLOT/HOUSING & RENTALS			
1. Munungaini MYW SHG	Mukaro	28	1991
2. Kamakwa Women Group	Mukaro	29	1983
3. Kamuyu Urungariini	Mukaro	56	1990
4. Majengo SHG Project	Mukaro	25	1986
Sub-Total		138	
F. TREES			
1. Kiungu Dam TNG	Mukaro	26	1988
2. Marua Tree Nursery	Mukaro	54	1994
Sub-Total		80	
G. WATERTANKS			
1. Gathima Tank Pr.	Mukaro	30	1991
2. Kiamunyi WG	Kiganjo	70	1994
3. Gachinga Tank Buyers	Kiganjo	30	1985
Sub-Total		130	
H. FISHING			
1. Wamwagathu Youth SHG	Kiganjo	26	1994
I. HANDCRAFT/TIE & DYE			
1. Bidii SHG	Mukaro	52	1989
2. Mwihoto WG	Mukaro	25	1992
Sub-Total		77	
J. NURSERY			
1. Thayu WG	Kiganjo	29	1992
K. CEREAL MARKETING			
1. Open Air Market WG	Mukaro	40	1988
L. ELECTRICITY			
1. Githiru Forest Stima	Mukaro	107	1984
2. Kihumbu Rural SHG	Mukaro	40	1993
Sub-Total		147	

ANALYSIS OF ACTIVITY AND NUMBER OF GROUPS

1. Credit	83
2. Farming	16
3. Rentals	4
4. Knitting	3
5. Quarry	3
6. Watertanks	3
7. Tree planting	2
8. Handicrafts	2
9. Fishing	1
10. Nursery	1
11. Cereal Marketing	1
12. Electricity	1
TOTAL	120

ANALYSIS OF ACTIVITY AND NUMBER OF MEMBERS

1. Credit	2,905
2. Farming	669
3. Electricity	147
4. Knitting	140
5. Rentals	138
6. Watertanks	130
7. Trees	80
8. Quarry	79
9. Handcraft	77
10. Fishing	26
11. Nursery	29
12. Cereals	40
TOTAL MEMBERSHIP	4,460

There are 120 self help groups in the municipality. Analysis of their activities does not show that they are only instruments of the poor. The bulk of the groups, 69%, with 65% of the membership, are for credit. They are therefore driven by the various donors who over the past ten years have used Nyeri town as a test for delivery of credit to the urban and peri-urban people. This proxy variable does not therefore allow us to define the women as the poor.

There are however, the slum dwellers who can be considered poor. In a 1991 survey in Kamwaka, Ngangarithi, Ruringu, Kangemi and Thunguma, HRDU showed that occupancy rates were 3.6 persons per unit. This is lower than the national average for this category at 5 persons per unit.

The overall occupancy rates are shown in Table 33: 'Occupancy Rates 1991'. They do not present a picture of poor slum living. No current data exists for comparison but it is doubtful whether there have been major changes. Only in Kiawara is there a typical urban slum.

Circumstantial data generated by the municipality when allocating market stalls to the poor revealed that many such persons had bank accounts with between Ksh. 60,000 and 100,000y. This places doubt on the assumption that all those who live in slums are poor. That definition seems to be driven by Nairobi experience and could only be tested by conducting systematic surveys.

TABLE 33: OCCUPANCY RATES 1991

Persons/Unit	No. Units	Percentage
1	10	21.5
2-4	23	57
5+	10	21.5

Source: Ngari et al. HRDU:1991.

Land is not cheap in the Municipality. This is a problem confronting the low income groups. In a survey conducted in 1991 a quarter of an acre in the residential areas cost between Ksh.100,000 and Ksh. 390,000 as shown in Table 34 below.

TABLE 34: 1991 LAND PRICES IN SELECTED RESIDENTIAL AREAS

Area	Plot size	CBD Distance	Price/0.1 Ha.
Kamakwa	0.10	3.5 km.	100,000
Thuguma	0.10	3.5 km.	110,000
Ngangarithi	0.10	3.0 km.	320,000
Ruringu	0.10	2.5 km	240,000
Kangemi	0.10	1.5 km	390,000

Source: Ngari et al. HRDU: 1991.

It should be noted that Kangemi, the nearest area to the central business district and therefore attractive to workers, was the most expensive. It can thus be safely concluded that as land prices go up, this area which, is also an alternative to the very poor neighbourhoods of Kiawara and Majengo, will get beyond the reach of the poor and workers. They will be pushed to the outlying areas. It was not possible to get data on land prices in Kangemi, Majengo or Kiawara as is shown in Table 22. However, given the general land prices in the Mukaro location in general, it is not unrealistic to expect the poor to be pushed to the periphery of the municipality where land is cheaper. Kiganjo is one such location.

Ngari's survey also established that on average, poor residents spent on average 26% of their incomes on monthly rents. The poorer area of Ruringu spent the highest amounts 37%, about Ksh. 450. In Kangemi and Thunguma the rent percentage was lower at 30% and ranged from Ksh.275 to Ksh.400.

In contrast and in the same neighbourhoods, middle income groups spent only 19% of their incomes on rent. The high income groups spent only 18.6% of their incomes on rent. It should be noted that in this survey, the highest rental costs per square metre were again in Kangemi. The lowest were in Thunguma followed by Kamakwa. Rents therefore seem to be driven by both proximity to town as well as access to other infrastructure. Table 35: 'Incomes and Rents' summarises these findings.

TABLE 35: INCOMES AND RENTS 1991

Area	Group	Average Mon. Rent Ksh.	% Income for Rent	Ksh. Average Sq.M Rent
Kamakwa	Low	100	15.0	21.82
	Middle	275	17.5	
	High	500	18.0	
Ngangari	Low	200	18.5	27.06
	Middle	317	16.0	
	High	1,500	19.0	
Ruringu	Low	450	37.5	23.16
	Middle	700	26.0	
	High	925	22.0	
Kangemi	Low	275	30.0	29.68
	Middle	442	21.0	
	High	1,600	17.0	
Thunguma	Low	400	30.0	21.11
	Middle	650	15.0	
	High	2,000	17.0	
Source: Ngari et. al. 1991				

10. DEVELOPMENT OF OTHER INFRASTRUCTURE SECTORS

10.1. Expansion in Floriculture and Horticulture

An important infrastructure development, with a bearing on the proposed project, is the development of floricultural and horticultural irrigation in Kieni. This is significant, for some of the owners of land in the municipal area are selling their small plots to finance land buying in the areas to be irrigated for production of these very lucrative agricultural crops. If one sells 0.10 Ha. of land say in Skuta, one is able to finance a lot of agricultural land in Kieni.

The International Fund For Agricultural Development, through the Nyeri Dry Areas Smallholder and Community Services Development Project, is the main donor for its current project plans to irrigate 300 hectares. It is anticipated that there will be future expansion of irrigation by this donor.

It should be noted that this is not the only irrigation which exists. All the previous water schemes on the Kieni East division have been converted to irrigation schemes even though they were not built for it. Consequently rivers like the Nairobi river do not flow during the dry season as all the water is taken by irrigation. Even during the wet season, as in November 1995, when fieldwork was being done, all the streams off the Mt. Kenya Catchment were being used for irrigation. Among them were Nairobi and Naro Moru and their tributaries.

In the Nyandarua catchment, there is irrigation planned off the Honi (Amboni). Gatarakwa water supply, although it is proposed for drinking water, is set to expand irrigation in Kieni West. Gatarakwa people have already built an intake inside the Nyandarua National Park and no doubt they will take significant amounts of water.

It should also be noted that other water schemes drawing water from this catchment are beginning to generate limited irrigation. For example, Aguthi water supply was not designed for irrigation. Yet some people are already irrigating patches of vegetables.

Given the fact that horticulture and floriculture is new in the area, the limiting factor in the past five years or so has been familiarity with their production technologies and marketing infrastructure. Farmers in the area are now familiarising themselves with the production technologies. Through self help, they are building irrigation systems. Private individuals are putting marketing infrastructure in place. Donors, like IFAD, are planning an extensive credit system for horticultural development.

The cumulative effect of all these activities is that a major expansion in irrigation will take place over the next five years.

Therefore, by the future and ultimate horizons, it is conceivable that there will be almost no water available for urban water supply in from the Nairobi and the Honi (Amboni) rivers. Since the Tetu farming systems are not suitable for irrigated floriculture and extensive horticulture, it is not likely that massive water will be taken out of the Chania for irrigation in the areas useful for Nyeri water supply.

10.2. Urban Infrastructure

Currently, there is a World Bank development project which has included Nyeri Town. Funds from this project will be used for limited resealing of roads in the municipality, construction of a few roads to facilitate traffic flow, especially downtown, systematisation and resealing of bus parks, construction of foot paths, street lights and traffic management systems. Its total financial outlay is about Ksh. 103 million.

This project is maintenance oriented and is not a large project to address the obvious issues of tarmacking a lot of the urban roads which are still of earth construction especially in the rural parts of the municipality.

10.3. Water Related Infrastructure

Three existing water projects are of some importance for they take water from the Nyandarua catchment and they abut the Municipality. These are:

Muhoya Self Help Water Supply, funded by the EEC and taking water out of Zaina River before it joins the Chania. It is intended to serve parts of Kihuyo sub-location.

Aguthi Water Supply, funded by Danida and operated by the National Water Conservation and Pipeline Corporation. It is metered. Its intake is from the Gura River. It supplies about 500 consumers at the south-west periphery of the municipality.

Tetu Thegenge Water Supply, was completed in 1976 and was locally financed. It takes water from the Chania river. It is a significant supplier to the Kihatha, Gitathi-ini, Karia and Chorong/Giachamwenge wards of the municipality.

There was no indication that any of these schemes were to expand in any significant manner. In any case the water supplied is not systematically treated. Since two of them are not metered, there is probability they will be used for minor kitchen garden irrigation. However all of these projects do not operate in areas of potential large scale irrigation.

Four water projects are under implementation: These are:

Njengu Self Help Water Supply, a small water project funded by the Canadian High Commission. It draws water from the Murigato River in the Nyandarua catchment. It is proposed to serve the Nyaribo and Njengu sub-locations. It is intended to be for both domestic and minor irrigation. Its water is not treated.

Kanuna Irrigation Project is funded by the Catholic Diocese in the dry areas of Kieni East, specifically in Lower Kirichu area which is currently not served by the Kiganjo system. It is intended to give domestic water and irrigate about 200 hectares with water abstracted from the Honi River.

Ndathi-ini Irrigation Project, next to the Kanuna Irrigation Project, intends to develop about 232 hectares for irrigation and to also supply domestic water. Water is to be abstracted from the Honi River

Nyaribo Water Supply Project has been scheduled since 1986 with Rural Development Fund assistance and some support from the Municipality. It is to abstract water from the Honi River. It is not clear how much area or irrigation will be served by the project.

Two projects are proposed but the plans have not matured to allow meaningful assessment of them. These are:

Wangi Self Help Water Supply, proposed for Kirichu sub-location in Kiganjo. It is supposed to abstract water from the Sagana.

Ileri-Kirumia Self Water Supply is proposed for Gachika sub-location and is also supposed to abstract water from the Sagana.

The existing, under construction and proposed water schemes point towards the communities commitment to developing their own water supply rather than wait for the municipality or other organs of the state to construct supplies. There is also a sense in which community construction liberates the water from metering and thus makes it available for irrigation even when not so designed.

The viability of most of the schemes, particularly those taking water from the Honi, is doubtful in the future and ultimate horizons for those rivers are to be used for irrigation upstream if the Kieni West takes irrigation seriously, a proposition considered more than likely.

Given intensification of land use and extensive deforestation in the Murigato catchment, it is doubtful whether this river will carry the proposed schemes into the future and ultimate horizons.

Besides, there seems to be significant contamination of the Muringato from the Mathari institutions and their coffee.

10.4. Elite Pressure for Services

It can be argued that as the Nyeri elite invest in the expanded municipality, they will pressurise for improvement of infrastructure, especially roads and water. However, given the decline in national government resource subventions to municipalities; the relative reluctance by many donors to invest in government development projects; and the slow economic recovery, it is not likely there will be many large scale infrastructure projects before the two horizon times.

11. PROJECT BENEFITS TO COMMERCE AND INDUSTRY

11.1. Cost of Inadequate Supply

Over and above the extensive interviewing of officials at both the municipal and the district level, selected businessmen were interviewed. Among these were persons from the Green Hills Hotel, Mt. Kenya Wine Co. Ltd., Kenya Industrial Estates, Nyeri Bakeries, Batian Hotel, Nyeri Provincial Hospital, Kenya Co-operative Creameries, Nyeri Supermarket, Ibis Hotel, Salim Hotel and Roma Dry Cleaners.

The Provincial Hospital is included in this section for it suffers major water shortages. They are so bad that at times it has to close. Water only comes in the morning hours and the hospital argues that at best it gets only about 5% of what it needs. This obviously has very serious implications for it means that it cannot function properly. It also has been shown that operating a hospital under such dire water shortages is dangerous to the health of the community for it becomes an incubator of disease.

The hospital water supply line has been tapped into for it passes through the downtown area. It may be useful that the project creates a supply line dedicated to the hospital. The municipality should ensure that no connections are made to this line in keeping with general practice. Of course the implication of this is that the lower down town areas and even Kangemi will have to have new and adequate supply so that they do not poach hospital water.

Roma Dry Cleaners, just off the Nairobi Road, has to condense the steam it uses to recycle it for it gets only about 40% of the 1,000 litres per day needed. They also had planned a chemical industry which they cannot start for it will need water not available. They are considering re-locating for water is not sufficient.

Industries in the Kingongo area which include Kenya Industrial Estates, Nyeri Bakeries and others have to close every once in a while. Workers told us they are often not allowed to use toilets for there is no water! This same comment came from Mount Kenya Wine Co. Ltd who operate a petrol station in the Central Business District.

The situation of Hotels is also serious. Batian, Ibis and Green Hill Hotels have had to invest in very large storage systems as is shown in Picture 2: 'Storage System for Ibis Hotel'. Some argued that they do not even get enough direct water supply for kitchens operations as required in law and international practice. Further, as often as two times a month, they have to ask the council water tankers to supply them. Green Hills have dug wells on their property and invested in a chlorination plant for they do not see how they can otherwise operate given the current water shortage.

KCC claimed that they need 300,000 litres per day. Since they are on the Kiganjo system, which does not function during the dry season, their operations are seriously curtailed. Mount Kenya Bottlers, the Coca Cola franchise holders, have developed their own water system, including treatment for they do not think they can rely on the municipal supply.

11.2. Cost of Inadequate Supply

The environmental report deals with this to a greater length. However, there has been occasions when even the treated water has not met standards. The Provincial Hospital, health and water professionals and business people pointed this out. During a meeting with the municipal senior staff, this subject was broached and the response was that there had been a technical hitch in the operation of the treatment works - failure in de-sludging - and that was a thing of the past. Over and above this argument, it is the opinion of the writer that the project to be constructed should be of such nature as to simplify operations and maintenance. A visit to the Kamakwa treatment works, portions of which have been added on at different times, did not reveal an easily operateable and manageable system.

Impure water is costly from a disease point of view.

11.3. Location of Supply for Industrial Growth

A key issue in improving future water supply is to assure water for industries at the future and ultimate horizons. Detailed discussions with District and Municipal Officials, as well as members of the business community, established clearly that it is the Kiganjo area which is likely to become the industrial area of the municipality. There are many reasons for this. One reason is better road and rail infrastructure. Another is terrain. The area between Kiganjo town and Chaka and to the west is relatively more flat than many areas of the municipality. Therefore construction of large industrial businesses is easier there than in any other part of Nyeri town. Those who argue for industrial location in the Kingongo area, within the large estates forget that it is not likely that the particular owners will sell large parcels of the land to facilitate this. In any case they are not likely to need the money. Nor are land prices there cheap as shown in Table 20.

The existing Kiganjo water supply is limited by the upstream abstractions as discussed in Chapter Ten. Such abstractions will not only increase but may dry up the Nairobi River completely before it gets into Kiganjo. In Chapter 10, it was also argued that the Honi river is also likely to be over-abstracted between now and the two planning horizons by horticulture and floriculture operations which are intensifying. In any case, it does not make much long term economic sense to have two treatment plants serving one small municipality.

These very probable future water use practices impacting on the Nairobi and Honi Rivers suggest that the only viable supply alternative is the Chania. The same water should be supplied to Kiganjo.

APPENDIX 1: TERMS OF REFERENCE: SOCIO-ECONOMIC IMPACTS

The assessment of environmental and socio-economic impacts of the recommended optimum solution will be carried out principally on the basis of the water project being executed alone, but with appropriate commentary of the changes in these impacts should the recommended sanitation solutions be implemented as well. The impacts will be assessed for both the future and ultimate horizons.

Essential areas of analysis will be in the effects on:

1. Population growth.
2. The level of labour productivity.
3. Availability of employment.
4. Levels of income and income disposal patterns.
5. Living standards.
6. Benefits to commerce and industry.
7. Economic growth in the Municipality.
8. Development of other infrastructure sectors.
9. Property values.
10. The situation of presently disadvantaged population sectors.
11. The rate of urbanisation.

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APPENDIX 3: LIST OF PERSONS INTERVIEWED

Eigel, U.	Small Towns Development Project.
Gaku, P. K.	Chief Accountant
Gatundu, S.	Drawing Office
Gikuhi, R.K.	Nyeri Town Clerk
Grootenhuis	Ministry of Local Government. Green Town
Kagathi, C.M.	Ministry of Health. Administration Officer
Kanyotu, P.	Senior Labour Inspector
Kenyariri, V.	Nyeri District Co-operative Officer
Keyonzo, N.	Pathfinder International
King'ori, A.R.	—
Kula, Otieno	Jua Kali Officer
Makara, L.M.	ADPO. IFAD.
Maleche, ?	University of Nairobi
Malombe, G.	University of Nairobi
Mayogi, Edward	ADDO
Muinami, N.	Nyeri District Employment Officer
Mukundia, T.	Ministry of Local Government
Mulwa, P.W.	Warden Abardares National Park
Murengi, E.G.	Nyeri District Labour Officer
Murila, K.	Ministry of Local Government Urban Development
Muritu, J.M.	Welfare Officer
Muthuna, S.	Mt. Kenya Wine Co. Ltd. & Petrol Station
Mwangi, K.	Nyeri District Population Officer
Ndirangu, F.M.	Kenya Industrial Estate(KIE)
Ndirangu, M.D.	Small Towns
Ndungu, Amy	Nyeri District Trade Development Officer
Nganga, J.M.	DSDO
Ngariama, N.	Nyeri District Development Officer
Ngoru, B.N.	Kenya Wildlife Service - Mweiga
Ngugi, K.	DPO (IFAD)
Nguiguti, J.	Nyeri Town Engineer
Njari, Godfrey	Water & Sewerage Accounts
Nyariki, N.	Green Town
Odiyo, Eliud	Nyeri District Credit Coordinator
Omor, F.Z.	Deputy Director CBS
Wagereka, I.	Nyeri District Water Engineer
Wagichuhi, P.	District Co-operative Training Officer
Wambet, M.T	District Agricultural Officer.
Wanjage, J.	Nyeri Mayor

APPENDIX 4: LIST OF ORGANIZATIONS VISITED

1. Salim Hotel
2. Ibis Hotel
3. Coca Cola
4. Roma Dry Cleaners
5. Mt. Kenya Wine Co. Ltd.
6. Kenya Industry Estates
7. Kenya Cooperative Creameries
8. Mureithi Valuers
9. Tysons
10. Green Hills Hotel
11. Batian Hotel
12. Nyeri Supermarket
13. Nyeri Provincial Hospital
14. Nyeri Bakeries
15. Provincial Administration.

ANNEX 3

ENVIRONMENTAL IMPACT
ASSESSMENT

EXECUTIVE SUMMARY

Currently the demand for treated water supply in Nyeri Municipality exceeds the rate of supply by a large margin. The aim of the Nyeri Water Supply Project is therefore to extend the water supply to meet the expanded demand up until year 2010.

Nyeri Water Supply will augment the levels of the treated water, improve sanitation and contribute to the reduction of incidences of water-borne diseases. A project of this nature will also have environmental implications. Hence a need to identify the project impacts at an early stage of the planning and project design.

The project area extends from the Aberdare Range to the West through the central region which covers the Municipality to the areas bordering Mt. Kenya to the East. A review of baseline environmental conditions of the project area has been carried out.

On the whole, the study area does not have acute environmental problems. However, soil erosion and siltation poor cultivation practices, use of agro-chemicals, deforestation, mining (quarrying) activities are areas that cause environmental concern.

The Municipality does have environmental problems that require immediate attention. These include, soil erosion and siltation, pollution, sanitation and disposal of wastes.

Out of all the environmental problems it faces, the Municipality has an acute problem in regard to the management of solid wastes. It is recommended that the disused Kabiruini quarries should be transformed into a sanitary landfill for the purposes of dumping the solid wastes generated in the Municipality.

Analysis of Municipal sewage and industrial effluents reveal a strong domestic effluent with high levels of BOD₅, COD and Permanganate Value. The Kenya Cooperative Creameries produce a strong plant effluent with very high values of BOD₅, COD and Permanganate Value. This effluent needs pretreatment before it is introduced to the Municipal Sewage Treatment Works.

To ascertain the quality of the natural waters, the Consultant has collected a wide range of water samples which have been analyzed for chemical and bacteriological quality. In general, the surface waters are of excellent chemical quality. They are acidic to neutral waters of low to moderate alkalinity and low salinity. Levels of fluorides and nitrates, substances that are detrimental to human beings in high concentrations are low. Results of bacteriological analysis reveal that all surface

waters in the study area are contaminated with bacteria of faecal origin. The surface waters are therefore unsatisfactory for drinking purposes unless treated.

Negative impacts of the project will largely emanate from construction activities, transmission pipelines and the operation of the water treatment works. Although no project designs and plans have been reviewed, the water supply project is expected to cause only minor to moderate environmental impacts.

Most of the impacts are expected from the construction works. This will include clearing and trampling of vegetation, excavation of soils, levelling of landscape and other general construction work. Such activities will stimulate degradation processes including destruction of vegetation complexity, loss of habitat for the fauna and flora, soil erosion and siltation.

Impacts associated with project operation include the production and disposal of sludges. There will be minor to moderate impacts on the downstream users. The Sagana Falls Hydroelectric Power Station may suffer a reduction in water flow in exceptionally dry conditions of Chania flow. The downstream users of the river water will get water with increased pollution following the expansion of the Nyeri Water Supply.

A number of measures have been proposed to mitigate the above negative impacts, including:

As part of the initial project stage

- Following the completion of the construction works activities, measures should be undertaken to restore the degraded habitats and curb soil erosion and siltation. This includes terracing, landscaping and planting of sediment binding grasses such as *Cynodon dactylon* and other appropriate plants.
- Sludge generated in the water treatment works should be disposed of using a sanitary landfill facility.
- There will be a need to increase the efficiency of the sewage treatment works in order to reduce pollution of water downstream. Consideration should be given to converting the waste stabilisation ponds into constructed wetlands to achieve this.

As part of the follow on stage

- In order to maintain the required flows to downstream users, there will be a need to build a reservoir with ample storage capacity upstream.
- Levels of agro-chemicals in the raw water at the Ihwa Intake need to be monitored. Should these be shown to be at an undesirable level, the intake should be relocated upstream of the agricultural zone.

1. INTRODUCTION

Nyeri Municipality operates two water supply systems. One serves the Town Centre and the surrounding areas at Kamakwa and the other serves Kiganjo. The two water supplies with a daily production of 5.5 million litres for Nyeri and 1.1 million litres for Kiganjo are only able to meet some of the Municipal's water demands estimated at 11.0 million litres for Nyeri alone. The aim of the project is therefore to extend the Nyeri Water Supply system to meet the expanded water demand.

Nyeri Water Supply will augment the levels of treated water supply, improve sanitation and reduce the incidences of water-borne diseases among other benefits. Such a development, however, has some environmental implications associated with it, either directly or indirectly. There is therefore a need to identify environmental impacts during the early stages of planning and project design. This will ensure sustainable development and help to protect the environment from negative impacts including degradation of natural resources, deforestation, soil erosion, and pollution in the project area.

2. STUDY AREA

The study area covered by the environmental assessment is shown on Fig. 1 and the project area on Fig. 2.

The Municipal boundary which coincides with the project area encloses an area of 208 km². This area is characterized by relatively flat or gently sloping hilltops intersected by very steep sloping and deep valleys. The main rivers are the Chania, and Muringato within the central area and Amboni and Nairobi to the north and east. To a large extent, the environmental study concentrates within the area covered by the Nyeri Municipality and the immediate surroundings. However, events controlling and influenced by the environmental conditions prevailing in the area stem from regions beyond the Municipality. Hence the study area.

The study area in regard to the present environmental assessment therefore extends from the Aberdares Range to the West through the lower valley including the Nyeri Municipality and environs to the regions bordering Mt. Kenya to the East. This area lies on either side of Equator between 0° 30'S and 0° 1'N. and also between 36° 30'E and 37° 30'E.

3. BASELINE CONDITIONS

3.1 General

The study area falls within Nyeri District. This is the northernmost district of Central Province. It is situated between Mt. Kenya to the east and the Aberdares to the west. Nyeri district covers an area of 3,284 km². The district is predominantly rural with a wide range of agricultural activities. The town of Nyeri serves both as an administrative and trading centre.

The Nyeri Municipality is situated close to the Equator at latitude 0° 25'S and longitude 36° 57'E. The town lies 10 km west of the main road and railway to Nanyuki. Much of the land within the Municipality is used for extensive agriculture. There are many small holdings as well as large coffee estates situated to the north.

Nyeri town is not heavily industrialized. There are however, light industries including bottling plants, saw mills, coffee factories, flour milling plants, a match factory and the Kenya Cooperative Creameries Plant.

3.2 Physiography

The most dominant topographical features of the study area are the Aberdare's Range (3,999 masl) to the west and Mount Kenya (5,199 masl) to the east. The two land massifs determine the general relief, climate and the soils of the study area.

The topography associated with the Aberdares and Mt. Kenya is diverse as would be expected of mountainous areas. From the highest points are canyon like V-Shaped valleys. The streams and rivers cascade down through some of the highest waterfalls in the country as exemplified by the Karuru Falls (272m) in the Aberdares.

Downslope, the terrain becomes more even with deep V-shaped valleys separated by the ridges. On the footslopes of the two mountains is a saddle which lies above 1,500 masl and maintains a great topographic variability. Chania River is a major feature in this section. From its source in the Aberdares, it crosses the saddle and joins Sagana River 18 km from Nyeri Town. Kiganjo is located on a flat ridge running north/south between the Amboni/Muringato rivers to the west and Nairobi River to the east. The Muringato River joins the Chania River about 7 km south of Kiganjo while Nairobi River is a tributary of the Sagana River.

3.3 Geology

The geology of Nyeri area has been described in detail by Shackleton (1945) and Baker (1966). The present landscape has been created through repeated faulting and lava outpours which date back to mid Tertiary times (25 million years ago). During the late Tertiary (2-25 million years ago) the formation of Mt. Kenya and the Aberdares started. This was also when the main outlines of the Rift Valley were formed. The Pleistocene (2-10 million years ago) was characterized by renewed volcanic activity and faulting, cutting out the landscape the present erosion processes are modifying.

The volcanic activity has resulted in the formation of the following major rock formations within the study area:

- Simbara Series
- Sattima Series
- Laikipian Basalts
- Mount Kenya Series
- Pleistocene and Recent Superficial Deposits

3.3.1 Simbara Series

The basalt of the Simbara series are the oldest volcanic rocks (from the Miocene) in the Study Area. They occur in wide areas east of Rift Valley. These basalts are exposed in the valleys of Amboni, Chania and Muringato rivers and on some ridges. Near Mt. Kenya, they are exposed on the slopes of Sagana and Nairobi Valleys to the south-west.

3.3.2 Sattima Series

Where the Simbara Series are overlain by poorly weathered lava as phonolites, olivine-alkali trachytes, mugearites and fissile basalt, they are referred to as the Sattima series. There was an interval between eruptions of the Simbara basalts and the Sattima series as the contact between the two is sharp.

3.3.3 Laikipia Basalts

These are mainly non-porphyrific basalts which overlie the trachytes and phonolites of the Sattima Series. The Aberdare moorlands, the eastern slopes of the range and the northern Aberdares consist of lavas and tuff of Laikipia series. Most of the waterfalls occur where columnar Laikipian basalts, often alternating with sheets of fissile lavas have been undercut. Examples of these are on the Chania River just above Nyeri, others in the Aberdare forest; and the Amboni Falls just below the Nyeri-Nanyuki Road.

3.3.4 The Nyeri Tuff Series

These rocks occur between Simbara Series and the overlying Laikipian Basalts and partly overstep the Simbara Series, resting directly on the Basement. The series consists mainly of Trachyte Tuffs of the Miocene.

3.3.5 The Mount Kenya Series

This group consists of volcanic rocks which erupted from Mt. Kenya and its satellite volcanoes presumably during the Pliocene. The rocks include olivine basalts on some areas to the north western and western slopes. There is a large region with phonolites, porphyrites and kenytes on the western side of mountain. There are some basalts between Nairobi and Sagana Rivers to the south west.

3.3.6 Pleistocene and Recent Superficial Deposits

These are thin unconsolidated or semi-consolidated deposits which have accumulated since the volcanic eruptions ceased. On the more elevated slopes around Mt. Kenya moraines occur, and along major river valleys alluvial deposits are found.

3.3.7 Basement Series

Underlying the geological formations of the study area is a zone of more ancient rock formation. The portion of basement rocks runs along a north-western to south-eastern trend in areas around Kiganjo-Kirichu, Marua and extending between Tumu-Tumu and Mukurweini towards Kirinyaga and Muranga Districts.

3.4 Soils

The soils of the study area can be conveniently divided into 3 major groups as determined by altitude. These include the soils of lower slopes (soils on volcanic foot ridges) below 2,700 masl, the soils of upper slopes (2,700 - 3,300 masl) and soils of high mountain belt (above 4000 masl)

3.4.1 Soils Lower Slopes

According to the FAO/UNESCO soil classification (1988) the soils of the lower study area, are mainly nitisols. The local name for this type of soil is Kikuyu Red Loam.

The nitisols are dark red, dusky red or dark reddish brown, depending on the presence of iron compounds. The soils are deep (often 150 cm deep) due to a high rate of weathering. They have a diffuse soil horizon boundaries. In addition, the soils are friable to very friable, porous throughout and have favorable moisture storage capacity and aeration conditions.

The soils show a marked structural stability and are known to have a high degree of phosphorus absorption. They allow good and deep rooting and contain weatherable minerals. However, for optimum crop production these soils require additional fertilizers and manure (Gronvall, 1987).

Other minor soils present in this altitude category include clay soils such as Acrisols, Luvisols and Phaeozems. The Acrisols have a top soil of about 20-40 cm of dark clay loam over 100-200 cm thick layer of reddish brown clay. The Luvisols are dark reddish brown clay up to 100 cm thick over the weathering rock. The Phaeozems have 30-40 cm of dark reddish brown, humic silt clay loam over dull reddish brown clay.

3.4.2 Soils of Upper Slopes

The predominant soils in the upper slopes between 2700-3300 masl have dark top horizons, rich in organic matter, with low bulk density, mainly formed from young pyroclastic rocks. They include the following soil types:

- **Andsols** have dark humic silt loam up to 60 cm thick, on top of brown sandy loam, mainly found in the *Hagenia* and bamboo forests.
- **Leptosols** and **Regosols** are soils with dark and stony loam, rich in organic matter, on top of greyish brown mottled loam.
- **Histosols** with up to a 15 cm thick layer of undecomposed organic matter, on top of black humic subsoil and silt loam found partly in parasitic craters.

3.4.3 Soils of High Mountain Belt

These are soils of partly very stony, dark loams with a high content of organic matter and low bulk density. They include:

- **Lithosols** - these are characterized by shallow depth and high content of stony material, occurring mainly on rock outcrops.
- **Regosols** - dark and rich in organic matter, with stony loams on ridges and moraines.
- **Leptosols** and **Gleysols** - soils of valley bottoms, dark and very rich in organic matter on top of brown sandy, mottled loams.

A more detailed account of soils in this area has been given by Scott and Friend (1962) and Speck (1982).

3.5 Climate

The climate of the study area is fundamentally governed by two geographical circumstances: These are the vicinity of the equator and the high attitude of Mt. Kenya and the Aberdare Range. The study area falls into three general climatic regimes:

- the western part of the moist windward side of Mt. Kenya
- the drier western leeward side of Mt. Kenya which borders the semi-arid Laikipia Plateau.
- the moist windward eastern slopes of the Aberdare Range

3.5.1 Rainfall

Due to the increase in attitude and the great variation in topography associated with the surrounding mountains and plateaus, there are significant contrasts in precipitation in the study area. Rainfall ranges from 2,300 mm per annum on the moist exposed edge of the Aberdare Range to 700 mm per annum on the Laikipia Plateau to the north. The rainfall figures from a wide variety of stations in or close to the study area are shown in Table 1. The lower rainfall figures are the results of rainshadow effect and lack of convectional rains. The higher slopes of Mt. Kenya and Aberdares receive more rain than the foot slope zones. They trap the moisture winds creating rain shadow effects on areas around them.

Table 1: Rainfall Figures from Various Stations in the Study Area

Ref No.	Altitude (m)	Station Name	Years of Record	Average Annual Rainfall (mm)	Average Monthly rainfall in mm											
					Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
9036017	1829	Nyeri	71	905	51	46	68	167	157	30	37	38	33	92	109	77
9036072	1890	Mweiga	40	899	65	52	70	159	103	28	41	40	24	97	129	91
9036128	1829	Othaya	31	1,402	42	37	74	320	293	57	52	63	53	169	172	70
9036157	2377	Kiandongoro	27	1,795	94	80	99	358	333	88	88	87	67	178	205	127
9036271	3076	Aberdare Nat. Park Kiandongoro Gate	15	2,231	90	97	202	355	328	93	101	130	113	302	294	126
9037002	1814	Karatina Tumu Tumu Mission	47	1,152	31	22	74	275	251	37	29	35	38	138	154	68
9037060	2317	Nanyuki Forest Station	28	918	44	26	73	182	112	43	54	67	63	128	44	82
9037064	2134	Naro Moru Forest	20	939	63	37	84	159	76	21	36	36	85	104	148	90
9037099	1981	Karatina, Kagochi	22	1,242	49	53	103	235	194	35	30	33	32	185	189	104

Source: Jaetzold & Smith, 1983

The rainfall pattern exhibits seasonality. The period of maximum rainfall (long rains) occurs from March to May and is followed by a relatively dry season from June to September. The short rain period occurs from October to December and is also followed by a short dry season from January to February. This seasonal pattern reflects the shift of the Intertropical Convergence Zone (ITCZ).

During the rainy season, the rainfall pattern also exhibits an element of diurnal variation. The precipitation is minimal in the morning (7-11 am) and maximal in the afternoon between 3 and 6 p.m.

3.5.2 Temperature

In contrast to the seasonal variation of rainfall, seasonal variations in temperature are very small. Temperature is mainly dependent on elevation. There is normally a temperature decrease of 0.56°C for a rise of 100m. This means that frost is expected in the study area at places with an altitude of or above 2,500 masl.

Monthly temperature distribution for the Sagana State Lodge Station (1,830m) are shown in Table 2. These are moderate temperatures with a mean of 16.5° and range of 16.1° to 17.6°C . A similar temperature regime is expected in Nyeri Municipality which has a similar altitude (1,829masl at Nyeri Ministry of Works Station).

Contrary to the low variations of temperature in the lower areas, the high mountains experience a high degree of diurnal temperature fluctuations. Temperatures of -5°C (night) and 27°C (day) have been recorded at an altitude of 2,940 masl at ground level in the Aberdares National Park (Schmitt, 1991).

3.5.3 Mist and Cloudiness

Mist and cloudiness are important environmental variables which are more prevalent in the higher zones of the study area. An important type of precipitation in the Aberdares and Mt. Kenya is mist.

Low clouds and mist are common during the rainy seasons and also during cold foggy periods. The highest peaks are often hidden by clouds in the afternoon and a stratum of clouds are common around the base of the mountains in the early morning.

During the night, cold air (mountain breeze) flows downhill and builds up clouds around the base of the mountains. The reverse happens during the day. After sunrise, the slopes are exposed to sunshine and ascending circulation produces strong convectional currents with clouds covering the slopes thus impeding direct insolation

Table 2: Temperature Data for the Study Area

Ref No.	Altitude (mm)	Station Name	Type of Record	Average Annual Temp. (°C)	Monthly temperature in °C											
					Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
9037158	1830	Sagana State Lodge	Mean max	23.3	24.6	25.4	24.9	24.0	22.4	21.0	20.2	21.1	23.7	24.3	23.4	24.2
			Mean temp	16.4	16.4	16.6	16.4	17.7	16.9	15.5	15.2	15.6	16.9	17.6	16.1	16.2
			Mean min.	9.7	8.2	7.9	7.9	11.4	11.4	10.1	10.2	10.2	10.2	11.0	9.8	8.2
			Abs. min.	1.5	2.0	2.4	1.5	2.2	5.0	3.0	3.8	4.8	4.0	5.6	5.5	1.5

Source: Jaetzold and Schmidt, 1980

3.5.4 Radiation and Sunshine

Solar radiation and radiative emissions increase with altitude. However, the frequent presence of clouds and mist reduce the radiation intensity especially in the high mountains. Generally, there is scarcity of records in regard to the above parameters within the study area. However, data presented in Table 3 shows that highest levels of solar radiation are received in the months of December, January and February. This is also the period with the highest number of hours of sunshine per day.

The average radiation and sunshine is 460 cal/cm²/day and 6.8 hours/day respectively.

Similar results have also been reported for other sites close to the study area. Mean annual radiation of 419 cal/cm²/day was recorded at South Kinangop Forest Station (2591 masl) with a range of 249 to 616 cal/cm²/day between 1963 and 1967 (Kenya Meteorological Department, 1984).

3.5.5 Evaporation

Evaporation follows a pattern inverse to that of rainfall, with periods of low evaporation occurring when rainfall is high and vice versa. Evaporation is also more pronounced in the drier zones of the study area.

Annual mean evaporation of 1,440 mm was recorded at Nyeri (1815m) between 1987 and 1980. The monthly mean maximum of 143 mm is recorded in March while the mean minimum of 79 mm is recorded in August (Kenya Meteorological Department, 1984). In contrast, Nanyuki which is much drier than Nyeri shows a monthly maxima of 182 mm and 185 mm in February and December respectively. The mean minimum evaporation (110 mm) occurs in April.

3.6 Hydrology

Surface water hydrology has been extensively covered in another report of this project in Annex 4 of Nyeri Water Supply Feasibility Study Situation Assessment Report, Volume II. The report focuses on the hydrology of river systems of Chania, Nairobi and Amboni, that may be utilized in the supply of water for the Nyeri Municipality.

The coverage is mainly in terms of expectations of run-off, rainfall and evaporation. Ground water resources have not been considered as a suitable source of water for Nyeri Municipality given the high level of water demand for such a project and the very limited ground water potential indicated for the area by the National Water Master Plan.

The following summary gives only a general view of hydrological conditions seen from an environmental perspective.

Table 3: Sunshine and Solar Radiation in the Study Area

Station Name	Type of Record	No of Years	Average Annual Value (hrs)	Monthly temperature in °C											
				Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Sagana Fish Farm	Mean hours per day of sunshine	7	6.8	9.4	9.3	8.3	6.6	6.0	5.9	4.1	4.1	6.4	6.8	6.1	8.4
Sagana State Lodge	Solar radiation in cal/cm2/day	6	460	512	521	485	445	437	423	393	403	487	507	417	495

Source: Patel, Mangat & Partners, 1977

3.6.1 Surface Water Resources

The study area falls within one of the most important water catchment zones in the country. The Aberdares and Mt. Kenya provide water to the Tana and Athi rivers, central rift and northern drainage. Numerous streams from the above mountains catch a considerable flow from rainfall to form major rivers which have substantial flows through out the year. These rivers form significant water resources of the study area and the surroundings. The rivers include: Ewaso Nyiro, Chania, Amboni, Gura, Muringato, Karemano, Thuti and Moyok, all from the Aberdares and the Burguret, Naromoru, Nairobi, Thogo, Sagana and Ragati rivers from Mt. Kenya.

The most important rivers for this project are the Chania, Amboni and Nairobi. The Chania River is an excellent source of water for Nyeri with a major part of catchment above the existing intake comprising undisturbed montane forest, bamboo and moorland. The Nairobi River rises below the snow line on Mt. Kenya. Only about 10% of the catchment is forested. The remainder is mainly grazing land with substantial cultivation. Nairobi River suffers large flow fluctuations. It has close to nil flows during the dry periods. This is largely due to excessive upstream abstractions to maintain irrigation demand in Kieni East of Nyeri District.

The Amboni River like the Chania River originates from the Aberdares. It presently has a 98% daily reliable estimated at about 10,370 m³/day. The catchment has no more than 10% forest cover and the rest is a mixture of grazing land and cultivation. At present there are no large scale abstractions from the Amboni River. However, this situation is expected to soon change as the small and large scale farmers in Kieni West increasingly resort to irrigation to increase crop production.

3.6.2 Ground Water Resources

Although most of Nyeri is well endowed with surface water resources, the more arid areas of Kieni East and West have few permanent rivers while other water resources are seasonal and unevenly distributed. In these areas ground water resources exist and they present a reasonable potential for ground water abstraction through boreholes and shallow wells (Ayako 1995).

The ground water flows more or less in a south easterly direction from the high areas of Mt. Kenya and the Aberdares. Table 4 gives location and depth at which water is struck with yields of various boreholes in Nyeri District.

The borehole depth varies from 19 m to 235 m with 107 m as average depth. The depth of the aquifers also varies considerably with average depth being 103m. The groundwater yield varies from zero to 16 m³/hr while the average yield is 5 m³/hr. The quality of ground water is classified as good (NES, 1980).

Table 4: Examples of Boreholes and their Characteristics in Nyeri District.

Borehole	Locality	Total depth (m)	Aquifer/ Water struck	Yield m ³ /hr
467	Kagumo	152.4	46.6	3.18
574	Kagumo School	138.0	72	9.54
1140	Naromoru	122	98.15,118.8	1.27
1643	Muringato East	85	31-77	9.09
2387	Naromoru	128	102.1	6.62
3706	Tree Tops	152	54.9,73,129	5.6
4560	Mweiga	141	100-120	6.8
4577	Mweiga	141	3.0	3.64
119	Naromoru	72.2	64.6	10.45
185	Timau	75	86.86	3.5
373	Nanyuki	59	50.0	4.3
508	Solio	91.0	113,151,124	16.4
514	Kamburai	128	47	6.36
674	Nanyuki	69	64-76	1.1
1117	Mweiga	93.9	32.0-79.2	0.473
1164	Naromoru	92	33-35	2.6
4625	Ruringu	155	32	6.81
4629	Wangombe	200	(83-145 153-189)	6.8

Source: NES, 1980

3.7 Flora

The vegetation of the study area is composed of a wide range of plant species of which the most common are listed in Appendix 1.

Interaction of several factors including relief, rainfall patterns, geology, soils and human activities have determined the vegetation characteristics of the study area. Six broad vegetation categories have been identified in this area as shown in Fig 3. They include the following:

- afro-alpine vegetation
- mountain bamboo zone
- moist montane forest
- dry intermediate forest
- montane sclerophyll forest
- upland bushland

3.7.1 Afro-alpine Vegetation

The afro-alpine vegetation occurs above 3,350 masl on the highest reaches of Mt. Kenya and the Aberdares. This vegetation is very distinct from the vegetation of the lower zones. It has some remarkable growth forms and a very high percentage of endemic species, that is to say they occur nowhere else. It is mainly a tropical alpine moorland vegetation of *Senecio*, *Lobelia* as well as scrubby plants of the genera *Helichrysum* interspersed amid tussock grassland.

3.7.2 Mountain Bamboo Zone

Below the afro-alpine zone, is a prominent vegetation of bamboo thicket which occurs between 2,400 and 3,300 masl. The bamboo thicket is dominated by *Arundinaria alpina*, a member of *Gramineae* (grass family). Scattered trees of *Podocarpus latifolius* and *Nixia congesta* do emerge from the bamboo thicket in some areas.

3.7.3 Moist Montane Forest

The moist montane forests of the study area are mainly found to the southwest of Mt. Kenya and eastern Aberdares where the rainfall is in excess of 2,200 mm per annum and in the altitude range of 1,700 - 2,400 masl.

The forest is dominated by the *Cassipourea malosana* community. *Podocarpus latifolius* is common in the upper wetter reaches. Other trees include *Juniperus procera* and *Podocarpus falcatus*. In the lower wet areas, the forest is dominated by the broad-leaved trees of *Neoboutonia macrocalyx* and *Croton macrostachyus*, while *Albizia gummifera* is a common species.

Where heavy logging has taken place, there develops a secondary forest type dominated by *Olea capensis* and *Teclea nobilis*.

3.7.4 Dry Intermediate Forest

These are semi-deciduous forests occurring within the lower zones (1,300-2,000 masl) on the saddle between the Aberdares and Mt. Kenya. They are found in the neighbourhood of Nyeri where the rainfall ranges from 875 to 1,000 mm and the climate is equable and cool.

These drier forests are dominated by the trees of *Brachylaena huillensis*, *Croton megalocarpus* and *Calodendrum capense*. Other species include *Eleodendron bucharanii*, *Ekebergia capensis*, *Diospyros abyssinica*, and *Telea nobilis*.

The undergrowth ranges from dense shrubland containing *Hypoestes forskalii* and *Ocimum suave* to dense grassland containing occasional herbs.

3.7.5 Montane Sclerophyll Forest

This is the type of vegetation characteristic of drier montane regions to the north west of Mt. Kenya and north of Aberdares. In these areas the rainfall decreases due to the rainshadow effect. The trees are dominated by pencil cedar (*Juniperus procera*), a tree with xeromorphic leaves.

3.7.6 Upland Bushland

The upland bushland vegetation is prevalent to the north of study area and forms the dominant vegetation of Kieni East and Kieni West. The bushland plant community has been greatly influenced by fire, grazing pressure and cultivation. The dominant shrubs include *Ocimum suave*, *Hypoestes verticillaris*, *Toddalia asiatica*, *Dodonea viscosa*, and *Solanum incanum* among others. The major grasses are *Cynodon dactylon*, *Themeda triandra* and *Chloris gayana*. Where the area has been overgrazed the dominant grasses include *Pennisetum schimperi* and *Harpachne schimperi*.

3.7.7 Effect of Cultivation

The bulk of the natural vegetation as described above exists in the National Parks and Forests Reserves of Mt. Kenya and the Aberdares. In the rest of the areas much of the natural vegetation has been destroyed through cultivation and other human activities. What used to be extensive forest vegetation has now been replaced by large and small scale farms of coffee, tea, maize bananas, beans and other crops. In addition, many of the indigenous trees in the cultivated areas have now been replaced by exotic species including: *Eucalyptus saligna*, *Grevillea robusta*, *Pinus patula*, *Cupressus lusitanica*, *Acacia meamsii* and *Jacaranda similis*.

Only small remnants of natural vegetation remain interspersed among cultivated and settled areas. Within Nyeri Municipality, the natural vegetation is preserved in the Nyeri Hill, Nyeri (Kabiruni) Forest and Kiganjo Forest as shown in Fig 2. There are also narrow bands of natural riverine vegetation along Chania, Amboni and Nairobi rivers.

3.8 Fauna

A list of animal species found in the study area is contained in Appendix 2. Virtually all the animals are confined to the Forest Reserve and the National Parks of Mt. Kenya and the Aberdares.

The large herbivores are represented by elephant, buffalo and rhino. The bushbuck, waterbuck, reedbuck, eland and duiker can often be seen in areas ranging from forest up to the moorlands. The rare Bongo antelope may occasionally be seen in the Bamboo Zone. The Burchell's zebra is only found on the grasslands of the north.

The predators include the lions most of which have been introduced. In addition leopard, golden cat, civet, genet, the mongoose, wild cat and spotted hyena are common.

The primates which include the baboons, colobus, sykes monkey and bushbaby are found in the montane forest. Other animals present in the forest habitat include the giant forest hog, side striped jackal and the antbear.

The avian fauna include the river ducks, forest and moorland francolins, white-naped ravens, hill chats, alpine swift sunbirds, mountain buzzard, crowned eagle, hawk eagle, African goshawk and plovers.

The reptilian life is minimal and the most important is the Hinds mountain viper (*Vipera hindii*) a species regionally endemic to the Aberdares and Mt. Kenya moorlands.

The fish fauna are represented by the rainbow and brown trout which were introduced early in the twentieth century in the ice-cold streams and rivers of the Mt. Kenya and the Aberdares.

3.8.1 Species of Special Interest

Elephant

The elephant is a key agent in vegetation change. On Mt. Kenya and the Aberdares, elephants cause considerable deforestation and in some instances depletion of vegetation especially in artificial watering holes. Elephants venturing outside the park cause considerable damage to crops. This has prompted the erection of an electric fence in a section of the Aberdare National Park.

Rhinoceros

There has been dramatic decrease in recent years in the number of black rhinoceros both in its range and numbers in Kenya. The black rhinos were poached in all areas inside and outside the protected areas. The Kenya Wildlife Service (KWS) has embarked on a policy of translocation of black rhinoceros into specially protected areas called sanctuaries. The sanctuaries are enclosed by specially designed electric fences. The Aberdare National park is one of the Rhino Sanctuaries in the country.

Bongo Antelope

The study area especially the Aberdares and Mt. Kenya are perhaps the only strongholds of the Bongo in the world. In Kenya, the only other areas where Bongo is known to exist but in low numbers is the Cherangani Hills and the Mau summit. Although there are no accurate records of the bongo population, the numbers of this unique antelope are on the decline.

3.9 Land Tenure and Land Use

3.9.1 Land Tenure

There are three broad categories of land tenure in Nyeri district, government land, trust land and private land.

Government Land

This is the land that was designated as crown land during the colonial period. Also included in this category are the National Parks and Forest Reserves

Trust Land

Trust land consists of the former native reserves which were under effective occupation by the indigenous people. Also included in this category are the Game Reserves.

Private Land

Most of the land in the district is under private ownership (freehold). This is land alienated both from Government land and trust land to private ownership through land adjudication.

3.9.2 Land Use

Land use patterns in Nyeri District are determined by the climate and soil conditions of the area. The high altitude land above 2,400m asl is not utilized for agriculture. These are important areas set aside for Forest Reserves and National Parks. The rest of the land forms important areas for crop production and animal husbandry.

Forest Reserves

The forest reserves are mainly associated with the high altitude areas of Mt. Kenya and the Aberdares. The total areas of Mt. Kenya Forest Reserve stands at 78,985 ha. while the total area of the Aberdare Forest Reserve is 40,751 ha. The Forest Reserves are shared by other districts including Meru, Embu, Laikipia, Muranga and Nyandarua.

There are 103,651 ha of areas gazetted as forests in Nyeri District. In addition 4,000 ha represent non-gazetted forests which fall under County Council and private ownership.

National Parks

Both the Aberdare National Park (76,619 ha) and Mt. Kenya National Park (71,500 ha) are an important part of the natural heritage of Kenya. They also constitute areas of great scenic beauty and socio-economic value. In addition, they provide conservation to the unique biotic community (flora and fauna) of the Central Highland Natural Region of Kenya. The parks contribute considerably to the national economy in earning foreign exchange through tourism. For example, in 1991 the Aberdare National Park was visited by 60,336 people earning a revenue of Kshs.12.4 million to the Government.

Agriculture

The study area is covered by a variety of agro-ecological zones. An agro-ecological zone provides a frame-work for ecological land use potential. According to Jaetzold and Schmidt (1983), available agricultural land (excluding areas occupied by forest reserves and national parks) falls under three major agro-ecological zones as follows:

- Upper Highland Zone (UH)
- Upper Midland Zone (UM)
- Lower Highland Zone (UL)

Upper Highland Zone

The UH Zone occupies the areas next to the moist montane forests of Mt. Kenya and the Aberdares. The most important crops grown in this zone are tea, pyrethrum, potatoes, cabbage, carrots and peas. Sheep and dairy farming are important agricultural activities. Fruits such as plums, pears and apples are grown.

Upper Midland Zone (UM)

The UM Zone covers the southern side of the district. This area has the highest agricultural potential. The farmers in this zone produce the bulk of high value crops (coffee and tea) for commercial purposes. Other major agricultural activities include the growing of crops such as maize and beans, kale, cabbages. Fruits including the bananas, pawpaws, avocados, citrus and loquats are important produce of the area. Horticulture and dairy farming are also practiced in this region.

Lower Highland Zone (LH)

A large extent of LH zone is situated to the north. These are areas of lower potential than the zones described above. They are mainly used for large scale wheat/barley farming and ranching. Some of the large farms have now been subdivided into small holder plots and crop production is enhanced through irrigation. Important crops produced through irrigation include maize, beans, cabbages, carrots and kale.

3.10 Human Health

3.10.1 Human Diseases

A wide variety of diseases are commonly reported in Nyeri District. Table 5 shows the morbidity (incidence of illness) in the 1970s in this area. Gastroenteritis, malaria, measles, upper respiratory diseases, trachoma and gonorrhea were the most commonly reported diseases. The highest number of deaths occurred from gastroenteritis, measles, meningitis, upper respiratory diseases, dysentery and tetanus.

Table 6 shows monthly morbidity between July and October, 1995 at the Town Health Centre in the Nyeri Municipality. The common diseases are problems of the respiratory system, diseases of the skin including ulcers, intestinal worms, diarrhoea, urinary tract diseases and malaria.

Since the 1970's, there has been a remarkable decline in cases of measles. This reflects the success of Expanded Programme of Immunization (EPI)

Table 5 Nyeri District Human Disease Incidence

Diseases	1975		1976		1977		1978	
	C	D	C	D	C	D	C	D
Amoebiasis	191	-	70	1	225	1	18	1
Chicken pox varicella	491	-	350	-	1511	-	725	-
Gastroenteritis	647	55	3462	37	-	-	-	-
Gonorrhea	118	-	2000	-	5128	-	2432	-
Infectious hepatitis	18	1	15	3	18	5	9	-
Influenza	48	-	268	-	1326	-	372	-
Leprosy	1	-	-	-	-	-	-	-
Malaria	639	-	1441	-	50	2	2	-
Malaria clinical	-	-	-	-	4055	2	876	1
Measles	926	66	-	-	1932	48	1243	27
Meningitis	9	9	45	23	87	28	330	29
Mumps	104	-	238	-	2450	-	996	-
Pneumonia	136	8	702	-	8998	25	852	30
Poliomyelitis	7	-	2	-	23	4	1	-
Syphilis	1	1	143	-	98	-	3	-
U.R.T.I Upper Respiratory	8311	122	9484	141	-	-	-	-
U.R.T.I.	-	-	40464	143	-	-	13148	-
Taehia (tapeworm)	11	-	-	-	356	-	77	-
Tetanus	38	34	40	31	73	52	25	25
Trachoma	881	-	2360	-	3585	-	956	-
Tuberculosis(p)	116	-	196	24	222	26	165	18
Tuberculosis	9	-	3	2	9	5	-	-
Typhoid Fever	2	-	8	3	29	5	17	2
Whooping Cough	121	-	19	2	422	4	446	2
Anthrax	-	-	1074	45	-	-	-	-
Kala-azar	-	-	2	1	-	-	-	-
Dysentery	-	-	132	132	32	5	3	-
Encephalitis	-	-	-	-	13	2	-	-
Salmonellosis	-	-	-	-	1	-	2	2
Gastroenteritis	-	-	-	-	11417	20	3763	14

KEY: C - Cases

D - Deaths

Source: NES, 1980

Table 6. Monthly Return of Morbidity (July-Oct., 1995), at Town Health Centre, Nyeri

NO	DISEASE	JULY	AUG.	SEPT.	OCT.
1	Diarrhoea Diseases	56	258	51	16
2	Tuberculosis	-	-	-	-
3	Leprosy	-	-	-	-
4	Whooping cough	-	-	-	-
5	Meningitis	-	-	-	-
6	Tetanus	-	-	-	-
7	Poliomyelitis	-	-	-	-
8	Chicken pox	13	44	24	-
9	Measles	-	1	9	3
10	Infectious Hepatitis (Jaundice)	9	-	-	-
11	Mumps	13	30	68	53
12	Malaria	40	120	12	24
13	Gonorrhea	16	6	20	57
14	Urinary Tract Infections	32	190	-	-
15	Bilharzia (Schistosomiasis)	-	-	-	-
16	Intestinal worms	62	241	57	93
17	Malnutrition	-	-	-	-
18	Anaemia	-	-	12	14
19	Eye infections	-	27	-	-
20	Cataract	-	-	4	11

NYERI/EA

21	Ear Infections	-	17	-	-	-
22	Dis. of Circulatory System	-	3	621	462	-
23	Dis. of the Respiratory System	721	881	21	-	-
24	Pneumonia	-	104	5	-	-
25	Abortion	-	-	-	-	-
26	Dis. of Puerperium	16	12	-	-	-
27	Neoplasms	-	-	-	-	-
28	Dis. of Blood and Blood Forming Organs	-	-	-	-	-
29	Mental Disorders	-	8	9	-	-
30	Dental Disorders	-	-	42	90	-
31	Dis. of the skin (incl. ulcers)	9	610	8	-	-
32	Rheumatism, Joint pains etc.	13	-	-	-	-
33	Congenital Anomalies	-	-	-	-	-
34	Pyrexia of Unknown Origin (PUO)	-	-	1	-	-
35	Poisoning	-	34	34	32	-
36	Accidents	20	59	-	-	-
37		-	-	-	-	-
38		-	-	-	-	-
39		-	-	-	-	-
40	All other diseases	30	76	27	62	-

Source: Public Health Officer, Nyeri.

NYERI/EA

A recent survey by Ayako (1995) show that Nyeri District has relatively low morbidity with only 13.7% of population reporting being sick. This is attributed to spatial accessibility of health facilities with 94% of household being less than 8 km from the health facilities.

3.10.2 Infant Mortality

In 1969 the infant mortality rate for Nyeri District was 5.7%. This improved to 4.4% in 1979 and 3.5% in 1989. These figures are low when compared to the national average infant mortality rate of 6.2% (DDP, 1994-1996).

The low rates of infant mortality may be attributed to relatively high productivity levels and hence high household incomes. It is also attributed to the high immunization coverage levels among children and reduced distances to health services.

However, low infant mortality does not prevail in all the areas of the district. In Kieni East and Kieni West, infant mortality is rather high and probably exceeds the national average. These are areas of recent settlement and experience low income levels due to low productivity and persistent drought.

There are also pockets of high infant mortality rates in some parts of Othaya and Mukurweini Divisions due to heavy reliance on cash crops at the expense of necessary food crops.

3.10.3 Nutrition

Nyeri District has relatively high levels of nutrition. However, the two divisions of Kieni (Kieni West and Kieni East) have relatively high levels of malnutrition. These are marginal areas of low potential. Periods of prolonged drought are common, while land productivity and incomes are low.

Some high potential areas such as Tetu, Mukurweini and to a lesser extent in Othaya have relatively high levels of malnutrition compared to other divisions in the high potential areas. This is mainly due to heavy reliance on cash crops at the expense of essential food crops.

3.10.4 Rural and Urban Poor

Although there is paucity of data on the state of poverty in this area, trends over the last couple of years show that a class of poor people is on the increase. These are the people without a stable means of livelihood. Pockets of rural poor are to be found in the Kieni East and Kieni West. The people in this area at times have had to rely on famine relief assistance.

Other smaller pockets of rural poor can be traced in Ngorano Location in Mathira Division, Kiganjo and Gachika in Nyeri Municipality and Rutune in Mukurweini. These have also been recipients of famine relief.

The majority of urban poor can be found in the slums of Kiawara and Majengo in Nyeri Municipality. Although no actual data is available, the number of slum dwellers in the urban areas is on the increase.

3.10.5 Prevalence of HIV/AIDS

The first AIDS case in Nyeri was recognized in 1987. To date over 700 cases of AIDS have been reported with 80% of cases being in the age category of 20-44 years. This is the productive age group and constitutes the labour force in the country.

The Nyeri Municipality has the highest percentage (32%) of the known AIDS cases in the District. As a whole the incidence of HIV is higher in urban than in rural communities and the rate of infection is on the increase.

3.10.6 Status of Women

Three major areas of concern in relation to status of women are: job opportunities, school drop outs and adolescent mothers. The employment opportunities in rural areas have continued to decline forcing young women to move to towns in search of jobs. Many of the young women have been earning their living as housemaids in the districts major urban areas. There are however, now many women who have undertaken several income generating activities as they endeavour to become self reliant. The women groups have now grown from the level of home improvement to a level of entrepreneurship. Some of the activities carried out by women include: construction of water tanks, tree nurseries, posho mills, livestock keeping, agricultural activities, home economics, handicraft and brick-making.

The adolescent mothers and school drop-outs have been increasing in numbers over the years. Some of the young women get guidance and counselling from the Child Welfare Society of Kenya (Nyeri Branch). On a positive note, the use of contraceptives is increasing. In addition, the attendance of ante-natal clinics and family planning sessions have been increasing since 1989. This is an indication that women are increasingly accepting family planning practices leading to decreasing fertility rates. This has a net effect of reducing dependency and improving the women's welfare.

3.11 General Environmental Quality

Environmental problems common in the study area mainly stem from human activities including farming practices, exploitation of natural resources, urbanization and industrial development. In a few cases, wildlife may also contribute to environmental degradation. The nature of environmental problems can be grouped into the following categories:

- soil erosion and siltation
- cultivation and use of agro-chemicals
- deforestation
- mining
- industrial pollution
- animal damage

3.11.1 Soil Erosion and Siltation

Nyeri District does not seem to have serious soil erosion problems when compared to many other districts where soil conservation measures are not practiced in appreciable level. However, due to increasing population pressure on the existing land holdings, there is increasing human encroachment on areas of steep slopes and marginal lands. Consequently, over-cultivation, overstocking, forest clearing, burning and other human activities have interacted with resultant increase in soil erosion in some areas.

Sheet erosion caused by runoff and rain drop splash is the district's common soil loss. Hill and gully erosion are also prevalent. Heavy runoff, especially along roadsides eventually discharges into the farms, thereby causing sheet and gully erosion in the neighbouring farms.

The problem of soil erosion can be seen especially during the heavy rains when rivers like Amboni are brown and silt laden. Along the banks of Chania, Kamweiga and Amboni, land has been greatly disturbed due to quarrying activities which have accelerated gully erosion in the area.

Soil erosion in the study area is also worsened by road construction activities. Nyeri is a rugged district with steep gradients. Road construction activities often cut across the slopes thus disrupting natural contours and setting the stage for soil erosion.

A problem related to soil erosion is siltation. Eventually the sediments washed during the soil erosion increase the silt levels of the rivers. During the rainy season rivers like Amboni and Sagana show relatively high levels of silt. Much of this is derived from soil loss along the drainage basins. It has also been observed that several dams especially in Kieni Division have now silted up.

In order to arrest the situation, conservation measures have to be applied in the affected areas. According to Agriculture Act, it is forbidden to cultivate on slopes steeper than 38%. Slopes between 13 and 38% have to be terraced to prevent soil erosion. This Act needs to be enforced. Other ways of preventing soil erosion include planting of trees, mulching, planting cover crops, strip cropping and planting grass along contours.

3.11.2 Cultivation and Use of Agro-chemicals.

Human farming practices such as irrigation can have tremendous positive impacts in improving food security, raising living standards and creating employment opportunities, among others. In the low potential areas of Kieni, a total of 720 ha distributed over 37 group-based projects are currently under irrigation (DIU, 1994). This mode of farming has also created negative impacts as follows:

- increased incidence of water borne diseases
- increased soil erosion especially on steep slopes
- increased salinization
- increased contamination of water resources
- decreased water flows. downstream

Some of the chemicals like Dieldrin and DDT are highly potent against the insects. The above pesticides are also highly toxic to mammals, birds and fish. The pesticides also have great chemical stability and can persist for many decades in water and soils without undergoing any significant biodegradation. Hence their use presents significant pollution risk in the environment.

Aldrin and dieldrin have been banned in Kenya since 1986. The use of DDT is also severely restricted since that date.

3.11.3 Deforestation

Environmental degradation in the study area has also been caused by deforestation and lack of proper catchment protection. The forest reserves are protected and no cutting of trees is allowed except under unusual circumstances. Tree harvesting is usually carried out when trees are mature about 30 years of age. Nevertheless deforestation still occurs mainly due to forest fires, damage by wild animals, overgrazing and illegal felling of trees.

A significant agent of deforestation is the spread of fires started by poachers, charcoal burners, honey hunters and through accidents. In addition, the forest squatters who clear natural forests in preparation for exotic forest plantations (e.g. *Pinus patula*) are also the cause of forest fires. Deforestation through exploitation, indiscriminate burning or the cutting of trees leaves the soil bare and more vulnerable to erosion.

One of the trees critically affected by deforestation through exploitation in this area is the cedar (*Juniperus procera*). In 1989, the Director of Forestry issued a General Order No. 238 which prohibits any person to cut fell, remove, transport, possess, sell or otherwise deal with cedar without a written permit from Director of Forestry.

3.11.4 Industrial Pollution

Industrial pollution is not a significant threat to the environment in the study area. Only light industries are present in and around Nyeri Municipality. The most important are the Mount Kenya Bottling Company, Highlands Mineral Water Plant, Wananchi and Aberdares Saw Mills and the Kenya Cooperative Creameries Plant at Kiganjo.

Wastes from the coffee industry are a significant threat to the rivers and streams especially during the picking season. Notwithstanding commendable efforts by Ministry of Water Development during the late 1970's and early 1980's, the waste effluents from numerous coffee factories are again being dumped into the nearby streams during the cleaning process. The ponds designed to treat the coffee factory effluents are frequently inefficient. They are usually situated near river banks and during the rainy season, the ponds fill up and the pollutants are washed into the nearby rivers and streams.

In regard to the saw mill industries, the workers have poor working conditions. They are exposed to high levels of dust and noise from the wood cutting machines. Few if any protective covering is provided for the workers. Where the saw mills are wrongly sited, as in Kiawara, the saw dust causes blockage of the drainage system and becomes a health hazard.

3.11.5 Mining

The study area in particular and Nyeri District as a whole is not endowed with mineral resources of any substance apart from quarryable stones. It should be emphasized that extreme exploitation of this resource has resulted in significant degradation of the environment. Quarry mining is common among the river banks of the Chania, Kamweiga and Amboni rivers. Sand mining, a more recent activity is now taking place along the Nairobi river near Kiganjo.

Quarry and sand mining contribute enormously to increase in soil erosion with serious threat to the siltation of the nearby rivers. Some of the quarries are dangerous and have caused landslides albeit on local scale. The quarries are also a threat to human being life. During the period of this study two quarry miners were buried alive when a section of the quarry caved in at the Thunguma Quarry just below Nyeri Sewage Treatment Works.

3.11.6 Wildlife Damage

Two animal species, the lion and the elephant have potential to cause profound changes in the plant and animal community structure of the National Parks and the surrounding areas.

Lion

The lion population in the Aberdare National park is believed to have increased considerably although no scientific counts have been done. The increase in lion population is suspected to have affected the numbers and the distribution of herbivore species such as eland, buffalo, waterbuck and bushbuck among others.

Elephant

The elephant is a key agent in vegetation change. Elephants cause considerable deforestation and in some instances depletion of vegetation through debarking and trampling. The effect is much more pronounced around artificial watering holes and salt licks.

Elephants venturing outside the park and forest reserves cause considerable damage to crops. Damage to crops by elephants and buffaloes has been reported in several locations in the study area. This has prompted KWS to erect an electric fence round part of the Aberdare National Park commonly referred to as the Salient.

3.12 Environmental Problems Prevalent in the Project Area

The above discussion in Section 3.11 mainly covers the general environmental conditions of the study area. Although some of these problems will definitely affect the Municipality, the present section 3.12 focuses in more detail the unique environmental problems characteristic of Nyeri Municipality. These problems are more likely to have a greater impact on the water supply project either directly or indirectly.

Table 8. shows the environmental "hot spots" of the Nyeri Municipality depicting the nature of the problem and the location where it is prevalent. The common environmental problems of the Municipality are mainly associated with:

- Soil erosion and siltation
- Pollution
- Sanitation
- Disposal of wastes

Table 8 Environmental Hot Spots in Nyeri Municipality

Location	Nature of Environmental Problem
Council Markets (Soko Mjinga, Mali Rahisi and Bus Park Market)	uncollected garbage poor sanitation poor drainage poor refuse management scattered litter
Town Centre	general pollution burning of tyres oil pollution poor sanitation poor drainage scattered litter and metal inadequate public toilets exhaust fumes
Blue Valley/Majengo	uncollected garbage blocked drains poor sanitation presence of Municipal Dump dump scavengers leachates from the dump overflowing septic tanks poor housing soil erosion poor vegetation cover scattered litter open drains
Kiawara	urban poverty damaged open drains poor housing poor sanitation saw dust pollution poor vegetation cover soil erosion
Along the Chania	quarrying activities soil erosion and siltation municipal effluents and storm water inflow of effluents from drains emanating from Blue Valley/Majengo/Kiawara inflow of effluents from slaughter house inflow of effluents from coffee factories unplanned settlements at the Valley bottom Cultivation in the riparian reserve inflow of treated effluents from Municipal Sewage Treatment Works

3.12.1 Soil Erosion and Siltation

Soil erosion is mainly caused by human activities associated with the cultivation and exploitation of resources in areas with steep slopes. This problem is much more pronounced in the rainy season.

Soil erosion is much more prevalent along the Chania River, Kingongo and the Nyeri Hill. Cultivation in the riparian reserve along the Chania river banks causes soil erosion and the subsequent siltation of the river. This situation is aggravated by grazing in the riparian reserve and the unplanned settlements in the valley bottom next to Kiawara.

The banks of the Chania River in Kangemi and Thunguma are greatly degraded due to quarrying activities. This has accelerated gully erosion in this area. In addition, the loosened earth is washed into the river thereby causing siltation.

Farming along the Nyeri Hill slopes presents a potential cause of soil erosion in this levels. The land is not terraced and the people have not adopted adequate soil conservation strategies. Although the area in Kingongo along the Chania River is terraced, the lack of adequate vegetation cover may soon stimulate sheet and gully soil erosion processes and the subsequent siltation of the river.

3.12.2 Pollution

Nyeri has only light industries and hence levels of industrial pollution are rather low. The major sources of pollution emanate from coffee wastes and domestic sewage effluents. Kenya Cooperative Creameries produce a strong effluent which is channeled into Municipal Sewerage system at Kiganjo for treatment. Coffee wastes contributes significantly to the levels of pollution on the nearby rivers especially during the picking season. Hill Farm along the Muringato River has been a source of pollution to the river for a long time. At present, however, the management has constructed four 5 x 50m ponds which are used for the treatment of coffee effluents before it is channeled to the receiving Muringato River.

Although the sewage treatment works at Kangemi seem to be working perfectly well, the effluent from maturation ponds has high coliform counts. The downstream users draw raw water 100 km from where the treated sewage effluent joins the Chania River. This may present a health hazard to the downstream population especially as the efficiency of the tertiary waste stabilisation ponds of the treatment works is low.

The situation may be worse in the stretch of Chania River which borders Majengo and Kiawara. Behind these estates there is an open drainage system which carries sewage (probably from spilling septic tanks) and other domestic wastes.

This drainage system also receives effluents from the Municipal slaughter house.

The effluents from the above drainage collect behind Kiawara and form a small wetland with luxuriant vegetation. Eventually the effluents pass through a banana plantation and empty into the Chania River.

3.12.3 Sanitation

Most of rural households in Nyeri have good sanitation with 99% of them owning a toilet. However, only very few (3%) of households have a ventilated improved pit (VIP) latrine (Ayako 1995). This situation also applies for the rural section of the Nyeri Municipality.

Nearly three quarter of premises in the urban Municipality are served by either pit latrines or septic tanks. The rest of the premises are connected to the municipal sewer system or have private sewage works.

On the whole, the condition of the pit latrines and septic tanks is satisfactory. However, in some areas where the Community share WC toilets, the pans are full and at times blocked or broken and filthy. In some cases the water system is discontinued. These are very unhygienic conditions which present a healthy risk to the community. The constant shortage of water adds to the problem of keeping the toilets clean.

The Municipal public toilet facilities are grossly inadequate. At present there are only five toilets four of which are located in the busparks and the Municipal markets. The situation is so critical that a section of community has resulted to using certain open space areas for urinating and defaecation purposes. One of such sites is situated behind the Nandi flame tree at the gate of the Town Hall!

3.12.4 Disposal of Wastes

Waste disposal mechanisms vary depending on facilities for disposal processes. In rural areas of the Municipality domestic wastes are normally thrown into cattle bomas or compost pits for conversion into manure and later used in the shambas. Pit latrines are commonly used for the disposal of human faeces.

In the urban areas of the Municipality, waste disposal is a major concern. Three major types of wastes emanate from the urban areas. These are:

- solid wastes
- domestic effluents
- industrial effluents

3.12.4.1 Solid Wastes

The composition of solid wastes is heterogeneous but mainly comprise the following material:

paper
plastic material
broken glassware
metallic cans and objects
tyres
textile
polythene material
fruit and vegetable remains

Solid waste disposal is a major problem for the Nyeri Municipality. This is mainly due to poor waste management practices, inadequate facilities and the unsatisfactory locations of the existing dumps.

Nyeri Municipality produces close to 20,000 metric tons of garbage per year. Most of the solid waste produced in industrial and residential areas is dumped in heaps along the roads and in certain designated areas for collection by the Municipal vehicles.

There are few dustbins and other receptacles. Collection of garbage is irregular and in many cases occasional. The management of the garbage collection vehicles and the supervision of workforce is sub-optimal. All the above factors culminate in the low efficiency of garbage collection prevalent in the Municipality.

Once collected the garbage is dumped on the Municipal dumping sites at the Blue Valley or Kangemi dump. For a long time, dumping has been done at the Blue Valley. This dump is located in a site very close to a steep gradient leading to Chania River. Due to the close proximity to the river, the leachates from the dump, especially during the wet season, drain into Chania River. This poses a potential health risk to human beings and animals downstream. The dump at the Blue Valley was condemned by the District Environmental Management Committee in February 1995. This site is still being used for dumping albeit occasionally.

Following the condemnation of the dump, the Municipal Council identified a new dumping site near the Nyeri Sewage Treatment Works at Kangemi. This dump is an old disused quarry. Like the dump in the Blue Valley it is also situated close to River Chania on a steep gradient. Leachate from the dump is likely to pollute the Chania River especially during the rainy season.

The dump is also situated in close proximity to the Municipal staff houses. The dump therefore poses a health hazard to the neighbourhood from flies, vermin such as rats, dust and smoke emanating from the dumping site. In addition, the dump produces a stench which becomes a nuisance to the people living in the neighbourhood.

Although the dumping site is better than the old dump at the Blue Valley the use of the new site is considered inappropriate on the above grounds and this has been communicated to the senior officers of the Municipality including the Municipal Engineer, the Town Clerk and the Mayor. Following discussions between the Consultant and the above Council Officials, a new dumping site was proposed in the Nyeri (Kabiruini) Forest. The suitability of this new location as a sustainable dumping site was therefore investigated.

The Proposed Dumping Site

The proposed site at Kabiruini will form a far better dump than either the Blue Valley or the Kangemi dumps. The Kabiruini disused quarries are located in an undulating landscape far away from the Kamweiga stream a tributary of Muringato. It is very unlikely that the leachates from the dump will ever reach the waters of Kamweiga stream. The quarries are located far from any human habitation. There will be no health risks associated with the proposed dumping facility.

The quarries are, however, overgrown with vegetation and in many places filled with stone chips, rock and earth debris. They will require to be cleared and the quarries transformed into a sanitary landfill.

Sanitary landfills are probably the most widely used means of normal solid waste disposal. The method is simple, requires little or no capital expenditure (apart from transportation costs) and has no environmental risk. In addition, it does not require any special expertise.

3.12.4.2 Sewage Effluents

Sewage effluent generated by the Nyeri Municipality is basically domestic sewage as the level of industrial development is quite low. Effluent from Kenya Cooperative Creameries, however, adds a significant contribution of milk products which increases the sewage BOD levels.

The sewage produced in the Municipality is treated at the sewage treatment works of Nyeri at Kangemi and Kiganjo Sewage Works. Analysis carried out during this study has revealed a very strong effluent from the KCC milk plant. The results of the analysis (Table 9) show very high values of BOD₅ (1,740 mg/l) COD (3,584 mg/l) and Permanganate Value (166 mg/l). The effluent from KCC requires pre-treatment before it is conveyed to the Municipal Waste Stabilisation Sewage Works. At present the form of "Pre-treatment" which involves grease stripping is grossly inadequate.

The Nyeri Sewage Works involve both physical and biological components of sewage treatment. The physical treatment involves screening, grit removal and settlement. The biological treatment involve the application of trickling filters and finally maturation ponds. Aerobic sludge digesters and sludge drying beds are also employed in the works. The effluent from the maturation ponds is channeled into the Chania River.

Kiganjo Sewage Works are located in two separate locations. In the first location, physical treatment including coarse and fine screening and grit removal is done. Thereafter the sewage is pumped into the main sewage works. The main sewage work consists of two parallel system of ponds, each stream having one anaerobic, two facultative and one maturation pond all in series. The effluents from the maturation ponds is conveyed into the Nairobi River.

Results of chemical and bacteriological analysis of the Nyeri and Kiganjo sewage is presented in Tables 9 and 10. The raw sewage is very strong considering its largely domestic origin. The values of BOD₅ for Nyeri sewage range from 685-1,270 mg/l compared to the American and British raw sewage BOD₅ values of 200 mg/l (Harworth, 1984). Mombasa sewage from Kiambeni Estate was found to have a BOD₅ value of 160 mg/l (Gov. Chemist, 1988).

Table 9: Chemical and bacteriological analysis of domestic and industrial effluents

PARAMETER	UNITS	NYERI SEWAGE WORKS (Influent Sewage)	Nyeri Sewage Works (Treated Effluent)	Kiganjo Sewage Works (Influent Sewage)	Kiganjo Sewage Works (Treated Effluent)	KCC-Plant Effluent	Mt. Kenya Bottling Co. (Treated Effluent)
pH		6.5	8.9	6.6	8.4	5.8	11.1
Suspended solids	mg/l	42	15	54	20.0	71.0	26.0
Biochemical Oxygen Demand (BOD ₅)	"	685	100	800	20	1740	376
Chemical Oxygen Demand (COD)	"	2867	184	1331	307	3584	1229
Permanganate value	"	233	5.8	46.8	12	166	22.8
Nitrate	"	Nil	0.25	Nil	0.02	Nil	Nil
Nitrate	"	Nil	0.06	Nil	Trace	Nil	Nil
Free and Saline Ammonia	"	214	0.02	91.0	3.2	248.3	0.04
Albuminoid Ammonia	"	Nil	Nil	Nil	Nil	Nil	Nil
Coliform Count	cells/100 ml water	1800	35	1800	1800	31	14
E coli Count	Cells/100 ml water	1	Nil	29	1800	29	Nil

Source: Present Study, Field Investigations

INTERVIEW

Table 10: Characteristics of Waste Waters in Nyeri and Kiganjo Treatment Works 9 Feb., 1995)

SOURCE OF WASTE WATER	PARAMETERS ANALYSED				
	BOD ₅ (mg/l)	COD (mg/l)	Suspended solids (mg/l)	Total coliforms/100ml	E. coli/100 ml
Nyeri Sewage (Influent)	1020 (morning) 900	1360 (morning) 1200	760 (morning) 320	360,000	195,000
Nyeri Sewage (Effluent)	48 (morning) 70 (mid-day)	64 (morning) 88 (mid-day)	20 (morning) 50 (mid-day)	270,000	134,000
Kiganjo Sewage (Influent)	1270	1696	240	350,000	170,000
Kiganjo Sewage (Effluent)	90	120	60	230,000	127,000

Source: HP Gauff Report, July 1995

INTERVIEW

The sewage treatment works both at Nyeri and Kiganjo seem to be operating at sub-optimal levels. In many developing countries, elaborate guidelines on effluent standards do not exist. However, as a general guide, the following minimum effluent standards (Mara, 1978) should be adopted before the effluent is discharged into the natural river such as Chania and Nairobi:

BOD₅ - <25 mg/l
Faecal Coliforms - < 500/100 ml
Algae <10⁵ cells/ml

The sewage effluents both from Nyeri and Kiganjo have higher values of BOD₅ and Coliform than the values recommended above. As they are both operating well below their design capacities, this is somewhat surprising. The sewage effluents from the two treatment works need to be improved to conform to the above standards.

3.13 Water Quality

In regard to the quality of the natural waters of the study area, a large number of water samples from Chania, Amboni, Nairobi and Sagana rivers were investigated for both chemical and bacteriological quality, during the present study.

3.13.1 Chemical Quality

Samples for chemical analysis were collected in clean plastic containers and transported in cool boxes to Nairobi. Analysis was conducted by the Government Chemist, Nairobi. The results are presented in Table 11, Table 12, and Appendix 4-10.

With regard to the water supply project, the surface waters of the study area are of excellent chemical quality. These are acidic to neutral (pH 6.5 - 7.9) waters of low to moderate alkalinity 8-36 mg/l). Water salinity is low (20-100 mS/cm). Levels of fluorides and nitrates (substances that are detrimental to human beings in high concentrations are much lower than the recommended maximum desirable levels by GOK/WHO (Table 13). Several samples are turbid. This is expected since the samples were taken during a rainy period.

Some rivers like Amboni, Nairobi and Sagana contain iron levels (0.7-7.4 mg/l) above the maximum limits (0.3) recommended by either WHO or GOK. However, none of the surface waters contain levels of other substances that may require any special treatment over and above the conventional treatment of flocculation, coagulation filtration and disinfection.

Parameter	Units	Chania River, Chania Falls, Akrotiri National Park	Chania River, below Zaina F. confluence, Maymyun	Chania River, at Thma gravity intake	Chania River, at pumping intake	Naxos River, at Nyerli	Chania River, just below old Sewage Treatment Works	Chania River, just below Nyerli Sewage T. Works	Amthol River, at gauging station, Ark Road	Amthol River, at Nyerli Kigapio Road	Naxos River, at bankside zone, Mt Kenya Forest	Naxos River, at Lusoli Primary School	Naxos River, at intake confluence with Nyerli River, at Naxos	Sagana River near Nyerli at Naxos	Sagana River at Marua close to Kaduna/Nyerli Bridge	
Colour	Hazen	49.0	30.0	40.0	45.0	30.0	10.0	10.0	30.0	20.0	10.0	180.0	500.0	180.0	70.0	60.0
Deposit		none	debris	silt	silt	silt	silt	silt	silt	debris	silt	silt	silt	silt	silt	silt
Taste		none	none	-	-	-	-	-	-	-	-	-	-	-	-	-
pH		6.5	6.8	6.4	6.8	6.6	7.9	6.6	7.0	7.0	7.4	6.5	6.7	very	6.8	6.8
Turbidity		clear	clear	clear	clear	slight	turbid	clear	slight	nil	nil	slight	turbid	turbid	turbid	turbid
Odour	TON	none	none	none	none	none	none	none	none	none	none	none	none	none	none	none
Electrical Conductivity at 25°C	uS/cm	23.0	20.0	34.0	29.0	29.5	32.0	39.0	55.5	100.0	20.0	34.0	59.0	41.0	59.0	63.0
Total Hardness as CaCO3	mg/l	14.0	12.0	22.0	20.0	16.0	16.0	14.0	8.0	30.0	36.0	8.0	14.0	28.0	24.0	22.0
Total Alkalinity as CaCO3	mg/l	nil	nil	nil	nil	nil	nil	nil	nil	nil	nil	nil	nil	nil	nil	nil
Phenolphthalein (CO3)-	mg/l	14.0	12.0	22.0	20.0	12.0	16.0	14.0	8.0	30.0	36.0	8.0	14.0	28.0	24.0	22.0
Methyl Orange (HCO3)-	mg/l	2.0	2.0	3.0	2.0	4.0	1.0	2.0	0.5	4.0	3.0	4.0	4.0	3.0	3.0	3.0
Chloride (Cl)-	mg/l	5.0	5.0	5.0	7.0	trace	0.3	0.5	10.0	nil	nil	3.5	3.0	2.0	2.0	0.2
Sulphate (SO4)-	mg/l	nil	nil	nil	nil	nil	trace	trace	nil	nil	nil	nil	nil	trace	0.6	trace
Nitrate (NO3)-	mg/l	nil	nil	nil	nil	nil	nil	nil	nil	trace	nil	nil	nil	nil	nil	nil
Nitrite (CO2)-	mg/l	nil	nil	nil	nil	nil	nil	nil	nil	nil	nil	nil	nil	nil	nil	nil
Fluoride (F)-	mg/l	0.2	0.1	0.2	0.2	nil	0.2	0.1	0.4	0.2	0.1	0.3	1.2	0.4	0.1	0.1
Total Anions	mg/l	1.9	1.6	2.8	2.4	2.7	2.8	3.2	5.8	7.0	2.7	4.1	9.5	6.1	6.6	6.0
Sodium (Na)+	mg/l	1.3	1.1	1.7	1.6	1.7	2.0	2.2	2.3	3.6	1.7	2.9	5.7	3.6	3.7	3.2
Potassium (K)+	mg/l	3.2	2.4	3.2	2.4	3.2	3.2	4.4	5.6	6.0	1.6	2.4	4.0	3.2	4.0	5.2
Calcium (Ca)++	mg/l	0.5	0.5	1.4	1.0	1.4	nil	1.4	1.0	1.9	2.2	nil	1.0	0.5	0.8	1.2
Magnesium (Mg)++	mg/l	0.1	0.17	0.1	0.1	0.2	0.09	0.1	1.0	0.83	0.02	0.7	7.4	2.4	1.5	1.5
Iron (Total)(Fe)+++	mg/l	0.03	0.03	0.01	trace	trace	trace	nil	0.02	0.01	0.003	nil	0.03	0.02	0.01	trace
Manganese (Mn)++	mg/l	nil	nil	nil	nil	nil	0.2	0.3	nil	nil	nil	nil	nil	nil	0.1	0.1
Ammonia free & Saline (NH4)+	mg/l	nil	nil	nil	nil	nil	nil	0.2	0.3	nil	nil	nil	nil	nil	nil	nil
Ammonia Albuminoid (NH3)+	mg/l	nil	nil	nil	nil	nil	nil	-	-	-	-	-	-	-	-	-
Lead, Copper, Zinc (Pb Cu Zn)	mg/l	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total Cations	mg/l	10.0	8.0	14.0	12.0	12.0	8.8	14.0	8.0	22.0	24.0	4.0	10.0	12.0	10.0	20.0
Carbonate Hardness (CaCO3)	mg/l	nil	nil	nil	nil	nil	nil	nil	7.0	nil	nil	nil	12.0	10.0	15.0	20.0
Non Carbonate Hardness (CaCO3)	mg/l	10.0	8.0	14.0	12.0	8.0	14.0	15.0	22.0	24.0	4.0	10.0	12.0	10.0	15.0	20.0
Total Hardness as CaCO3	mg/l	23.0	6.0	22.0	5.0	18.0	2.0	6.0	4.0	8.0	3.0	23.0	6.0	30.0	6.0	6.0
Free Carbon Dioxide (CO2)	mg/l	10.0	20.0	16.0	16.0	20.0	10.0	20.0	22.0	25.0	30.0	24.0	30.0	22.0	25.0	25.0
Silica (SiO2)	mg/l	2.9	3.9	2.65	2.35	2.3	1.95	2.9	3.1	3.5	2.3	3.65	9.25	5.3	5.0	3.9
Oxygen absorbed, 4hr at 27°C (P.V.)	mg/l															
Total dissolved solids, residue dried at 180°C	mg/l	18.0	14.0	24.0	19.5	20.5	22.0	27.0	30.0	38.5	70.0	14.0	41.0	29.0	41.5	45.0
Coliform count (cells) /100 ml	/100 ml	900	500	1,600	1,800	1,800	61	>1,800	>1,800	>1,800	57	1,800	41	1,800	425	1,800
Cell count (cells) /100 ml	/100 ml	16	6	45	1,800	1,800	5	1,800	1,800	2	51	5	29	1,600	6	1,800

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Table 12: Chemical and Bacteriological analysis of treated (river) water

PARAMETER	UNIT	KAMAKWA TREATMENT WORKS	KIGANJO TREATMENT WORKS	TAP WATER AT THE KIGANJO SEWAGE TREATMENT WORKS	TAP WATER AT THE KIRICHO TOWN	TAP WATER AT GREEN HILLS HOTEL
Colour	Hazen Units	10	150	170	5.0	< 5
Deposit		Silt	Silt	Silt	None	Silt
Taste		-	-	-	-	-
pH		7.1	6.3	5.9	5.9	7.3
Turbidity	JTUs	Clear	Turbid	Turbid	Slightly Turbid	Clear
Odour	TON	None	None	None	None	None
Electrical Conductivity at 75°C	MS/cm	52	110	83	110	47.0
Total Alkalinity as CaCO ₃	mg/L	10.0	10.0	12.0	8.0	10.0
Phenolphthalein (CO ₃)=	"	Nil	Nil	Nil	Nil	Nil
Methyl Orange (CO ₃)=	"	10.0	10.0	12.0	8.0	10.0
Chloride (Cl)-	"	4.0	6.0	2.0	3.0	2.0
Sulphate (SO ₄)=	"	10.0	31.0	33.0	0.2	Nil
Nitrate (SO ₃)=	"	Nil	Nil	Nil	0.4	Trace
Nitrite (NO ₂)=	"	Nil	Nil	Nil	Nil	Nil
Fluoride (F)-	"	0.3	0.3	0.4	0.10	0.1
Total Anions	"					
Sodium (Na)+	"	3.2	9.7	9.9	8.5	3.2
Potassium (K)+	"	1.9	4.4	4.5	3.9	1.7

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Calcium (Ca)++	"	4.0	7.2	4.0	7.2	4.0
Magnesium (Mg)++	"	1.0	1.4	1.0	1.4	1.0
Iron (Total) (Fe)+++	"	0.06	0.6	1.0	0.6	0.01
Manganese (Mn)++	"	0.01	0.06	0.05	0.10	0.02
Ammonia- Free & Saline (NH ₃) ₊	"	Nil	Nil	Nil	0.10	Nil
Ammonia- Albuminoid (NH ₃) ₊	"	Nil	Nil	Nil	Nil	Nil
(Ph Cu Zn)	"	-	-	-	-	-
Total Cations	"					
Carbonate Hardness as (CaCO ₃)	"	14.0	24.0	14.0	8.0	10.0
Non Carbonate Hardness as (CaCO ₃)	"	Nil	Nil	Nil	16.0	4.0
Total Hardness as (CaCO ₃)	"	14.0	24.0	14.0	24.0	14.0
Free Carbon Dioxide	"	4.0	6.0	30.0	7.0	7.0
Silica (SiO ₂)	"	20.0	20.0	20.0	10.0	20.0
Oxygen absorbed 4hr at 27°C (P.V)	"	0.7	1.15	1.45	1.50	0.5
Total Dissolve Solids, residue drive at 180°C	"	36.0	80.0	59.5	75.0	33.0
Coliform Count	Cells/100ml water	Nil	Nil	55	17	Nil
E Coli Count	Cell/100ml water	Nil	Nil	55	2	Nil

Source: Present Study Field Investigation

3.13.2 Bacteriological Quality

Water samples for bacteriological analysis were collected in sterile specimen bottles and transported in cool boxes to Nairobi. Analysis for coliform bacteria and *Escherichia coli* was done at the National Public Health Laboratory Services, Nairobi.

Coliform bacteria are usually used as indicator organisms for bacteriological water quality. Coliform counts of 0-25 cells per 100ml water indicates good drinking water. When the coliform counts rise above 25 per 100 ml or *Escherichia coli* is present, the water is considered unsatisfactory for drinking purposes.

Results of bacteriological analysis (Table 11) reveal that all the surface waters in the study area are contaminated with bacteria of faecal origin. The waters are therefore unsatisfactory for drinking purposes unless treated.

It was interesting to find that water samples collected from waters in areas beyond the human habitation (Aberdare National Park and Mt. Kenya Forest) were also contaminated with coliform and *E. coli*. The origin of the coliforms in this case is attributed to contamination by animal faecal material.

During the present investigation bacteriological analysis of waters from Kamakwa and Kiganjo Water Treatment Works showed nil counts of coliforms and *E. coli*. The water was highly satisfactory.

Tap water sample at the Green Hills Hotel showed no coliforms and *E. coli*. However, tap water sampled in Mr. Kaberia's House at the Kiganjo Sewage Treatment Works revealed high counts of coliforms and *E. coli* (Appendix 7). Similarly tap water sampled at Kirichu Market showed some contamination through leakage albeit at low levels. Similar results were reported by the Ministry of Water Development, Water Testing Laboratory (Appendix 7). Presence of coliforms in tap water indicates that water is either not effectively disinfected or there is contamination during the distribution.

4. PROJECT DESCRIPTION

The present major source of water for Nyeri Municipality is the Chania River which has its headwaters on the Aberdare Range. The Chania has a 98% daily reliable flow of 27,560 m³/day. The present source of water for Kiganjo is the Nairobi River which originates from Mt. Kenya. The water flow in Nairobi river is unreliable due to high levels of upstream abstractions which almost dries the river in the dry season.

The Nyeri Municipality operates two water supply systems, one serving the town centre and the surrounding areas of Kamakwa and the other at Kiganjo. The two water supplies have a daily production rates of 5.5 million litres at Kamakwa and 1.1 million at Kiganjo Water Treatment Works. The above quantities are only able to meet some of the Town's daily water demands estimated at 11.0 million litres for Nyeri Town and 3.0 million litres for Kiganjo. The aim of this project is to complete a feasibility study on the extension of the Nyeri Water Supply, possibly including Kiganjo in order to meet the above projected water supply demand.

It should be noted that at this pre- feasibility stage a final project has not been selected, although the various options and alternatives are known. In order to meet the demand for the water supply it is anticipated that the following activities will be carried out:

- uprating of water intake(s)
- construction of new intakes/expansion of reservoirs at present intake
- reinforcement of water distribution system
- expansion and rezoning of water distribution system
- rehabilitation and expansion of water treatment works
- construction of new treatment work(s)
- rehabilitation of sewage treatment works

In addition, to the above components, alternatives anticipate the use of Amboni River for water supply to Kiganjo or the use of Chania River for supply to both Nyeri and Kiganjo town.

In connection with new source of water for Kiganjo, Amboni River flowing from the Aberdares has a more reliable source of water than Nairobi River which has close to zero flow in the dry seasons due to upstream abstractions. In this regard Amboni River has a 98% daily reliable flow of about 10,370 m³/day.

The following observations about this river need to be noted. At present there are no large scale abstractions from the Amboni River. This situation may soon change as the small scale farmers and large scale farmers in Kieni are now increasingly resulting to irrigation to increase the land productivity. The Gatarakwa scheme is now involved in preparations for the Gatarakwa water supply and they have already constructed an intake facility in the headwaters of Amboni in Aberdare National Park. Other water schemes planned to abstract water from Amboni River are:

- Kanuna Irrigation Project
- Dathi-ini Irrigation Project

- Nyaribo Water Supply

In addition there will be individual farmers who will also be involved in abstraction of water either for domestic requirements or for irrigation. If the abstraction trend continues, the Amboni River dry season flow could be reduced to levels comparable to Nairobi River in a decade or so. Hence any water supply developed from Amboni River may be a short-term measure unless a reservoir to moderate dry season flow is planned. Otherwise the long-term solution for Kiganjo water supply probably lies with the Chania River. This will involve the construction of water trunk main from Nyeri Town to Kiganjo. Such a project is likely to have significant environmental impacts in the study area.

5. ASSESSMENT OF POSITIVE ENVIRONMENTAL IMPACTS

A major positive impact of an enhanced treated water supply in Nyeri will be the improvement in health conditions and sanitation especially in regard to the transmission of water-borne diseases.

Bacteriological examination in this study has shown high coliform counts in all the surface waters of the study area (Table 11). When coliform bacteria are found in water, it indicates fairly fresh faecal contamination. On that basis there is a possibility of presence of pathogenic bacteria and virus including organisms that cause water borne diseases. These results have serious health implications in the project area.

The principal human diseases that can be transmitted by water and their causative agents are listed below:

<u>Pathogen</u>	<u>Diseases</u>
a. Bacteria	
<i>Vibrio cholerae</i>	Cholera
<i>Escherichia coli</i>	Gastroenteritis
<i>Salmonella typhimurium</i>	Typhoid
<i>Shigella</i> spp. (<i>dysenteriae</i> , <i>flexneri</i> , <i>boydii</i> and <i>sonnei</i>)	Shigellosis (bacillary dysentery)
b. Protozoa	
<i>Eutamoeba histolytica</i>	Amoebic dysentery (amoebiasis)
c. Virus	
<i>Poliovirus</i>	Poliomyelitis
d. Helminths	
<i>Schistosoma</i> spp. (<i>haematobium mansonii</i> and <i>japonica</i>)	Schistosomiasis
<i>Ascaris lumbricoides</i>	Ascariasis (round worm)
<i>Ancylostoma</i>	Ancylostomiasis (hookworm)

It should be emphasized that a great proportion of rural population is not served with treated water. Even within the Municipality there are sections of community who do not get treated water and have to depend on the river water for their washing and domestic requirements. It is these people who are more prone to contracting water-borne diseases.

A wide range of diseases in this area are shown in Tables 5 and 6. Out of this list the water-borne diseases in this area include gastroenteritis, dysentery, intestinal worms and poliomyelitis. The water-borne diseases contribute significantly to the cause of morbidity in the District. Although a quantitative link between water supply and the incidence and intensity of water borne diseases is not established, enhancing the treated water supply is definitely a prerequisite for the reduction of water-borne diseases in the area.

Provision of water supply alone will not be sufficient to mitigate the incidence of water-borne diseases. Other factors including the use of water, storage, sanitation, personal habits, cultural beliefs and attitudes also contribute to the spread of water-borne diseases.

Hygiene education, improved sanitation, disposal of wastes and increase in health awareness are other essential inputs in the control of water-borne diseases.

6. ASSESSMENT OF NEGATIVE ENVIRONMENTAL IMPACTS

It should be noted that this project is in the initial stages of development. In assessing the impacts of the water supply, the Consultant does not have the benefit of reviewing the project designs or detailed plans that will take place in the study area. Negative impacts of this project may arise due to the modifications to the intakes, construction of a new intakes, operation of the treatment works and the impacts arising from transmission pipe lines.

6.1 Impacts Related to Project Location

At present the Nyeri Town water supply is based on the gravity and pumped intakes from the Chania River. This is an excellent water source for Nyeri since the major part of Chania catchment comprises undisturbed forest, bamboo and the moorland of the Aberdares.

In contrast the present source of Kiganjo water supply from Nairobi River is inadequate. During the dry season, Nairobi River has close to zero flow due to upstream abstractions. In this case the Amboni River could provide an alternative source of water for Kiganjo. This, however, may be a short-term solution. It is anticipated that more abstractions will be made on Amboni in future. Eventually the dry season flows in Amboni will be reduced to comparable levels to those prevailing in Nairobi River. Hence the long-term solution to Kiganjo water supply will depend on the Chania River.

For long-term strategic planning it may be necessary to impound wet weather flows of the Chania River near the source within the boundaries of the Aberdare National park.

This location has two major advantages. The section of Chania through the montane forest is characterised by steep V shaped valleys and gorges. This area of rugged terrain may not present a suitable gravity intake for Nyeri Water Supply.

The present intake has water of excellent chemical quality. However it is surrounded by an intensively farmed area that uses agro-chemicals to increase farm productivity. Although levels of pesticides were not available in time for this report, it is anticipated that use of pesticides will be on increase. This may pose a problem of water quality in future. A site upstream of human habitation will be an excellent intake for Nyeri Water Supply. However, location of water supply intake in the Aberdare National Park will encroach into a protected area. This is a national heritage and constitutes an area of immense scenic beauty. The park provides protection to the unique biotic community (flora and fauna) of the Central Highland Natural Region of Kenya. The Aberdare National Park and the forest reserve provides a suitable habitat to over 700 species of plants and to over 50 species of mammals. In addition, there are other forms of wildlife including birds, fish, reptiles, insects and other forms of life. Any development in the park can only be justified if there are no other suitable alternatives.

The preferred long term location for an intake would therefore be immediately below the National Park boundary.

6.2 Impacts Related to Construction Works

Site preparation activities related to the construction of the intake and the associated pipeline will change the salient features of the impacted area. Activities involved include the clearing and trampling of vegetation, excavation of soils and other geological formations, levelling of landscape and general construction work.

The above activities will have immediate impacts including loss of habitat and destruction of floral and the sedentary faunal communities. Soil excavation will trigger soil erosion and other degradation processes. In addition, there will be far-reaching effects on the adjacent riverine aquatic systems through the effect of run-off and subsequent siltation of water bodies.

On a localized scale there will be a loss of plant biomass and the destruction of plant community complexity at the project site. The impacts of water transmission pipelines will be similar to that described above.

6.3 Impacts Related to Project Operation

Once constructed, the operation of the intake is not expected to generate any significant negative impacts.

Abstraction of water from Chania during low flow periods is also not expected to have any adverse effects on flora and fauna of the area. There will be enough flow in the channel to sustain the faunal and floral communities associated with river ecology.

The operation of the water treatment works may generate some minor negative impacts in connection with the disposal of used alum and the sludge from tropical chloride of lime. Aluminium sulphate (alum) is used as a coagulant in the treatment works. Tropical chloride of lime (TCL) is the source of hypochlorous acid which is used to disinfect water. In the process of hypochlorous acid preparation sludge is produced. These wastes may have minor impacts especially on plants depending on the mode of disposal. Although the sludge is mainly calcium carbonate it contains traces of hypochlorous acid that are injurious to plant life.

6.3.1 Downstream Impacts

In regard to the large scale abstractions there are nine public water supplies within the municipal borders at different stages of implementation as follows:

1 Public Water Supplies in Operation

- Muhoya Self Help Water Supply
Intake -Zaina River
Abstraction - 367.2 m³/day
- Aguthi Rural Water Supply
Intake Gura-River
Abstraction - 5,300m³/day

- Tetu - Thegenge Rural Water Supply
Intake - Chania River
Abstraction - 4,000 m³/day
- 2 Public Water Supplies under Implementation**
- Njengu Self Help Water Supply
Intake - Muringato River
Abstraction - 6,205 m³/day
 - Kanuna Irrigation Project
Intake - Honi (Amboni) River
Abstraction - 1,140 m³/day
 - Ndathi-ini Irrigation Project
Intake - Honi (Amboni) River
Abstraction - 140 m³/day
- 3 Proposed Water Supply Project**
- Wangi Self-Help Water Supply
Intake - Sagana River
Abstraction 2,212 m³/day
 - Ileri - kirumia Self Help Water Supply
Intake - Sagana River
Abstraction _ _ _ _
 - Nyaribo Water Supply Project
Intake - Honi (Amboni)
Abstraction _ _ _ _

It should be noted that none of the above projects is or will be located between Ihwa intake and Sagana River. Hence the Nyeri water supply will not have any impacts on the above users.

One private user, Mt. Kenya Bottlers abstracts 600 m³/day below the Ihwa intake. The low flows of Chania downstream of intake have been estimated for a return period of 50 years to be 0.319 m³/sec (27,562 m³/day). The amount abstracted by the Mt. Kenya Bottlers is only 2% of the above flow of Chania. Hence Nyeri water supply will not affect the abstraction of the above company even after the projected abstraction of 14,000 m³/day (estimates for Nyeri and Kiganjo) is implemented..

A significant downstream user is the Sagana Falls Hydroelectric Power Station situated below the confluence of Chania and Sagana River. The Sagana Falls Power Station was built in pre-independence days. It has 3 turbines each of which uses a flow rate of 0.5 m³/sec with a total water demand of 1.5m³/sec (129,600 m³/day). The Chania River accounts for 21% of the flow (assuming 1.5 m³/sec is the total Sagana flow at the station). After the projected abstraction (14,000m³/day) Chania contribution will be reduced to 10% of the Sagana flow.

This is likely to have some minor to moderate impacts in the operation and power generation of Sagana Falls Hydroelectric Station especially during periods of exceptional drought. This situation will be aggravated by the present lack of storage capacity (reservoir) for the Sagana Falls Hydro-electric Power Station.

Other downstream users include the community that use the river water for domestic purposes and watering of animals. The demands for this community is negligible when compared with the low flow of Chania River.

The community downstream of Nyeri Sewage Treatment Works receives the Chania River after the addition of treated effluents from the sewage works. The effluent does not conform to the set guidelines as explained above in section 3.11.4.2 (Sewage Effluents). A community of Thunguma quarry miners and other people from the area use the Chania River barely 100m below where the Chania receives the effluent. Chania River was sampled at this point and bacteriological analysis revealed high counts of coliform and *E coli* of the order +1800 and 1600 cells/100 ml respectively. This type of pollution is expected to increase with the augmentation of Nyeri Water Supply.

6.4 Environmental Mitigation Plan

6.4.1 Impacts Associated with Soil Erosion and Siltation

Following the completion of construction activities, there should be a programme to rehabilitate the degraded environment. A major problem will emanate from the disposal of loose earth. The loose earth will be a source of silt in the run off especially during the rainy season. Immediate action should therefore be taken to address this issue. The recommended short term measures are:

- earth works to be carried out during the dry season
- excess earth to be disposed off before the onset of rains
- silt traps to be installed to prevent sediments from entering the water bodies

The following long-term measures to curb soil erosion and siltation are recommended.

- proper terracing and landscaping of the disturbed substrate.
- planting of sediment binding grasses such as *Cynodon dactylon* and other appropriate vegetation type as determined by the environmental conditions.

6.4.2 Impacts Associated with Water Treatment

The sludge generated by use of alum and TCL and other wastes such as paper, plastic ware and polythene should be disposed of using a landfill method

6.4.3 Impacts Associated with Water Abstractions

In order to maintain the required flows for the downstream users, a reservoir with adequate capacity to mitigate the dry season low flows requires to be built at the appropriate location. This can be undertaken as a subsequent stage project.

Proper treatment of sewage should be done in order to reduce contamination of the river downstream. This is especially important for the Chania River. In addition, the downstream users should be educated on the dangers of drinking raw water. Use of such waters should be boiled.

To achieve an improvement in BOD₅ and coliform levels, consideration should be given to converting the waste stabilisation ponds of the Nyeri sewage works into constructed wetlands. Area for area, these can provide a significantly better tertiary treatment process.

7 ENVIRONMENTAL MITIGATION PLAN

7.1 Impacts Associated with Project Location

It is not currently anticipated that there will be any construction within the National Park during the present stage of the water supply project.

Should this prove not to be the case, it must be noted that in a national park, the flora and fauna are fully protected. Disturbance or collection of organisms is prohibited. Any activity in regard to construction of a water intake in the Aberdare National Park must therefore be planned to cause minimal disturbance to plants animals and their habitat. Execution of planned activities will require prior endorsement from the Director, Kenya Wildlife Service (KWS).

This of course applies equally to the construction of any dam for purposes of river regulation.

7.2 Impacts Associated with Construction Activities

Following the completion of construction activities, there should be a programme to rehabilitate the degraded environment. A major problem will emanate from the disposal of loose earth. The loose earth will be a source of silt in the run off especially during the rainy season. Immediate action should therefore be taken to address this issue. The recommended short term measures are:

- earth works to be carried out during the dry season
- excess earth to be disposed before the onset of rains
- silt traps to be installed to prevent sediments from entering the water bodies.

The following medium to long-term measures to curb soil erosion and siltation are recommended.

- proper terracing and landscaping of the disturbed substrate.
- planting of sediment binding grasses such as *Cynodon dactylon* and other appropriate vegetation type as determined by the environmental conditions.

7.3 Impacts Associated with Water Treatment

The sludge generated by use of alum and TCL and other wastes such as paper, plastic ware and polythene should be collected and disposed of using a landfill facility. This can be done by use of drying beds for the alum sludge and the subsequent collection and disposal of this and other waste using the Municipal solid waste disposal system.

7.4 Impacts on Downstream Users

In order to maintain the required flows for the downstream users, a reservoir with adequate capacity to mitigate the dry season low flows requires to be built at an appropriate location. The only presently noted suitable location is above the forest and within the National Park. This would provide regulation to ensure both sufficient water for abstraction and for downstream users. It is not expected to feature within the present stage of this project but will probably be required for the post 2010 stage.

Improved treatment of sewage should be done, especially at the Nyeri Sewage Works, in order to reduce contamination of the river downstream. There should be a thorough assessment of the present treatment processes at Nyeri and Kiganjo with a view of rehabilitating them in order to increase their efficiency in sewage treatment. Feasibility of adding a constructed wetland component to the present treatment works needs to be explored, possibly as a replacement to the waste stabilisation ponds. In the meantime, the downstream users should be educated on the dangers of drinking raw water. As a first step the downstream users should boil the river water drawn for drinking purposes.

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Appendix 1: Common plant species of the study

Acanthaceae

Acanthus pubescens
Didymopanax laxata
Hypoestes forskalii
Justicia striata

Amaranthaceae

Achyranthes aspera
Amaranthus hybridus
Cyathula pepuriana
Digera muricata

Anacardiaceae

Rhus natalensis

Apocynaceae

Carissa edulis
Acokanthera schimperi

Araliaceae

Cussonia holstii
Polyscias kikuyuensis
Schefflera volkensii

Asclepiadaceae

Gomphocarpus fruticosus
Dregea asyrsinica

Asparagaceae

Asparagus africanus
Asparagus falcatus

Aspidiaceae

Dryopteris callolepis
Dryopteris manniana
Polystichum volkeusii

Balsaminaceae

Impatiens fischeri
Impatiens meruensis

Bignoniaceae

Jacaranda mimosifolia
Spathodea campanulata

Boraginaceae

Cordia africana
Cyoglossum lancifolium
Ethretia cymosa
Heliotropium scotteae

Canellaceae

Warburgia ugandensis

Capparaceae

Capparis viminea
Maerua triphylla
Ritchiea albersii

Celastraceae

Elaeodendron buchananii
Hippocratea goetzei
Maytenus heterophylla
Maytenus undata

Commelinaceae

Commelina africana
Commelina imberbis
Commelina latifolia

Compositae

Anthemis tigrisensis
Conyza floribunda
Bidens pilosa
Conyza schimperi
Helichrysum cymosum
Helichrysum brownei
Helichrysum schimperi
Senecio jacksonii
Senecio johnstonii
Senecio keniodendron
Senecio msorei
Sphaeranthus suaveolens
Tagetes minuta
Vernonia galamensis
Vernonia glabra
Vernonia lasiopus

Cornaceae

Afrocrania volkensii

Cupressaceae

Cupressus funebris
Cupressus lusitanica
Juniperus procera

Cyperaceae

Carex conferta
Carex johnstonii
Carex monostachya
Carex simensis
Cyperus erectus
Cyperus rotundus

Dracaenaceae

Dracaena afromontana

Ebenaceae

Diospyros abyssinica
Euda divinatorum

Ericaceae

Erica arborea
Erica excelsa
Erica elongensis
Phillipia excelsa
Phillipia trimeria

Euphorbiaceae

Acalypha volkensii
Clusia abyssinica
Croton atienus
Croton macrostachyus
Croton megalocarpus
Drypetes gerrardii
Euphorbia candelabrum
Euphorbia shimperana
Macaranga kilimandscharica
Neoboutonia macrocalyx
Phyllanthus boehmii
Phyllanthus fischeri

Flacourtiaceae

Dombeya torrida
Dombeya kikuyuensis
Dovyalis abyssinica

Gramineae

Agrostis gracifolia
Agrostis keniensis
Agrostis kilimandscharica
Agrostis volkensii
Andropogon lima
Bothriochloa insculpta
Chloris virgata
Cymbopogon nardus
Cynodon dactylon
Digitaria abyssinica
Digitaria abyssinica
Eragrostis olivaceae
Festuca abyssinica
Festuca pilgeri
Festuca simensis
Koeleria capensis
Panicum calrum
Pennisetum clandestinum
Setaria plicatilis
Arundinaria alpina
Sporobolus africanus
Sporobolus spicatus
Themeda triandra

Hypericaceae

Hypericum afromontanum
Hypericum revolutum

Juncaceae

Juncus effusus
Juncus oxycarpus
Luzula johnstonii

Labiatae

Leonitis mollissima
Leonitis nepetifolia
Leucas trifolia
Orimum keniense
Ocimum suave
Salvia nilotica

Leguminosae

Acacia melanoxylon
Acacia mearnsii
Acacia drepanolobium
Albizia gummifera
Erythrina abyssinica
Indigofera arrecta

Lobeliaceae

Lobelia deckenii
Lobelia holstii
Lobelia teleki

Loganiaceae

Nuxia congesta

Malvaceae

Abutilon mauritianum
Abutilon langicusp
Hibiscus ludwigii
Hibiscus macranthus
Hibiscus verticillata
Pavonia patens
Pavonia urens
Sida rhombifolia
Sida tenuicarpa

Meliaceae

Bersama abyssinica
Ekebergia capensis
Lepidotrichilia Volkensii

Moraceae

Dorstenia afromontana
Dorstenia hildebrandtii
Ficus thonningii

Myrsinaceae

Maesa lanceolata
Myrsine africana
Rapanea melanophloeos

Myrtaceae

Eucalyptus saligna
Syzygium guineense

Ochnaceae

Ochna insculpta

Oleaceae

Jasminum abyssinicum
Olea capensis
Olea europaea

Oliniaceae

Olinia rochetiana

Pinaceae

Pinus patula
Pinus radiata

Podocarpaceae

Podocarpus falcatus
Podocarpus latifolius

Proteaceae

Faurea saligna
Protea caffra
Protea kilimandscharica

Rhizophoraceae

Cassipourea malosana

Rosaceae

Alchemilla argyrophylla
Alchemilla fischeri
Alchemilla johnstonii
Hagenia abyssinica
Prunus africana
Rubus keniensis
Rubus steudneri
Rubus volkensii

Rutaceae

Calondendrum capense
Clausena anisata
Fagaropsis angolensis
Teclea hanangensis
Teclea nobilis
Teclea simplicifolia
Teclea trichocarpa
Toddalia asiatica
Zanthoxylum lepriurii
Zanthoxylum usambarensis

Sapindaceae

Allophylus abyssinica

Sapotaceae

Aningeria adolf-friedricii

Selaginellaceae

Selaginella krausiana

Solanaceae

Physalis peruriana

Solanum indicum

Solanum incanum

Solanum nigrum

Tiliaceae

Grewia similis

Sparmania ricinocarpa

Triumfetta macrophylla

Verbenaceae

Clerodendrum johnstonii

Lantana camara

Lantana trifolia

Lantana viburnoides

Lippia

ukambensis

Source: Field observations, KWS Records and Literature Survey (Schmitt, 1991 and Bussmann, 1994).

Appendix 2: Animal Species of the Study Area

Common Name	Scientific Name
Bush pig	<i>Potamochoerus porcus</i>
Warthog	<i>Phacochoerus aethiopicus</i>
Giant Forest Hog	<i>Hylochoerus meinertzhageni</i>
Peter's Duiker	<i>Cephalophus callipygus</i>
Red Duiker	<i>Cephalophus natalensis</i>
Black-fronted Duiker	<i>Cephalophus nigrifrons</i>
Yellow-backed Duiker	<i>Cephalophus silvicultor</i>
Common Duiker	<i>Sylvicapra grimmia</i>
Suni	<i>Neotragus moschatus</i>
Kirk's Dikdik	<i>Madogua kirkii</i>
Guenther's Dikdik	<i>Madogua guentheri</i>
Steenbok	<i>Raphicerus campestris</i>
Oribi	<i>Ourebia ourebia</i>
Kilpspringer	<i>Oreotragus oreotragus</i>
Bushbuck	<i>Tragelaphus scriprus</i>
Bongo	<i>Tragelaphus euryceros</i>
Eland	<i>Tragelaphus oryx</i>
Waterbuck	<i>Kobus ellipsiprymnus</i>
Mountain Reedbuck	<i>Redunca fulvorufula</i>
Bohor Reedbuck	<i>Redunca redunca</i>
Thomson Gazelle Gazelle	<i>Gazella thomsonii</i>
African Buffalo	<i>Syncerus caffer</i>
Burchell's Zebra	<i>Equus burchellii</i>
Black Rhinoceros	<i>Diceros bicornis</i>
Tree Hyrax	<i>Dendrohyrax arboreus</i>
Rock Hyrax	<i>Procavia capensis</i>
Yellow-spotted Hyrax	<i>Heterohyrax brucei</i>
African Elephant	<i>Loxodonta africana</i>
Aardvark	<i>Orycteropus after</i>
South African Porcupine	<i>Hystrix africaeastensis</i>
North African Porcupine	<i>Hystrix cristata</i>
Cane Rat	<i>Thryonomys swomderoamis</i>
Giant Rat	<i>Cricetomys gambianus</i>
Maned Rat	<i>Lophiomyys imhausii</i>
Cape Hare	<i>Lophiomyys imphausii</i>
Whyte's Hare	<i>Lophiomyys Whytei</i>
Side-striped Jackal	<i>Canis adustus</i>
Black backed Jackal	<i>Canis mesomelas</i>
Golden Jackal	<i>Canis aureus</i>
Hunting Dog	<i>Lycaon pictus</i>
Zorilla	<i>Ictonyx striata</i>
Ratel	<i>Mellivora capensis</i>
Spotted-necked otter	<i>Lutra maculicollis</i>
Clawless otter	<i>Aonyx capensis</i>
Common Genet	<i>Genetta genetta</i>
Servaline Genet	<i>Genetta Servalina</i>

Pardine Genet	<i>Genetta Tigrina</i>
African Civet	<i>Viverra civetta</i>
Palm Civet	<i>Nandinia binotata</i>
Egyptian Mongoose	<i>Herpestes inneumon</i>
Slender Mongoose	<i>Herpestes sanguineus</i>
Marsh Mongoose	<i>Atilax paludinosus</i>
Banded Mongoose	<i>Mungos Mungo</i>
White tailed Mongoose	<i>Ichneumia albicauda</i>
Pygmy Mongoose	<i>Helogale parvula</i>
Spotted Hyaena	<i>Crocuta crocuta</i>
Lion	<i>Panthera leo</i>
Leopard	<i>Panthera Pardus</i>
Serval	<i>Relis serval</i>
Wild Cat	<i>Relis silvestris</i>
Caracal	<i>Relis caracal</i>
Golden Cat	<i>Relis aurata</i>
Thick tailed Bushbaby	<i>Otolemur crassicaudatus</i>
Lesser Bushbay	<i>Galago senegalensis</i>
Baboon	<i>Papio cynocephalus anubis</i>
Patas	<i>Cercopithecus patas</i>
Syke's Guenon	<i>Cercopithecus mitis</i>
Green monkey Vervet	<i>Cercopithecus aethiops</i>
Guereza	<i>Colobus guereza</i>
Colobus monkey	<i>Colobus abyssinica</i>
Squirrel	<i>Xerus erythropus</i>
Honey badger	<i>Aonyx Sp.</i>

Source: KWS Records, field observations and literature survey (Schmitt, 1991; Bussmann, 1994 and Milner Littoroh and Gathua, 1993).

Appendix 3

A series of photographic plates (1-20) showing environmental features of the project area.



Plate 1: Afro-alpine environment in the Aberdare National Park



Plate 2: *Hagenia* vegetation zone in the Aberdare National Park

NYERYIEIA



Plate 3: Chania Falls in the Aberdare National Park



Plate 4: *Podocarpus*/bambo zone in Mt Kenya Forest

NYERYIEIA



Plate 5: Kabiruini Forest - a remnant of the Upland Dry Intermediate Forest



Plate 6: *Pinus patula* plantation in Mt. Kenya Forest

NYERYEIA



Plate 7: Kamburaini Water Intake in Mt. Kenya Forest



Plate 8: Mining of sand along the Nairobi River in Kiganjo Forest

NYERYIEIA



Plate 9: Kabiruini disused quarry, the proposed Municipal Dumping site



Plate 10: Kabiruini active quarry

NYERYEIA



Plate 11: Treatment works for the Mt. Kenya Bottling Company



Plate 12: Oxidation ponds for the treatment of coffee wastes from Hill Farm, Nyeri

NYERYIEIA



Plate 13: Blue Valley Dumping Site. Note the proximity of the Chania River



Plate 14: A close look at the Blue Valley Dumping Site

NYERYEIA



Plate 15: The location of Kangemi Dumping Site close to Nyeri Sewage Treatment Works



Plate 16: A close view of Kangemi Dumping Site

NYERIEIA



Plate 17: Drainage from Majengo/Kiawara Area. The Drainage effluent is leading to Chania River



Plate 18: Settlement at the Chania Valley Bottom below Majengo

NYERYIEA



Plate 19: Haphazard dumping of solid wastes on the wayside opposite in Kiganjo



Plate 20: Dumping of sewage effluent from septic tank in Kiganjo close to the solid wastes

Appendix 4

Chemical analysis of domestic and industrial effluents



REPUBLIC OF KENYA

GOVERNMENT CHEMIST'S DEPARTMENT

P.O. Box 20753

TEL. 725806/7 and 725873/4

NAIROBI

CERTIFICATE OF ANALYSIS

Report Reference No.: P/EFF.VOL.1/95/116

Sender:

Lab. sample No. 134/95

Prof. F. M. Muthuri,
P.O. Box 43844,
NAIROBI

Sender's Reference:

Sample No. 10

Description of Sample:

Date Received: 20/11/95

Effluent from Nyeri sewage treatment works.
Maturation ponds before joining Chania

Examination Required:

Effluent Analysis.

Analytical Report: pH 8.9
Suspended solids 15.0 mg/l
Biochemical oxygen demand (B.O.D) 100.0 mg/l
Chemical oxygen demand (C.O.D) 184.3 mg/l
Permanganate value 5.8 mg/l
Nitrate (N) 0.25 mg/l
Nitrite (N) 0.06 mg/l
Free and saline Ammonia (N) 0.02 mg/l
Albuminoid Ammonia (N) Nil
An alkaline and strong effluent.

Date: 13th December, 95


.....(M. Kasina).....
Government Chemist

For

CPK 6587-5m-9/94



REPUBLIC OF KENYA

GOVERNMENT CHEMIST'S DEPARTMENT

P.O. Box 20753

TEL. 725806/7 and 725873/4

NAIROBI

CERTIFICATE OF ANALYSIS

Report Reference No.: P/EFF. VOL.1/95/117

Sender:

Lab. sample No. 136/95

Prof. F. M. Muthuri,
P.O. Box 43844,
NAIROBI.

Sender's Reference:

Sample No. 18

Description of Sample:

Date Received: 20/11/95

Kiganjo Sewage treatment works.
(Sewage effluent-treated)

Examination Required:

Effluent Analysis.

Analytical Report: pH 8.4
Biochemical oxygen demand B.O.D 20 mg/l
Chemical oxygen demand (C.O.D) 307.2 mg/l
Permanganate value 12.2 mg/l
Nitrate (N) 0.02 mg/l
Nitrite (N) Trace
Free and Saline Ammonia (N) 3.18 mg/l
Albuminoid Ammonia (N) Nil
Suspended Solids 20.0 mg/l
Alkaline and strong effluent. Further treatment is still
~~required.~~

Date: 13th December, 95


..... (M. KASINA)
For: Government Chemist

CPK 6587-5m-9/94



REPUBLIC OF KENYA

GOVERNMENT CHEMIST'S DEPARTMENT

P.O. Box 20753

TEL. 725806/7 and 725873/4

NAIROBI

CERTIFICATE OF ANALYSIS

Report Reference No.: P/EFF.VOL.1/95/112

Lab. sample No. 147/95

Sender:

Prof. F.M. Muthuri,
P.O. Box 43844,
NAIROBI.

Sender's Reference:

No. 30 Kcc-Kiganjo

Description of Sample:

Date Received: 29/11/95

Effluent from K.C.C. Kiganjo


Examination Required:

Effluent Analysis

Analytical Report:

pH	5.8
Biochemical Oxygen demand (B.O.D)	1740.0 mg/l
Chemical oxygen demand (C.O.D)	3584.0 mg/l
Permanganate value	166.0 mg/l
Nitrate (N)	Nil
Nitrite (N)	Nil
Free and saline Ammonia (N)	248.3 mg/l
Albuminoid Ammonia (N)	Nil
Suspended solids	71.0 mg/l
Acidic and strong effluent. Treatment is recommended.	

Date: 13th December, 95


..... (M. KASINA)

For: Government Chemist

MK/lwm.
GPK 6587-5m-9/94



REPUBLIC OF KENYA

GOVERNMENT CHEMIST'S DEPARTMENT

P.O. Box 20753

TEL. 725806/7 and 725873/4

NAIROBI

CERTIFICATE OF ANALYSIS

Report Reference No.: P/EFF. VOL.1/95/113

Lab. sample No. 135/95

Sender:

Prof. F.M. Muthuri,
P.O. Box 43844,
NAIROBI

Sender's Reference:

Sample No. 17

Description of Sample:

Date Received: 20/11/95

Kigango sewage treatment works
influent.

Examination Required:

Effluent Analysis.

Analytical Report: pH 6.6
Suspended solids 54.0 mg/l
Biochemical oxygen demand (B.O.D) 800.0 mg/l
Chemical oxygen demand (C.O.D) 1331.2 mg/l
Permanganate value 46.8 mg/l
Nitrate (N) Nil
Nitrite (N) Nil
Free and saline Ammonia (N) 91.02 mg/l
Albuminoid Ammonia (N) Nil
Acidic and strong effluent.

Date: 13th December, 95

(M. KASINA)

For: Government Chemist

MK/lwm.

GPk 6587-5m-9/94



REPUBLIC OF KENYA

GOVERNMENT CHEMIST'S DEPARTMENT

P.O. Box 20753

TEL. 725806/7 and 725873/4

NAIROBI

CERTIFICATE OF ANALYSIS

Report Reference No.: P/EFF.VOL.1/95/114

Lab. sample No. 146/95

Sender:

Prof. F.M. Muthuri,
P.O. Box 43844,
NAIROBI

Sender's Reference:

Sample No. 26

Description of Sample:

Date Received: 29/11/95

Effluent from Cocacola Bottling Company.

Examination Required:

Effluent Analysis.

Analytical Report: pH 11.1
Biochemical oxygen demand (B.O.D) 357.5 mg/l
Chemical oxygen demand (C.O.D) 1228.8 mg/l
Permanganate value 22.8 mg/l
Nitrate (N) Nil
Nitrite (N) Nil
Free and Saline Ammonia (N) 0.04 mg/l
Albuminoid Ammonia (N) Nil
Suspended Solids Nil
Suspended solids 26.0 mg/l
Alkaline and strong effluent. Further treatment is necessary.

Date: 13th December, 95

..... (M. KASINA)
For: Government Chemist

MK/lwm.
GPK 6587-5m-9/94



REPUBLIC OF KENYA

GOVERNMENT CHEMIST'S DEPARTMENT

P.O. Box 20753

TEL. 725806/7 and 725873/4

NAIROBI

CERTIFICATE OF ANALYSIS

Report Reference No.: P/EFF.VOL.1/95/115

Lab. sample No. 133/95

Sender:

Prof. F. M. Muthuri,
P.O. Box 43844,
NAIROBI

Sender's Reference:

Sample No. 9

Description of Sample:

Date Received: 20/11/95

Effluent from Nyeri Sewage treatment works.
(Raw Sewage 8.45 a.m.)

Examination Required:

Effluent Analysis.

Analytical Report: pH 6.5
Suspended solids 42 mg/l
Biochemical oxygen demand (B.O.D) 685.0 mg/l
Chemical oxygen demand (C.O.D) 2867.2 mg/l
Permanganate value (P.V) 233.0 mg/l
Nitrate (N) Nil
Nitrite (N) Nil
Free and Saline Ammonia (N) 214.0 mg/l
Albuminoid Ammonia (N) Nil
Acidic and strong effluent. Treatment is ~~refused~~ before
it is discharged into a watercourse. *required*

Date: 13th December, 95


..... (M. KASINA)
For: Government Chemist

MK/lwm.
GPK 6587-5m-9/94

Appendix 5

Bacteriological examination of domestic and industrial effluents

REPUBLIC OF KENYA

MED. 72

NATIONAL PUBLIC HEALTH LABORATORY SERVICES
P.O. Box 20750
NAIROBI

26 november 1995

BACTERIOLOGICAL EXAMINATION OF WATER

Lab. Ref. No. 544/95

Sample No. 9

Time and date sample taken 8.45am 20.11.95

Time and date sample examined

TAKEN BY pro. P.M. MUTHURI

AUTHORITY KENYATTA UNIVERSITY

REASON FOR SAMPLING INVESTIGATIONS ON WATER QUANTITY
(If water is suspected of causing ill health please say so).

SOURCE OF SAMPLE UNTREATED SEWAGE NYERI TREATMENT WORKS
(State if well, spring, stream or public supply).

Is it protected? NO

If so, how?
(Is it completely covered, or sides only?)

Is there a pump?

If so, how long has it been in use?

Has it been overhauled recently?

EXACT SITE SAMPLE TAKEN FROM
(i.e. tap in kitchen, through cistern or direct from mains?)

ARE THERE ANY LATRINES OR OTHER SOURCES OF POLLUTION?

If so, where?

IS IT A CHLORINATED SUPPLY? NO

REPORT PRESUMPTIVE COLIFORM TEST

COLIFORM COUNT - 1800/100 mls water

E. COLI COUNT - 1/100 mls water

UNSATISFACTORY

NOTE REFER

Copies to:

PERMANENT SECRETARY,
MINISTRY OF HEALTH HDQS.,
P.O. BOX 30016,
NAIROBI.

PUBLIC HEALTH BACTERIOLOGY

Pathologist

Date 27/11/95

GPK 5016-10m-1/89

REPUBLIC OF KENYA

M&D. 72

NATIONAL PUBLIC HEALTH LABORATORY SERVICES
P.O. Box 20750
NAIROBI

26 november 1995

BACTERIOLOGICAL EXAMINATION OF WATER

Lab. Ref. No. 545/95

Sample No. 10

Time and date sample taken 9.00am 20.11.95

Time and date sample examined

Taken By pro. F.M. MUTHURI

AUTHORITY KENYATTA UNIVERSITY

REASON FOR SAMPLING INVESTIGATION ON WATER QUANTITY
(If water is suspected of causing ill health please say so).

SOURCE OF SAMPLE TREATED SEWAGE EFFLUENT NYERI TREATMENT WORKS.
(State if well, spring, stream or public supply).

Is it protected? NO

If so, how?
(Is it completely covered, or sides only?)

Is there a pump?

If so, how long has it been in use?

Has it been overhauled recently?

EXACT SITE SAMPLE TAKEN FROM
(i.e. tap in kitchen, through cistern or direct from mains?)

ARE THERE ANY LATRINES OR OTHER SOURCES OF POLLUTION?

If so, where?

IS IT A CHLORINATED SUPPLY? NO

REPORT PRESUMPTIVE COLIFORM TEST

COLIFORM COUNT - 35/100 mls water.

E. COLI COUNT - nil

unsatisfactory

note refer.

PERMANENT SECRETARY,
MINISTRY OF HEALTH HQS.,
P.O. BOX 30016,
NAIROBI (ATTN: CPHO/PHO)

Copies to:

Date 21/11/95

PUBLIC HEALTH BACTERIOLOGY

Pathologist

GPK 5016-10m-1/89

REPUBLIC OF KENYA

MED. 72

NATIONAL PUBLIC HEALTH LABORATORY SERVICES
P.O. Box 20750
NAIROBI

26 november 1995

BACTERIOLOGICAL EXAMINATION OF WATER

Lab. Ref. No. 552/95

Sample No. 17

Time and date sample taken 11.45am 20.11.95

Time and date sample examined

TAKEN BY F.M. MUTHURI

AUTHORITY KENYATTA UNIVERSITY

REASON FOR SAMPLING
(If water is suspected of causing ill health please say so).

SOURCE OF SAMPLE KIGANJO SEWAGE(UNTREATED)
(State if well, spring, stream or public supply).

Is it protected? NO

If so, how?
(Is it completely covered, or sides only?)

Is there a pump?

If so, how long has it been in use?

Has it been overhauled recently?

EXACT SITE SAMPLE TAKEN FROM
(i.e. tap in kitchen, through cistern or direct from mains?)

ARE THERE ANY LATRINES OR OTHER SOURCES OF POLLUTION?

If so, where?

IS IT A CHLORINATED SUPPLY? NO

REPORT PRESUMPTIVE COLIFORM TEST

COLIFORM COUNT- 1800/100mls water

E. COLI COUNT- 29/100mls water

unsatisfactory.

note refer

Copies to:

PERMANENT SECRETARY,
MINISTRY OF HEALTH HDQS.,
P.B. BOX 30016,
NAIROBI(ATT. CPHO/PHO).

Date 27/11/95

PUBLIC HEALTH BACTERIOLOGY

Pathologist

CPK 5016-10m-1/89

REPUBLIC OF KENYA

MED. 72

NATIONAL PUBLIC HEALTH LABORATORY SERVICES
P.O. Box 20750
NAIROBI

26 november 1995

BACTERIOLOGICAL EXAMINATION OF WATER

Lab. Ref. No. 553/95 Sample No. 18
Time and date sample taken 11.50am
Time and date sample examined

TAKEN BY F.M.MUTHURI

AUTHORITY KENYATT UNIVERSITY

REASON FOR SAMPLING
(If water is suspected of causing ill health please say so).

SOURCE OF SAMPLE ^{TREATED} SEWAGE EFFLUENT KIGANJO TREATMENT WORKS
(State if well, spring, stream or public supply).

Is it protected? NO

If so, how?
(Is it completely covered, or sides only?)

Is there a pump?

If so, how long has it been in use?

Has it been overhauled recently?

EXACT SITE SAMPLE TAKEN FROM
(i.e. tap in kitchen, through cistern or direct from mains?)

ARE THERE ANY LATRINES OR OTHER SOURCES OF POLLUTION?

If so, where?

IS IT A CHLORINATED SUPPLY? NO

REPORT PRESUMPTIVE COLIFORM COUNT

COLIFORM COUNT-1800/100mls water

E.COLI COUNT-1800+/100mls water.

UNSATISFACTORY

NOTE REFER

Copies to:

PERMANENT SECRETARY,
MINISTRY OF HEALTH HDQS.,
P.O. BOX 30016
NAIROBI(ATT.CPHO/PHO).

Date 27/11/95

[Signature]
PUBLIC HEALTH BACTERIOLOGIST
Pathologist

CPK 5016-10m-1/89

REPUBLIC OF KENYA

MED. 72

NATIONAL PUBLIC HEALTH LABORATORY SERVICES
P.O. Box 20750
NAIROBI

4 december 95

19

BACTERIOLOGICAL EXAMINATION OF WATER

Lab. Ref. No. 586/95

Sample No. 39

Time and date sample taken 2.15

Time and date sample examined

TAKEN BY pro. F.M. MUTHURI

AUTHORITY KENYATTA UNIVERSITY

REASON FOR SAMPLING

(If water is suspected of causing ill health please say so).

SOURCE OF SAMPLE KENYA COOPERATIVE CREAMERIES, KIGANJO PLANT MILK EFFLUENT
(State if well, spring, stream or public supply).

Is it protected? NO

If so, how?

(Is it completely covered, or sides only?)

Is there a pump?

If so, how long has it been in use?

Has it been overhauled recently?

EXACT SITE SAMPLE TAKEN FROM PLANT EFFLUENT AFTER GREASE & OIL STRIPPERS.
(i.e. tap in kitchen, through cistern or direct from mains?)

ARE THERE ANY LATRINES OR OTHER SOURCES OF POLLUTION?

If so, where?

IS IT A CHLORINATED SUPPLY? NO.

REPORT PRESUMPTIVE COLIFORM TEST

COLIFORM COUNT - 31/100 ml

E. COLI COUNT - 29/ "

UNSATISFACTORY

NOTE - REFER

PERMANENT SECRETARY,
MINISTRY OF HEALTH HQS.,

Copies to:

P.O. BOX 30016
NAIROBI.

Date

4 / DEC / 1995

PUBLIC HEALTH

Pathologist

GPK 5016-10m-1/89

REPUBLIC OF KENYA

MED. 72

NATIONAL PUBLIC HEALTH LABORATORY SERVICES
P.O. Box 20750
NAIROBI

4 december, 1995

BACTERIOLOGICAL EXAMINATION OF WATER

Lab. Ref. No. 584/95

Sample No. 27

Time and date sample taken 1.00pm 28.11.95

Time and date sample examined

TAKEN BY pro. M.F. MUTHURI

AUTHORITY KENYATTA UNIVERSITY

REASON FOR SAMPLING
(If water is suspected of causing ill health please say so).

SOURCE OF SAMPLE EFFLUENT FROM COCOA COLA BOTTLING COMPANY (MT.KENYA) NYERI
(State if well, spring, stream or public supply).

Is it protected?

If so, how?
(Is it completely covered, or sides only?)

Is there a pump?

If so, how long has it been in use?

Has it been overhauled recently?

EXACT SITE SAMPLE TAKEN FROM EFFLUENT OF TREATMENT WORKS ST IT LEAVES KINGONGO PRISONS
(i.e. tap in kitchen, through cistern or direct from mains?)

ARE THERE ANY LATRINES OR OTHER SOURCES OF POLLUTION?

If so, where?

IS IT A CHLORINATED SUPPLY? PRESUMPTIVE COLIFORM TEST

REPORT COLIFORM COUNT - 14 / 100 mls water

E. COLI COUNT - nil "

unsatisfactory

note -refer

Copies to:

Date 4 / 12 / 1995

CPK 5016-10m-1/89

PERMANENT SECRETARY,
MINISTRY OF HEALTH HDQS.,
P.O. BOX 30016,
NAIROBI
PUBLIC HEALTH BACTERIOLOGY

Pathologist

REPUBLIC OF KENYA

MED. 72

NATIONAL PUBLIC HEALTH LABORATORY SERVICES
P.O. Box 20750
NAIROBI

4 DECEMBER 1995

BACTERIOLOGICAL EXAMINATION OF WATER

Lab. Ref. No. 582/95 Sample No. 24

Time and date sample taken 10.00am 25.11.95

Time and date sample examined

TAKEN BY PRO. F.M. MUTHURI

AUTHORITY KENYATTA UNIVERSITY

REASON FOR SAMPLING
(If water is suspected of causing ill health please say so).

SOURCE OF SAMPLE CHANIA R. AT CHANIA FALLS IN ABERDARES N. PARK
(State if well, spring, stream or public supply).

Is it protected? NO

If so, how?
(Is it completely covered, or sides only?)

Is there a pump?

If so, how long has it been in use?

Has it been overhauled recently?

EXACT SITE SAMPLE TAKEN FROM RIVER WATER
(i.e. tap in kitchen, through cistern or direct from mains?)

ARE THERE ANY LATRINES OR OTHER SOURCES OF POLLUTION?

If so, where?

IS IT A CHLORINATED SUPPLY? NO

REPORT PRESUMPTIVE COLIFORM TEST

COLIFORM COUNT - 550 / 100 mls water

E. COLI COUNT - 6 / "

unsatisfactory

note - refer

Copies to:

PERMANENT SECRETARY,
MINISTRY OF HEALTH HDQS.,

P.O. BOX 30016

NAIROBI

PUBLIC HEALTH BACTERIOLOGY
Pathologist

Date 4/12/1995

GPK 5016-10m-1/89

REPUBLIC OF KENYA

MBD. 72

NATIONAL PUBLIC HEALTH LABORATORY SERVICES
P.O. Box 20750
NAIROBI

23rd Nov, 19 95

BACTERIOLOGICAL EXAMINATION OF WATER

Lab. Ref. No. 536/95

Sample No. 1 NWS CHANIA RIVER

Time and date sample taken 10.15 ON 17/11/95

Time and date sample examined

TAKEN BY PROF. F.M MUTHURI

AUTHORITY KENYATTA UNIVERSITY

REASON FOR SAMPLING INVESTIGATIONS ON WATER QUALITY
(If water is suspected of causing ill health please say so).

SOURCE OF SAMPLE CHANIA RIVER - ABERDARE FOREST - ZAINA RD.
(State if well, spring, stream or public supply).

Is it protected? NO

If so, how?
(Is it completely covered, or sides only?)

Is there a pump?

If so, how long has it been in use?

Has it been overhauled recently?

EXACT SITE SAMPLE TAKEN FROM
(i.e. tap in kitchen, through cistern or direct from mains?)

ARE THERE ANY LATRINES OR OTHER SOURCES OF POLLUTION?

If so, where?

IS IT A CHLORINATED SUPPLY? NO

REPORT PRESUMPTIVE COLIFORM COUNT

COLIFORM COUNT 900/100 mls of water

E.COLI COUNT 16/100 mls of water

Unsatisfactory. The Coliform Count should lie between 0-25/100 mls of water. If it should rise above this figure OR E.Coli appears at all, then it should be considered unsatisfactory for drinking purposes unless further treated.

Copies to: PROF. F.M MUTHURI
KENYATTA UNIVERSITY

THE PERMANENT SECRETARY
MINISTRY OF HEALTH
P.O BOX 30016
NAIROBI

PUBLIC HEALTH BACTERIOLOGY

Date 22/4/95

Pathologist

GPK 5016-10m-1/89

REPUBLIC OF KENYA

MED. 72

NATIONAL PUBLIC HEALTH LABORATORY SERVICES
P.O. Box 20750
NAIROBI

23rd Nov

, 19 95

BACTERIOLOGICAL EXAMINATION OF WATER

Lab. Ref. No. 537/95

Sample No. 2NWS CHANIA RIVER

Time and date sample taken 12.30 on 17/11/95

Time and date sample examined

TAKEN BY PROF. F.M MUTHURI

AUTHORITY KENYATTA UNIVERSITY

REASON FOR SAMPLING INVESTIGATIONS ON WATER QUALITY
(If water is suspected of causing ill health please say so).

SOURCE OF SAMPLE CHANIA RIVER EAST OF MAGAUNI AT THE BRIDGE
(State if well, spring, stream or public supply).

Is it protected? NO

If so, how?
(Is it completely covered, or sides only?)

Is there a pump?

If so, how long has it been in use?

Has it been overhauled recently?

EXACT SITE SAMPLE TAKEN FROM
(i.e. tap in kitchen, through cistern or direct from mains?)

ARE THERE ANY LATRINES OR OTHER SOURCES OF POLLUTION?
NO

If so, where?

IS IT A CHLORINATED SUPPLY? NO

REPORT PRESUMPTIVE COLIFORM COUNT

COLIFORM COUNT - 1600/100 mls of water

E. COLI COUNT - 45/100 mls of water

Unsatisfactory. The Coliform Count should lie between 0-25/100 mls of water

If it should rise above this figure OR E. Coli appears at all, then it should
be considered unsatisfactory for drinking purposes unless further treated.

Copies to: PROF. F.M MUTHURI
KENYATTA UNIVERSITY

THE PERMANENT SECRETARY
MINISTRY OF HEALTH
P.O BOX 30016
NAIROBI

Date

27/4/95

PUBLIC HEALTH BACTERIOLOGIST

Pathologist

HPK 3016-10m-1/89

REPUBLIC OF KENYA

Med. 72

NATIONAL PUBLIC HEALTH LABORATORY SERVICES
P.O. Box 20750
NAIROBI

23rd Nov, 1995

BACTERIOLOGICAL EXAMINATION OF WATER

Lab. Ref. No. 538/95

Sample No. 3NWS CHANIA RIVER

Time and date sample taken 12.45 17/11/95

Time and date sample examined

TAKEN BY PROF. F.M MUTHURI

AUTHORITY KENYATTA UNIVERSITY

REASON FOR SAMPLING INVESTIGATIONS ON WATER QUALITY
(If water is suspected of causing ill health please say so).

SOURCE OF SAMPLE CHANIA RIVER AT IHUA INTAKE
(State if well, spring, stream or public supply).

Is it protected? NO

If so, how?
(Is it completely covered, or sides only?)

Is there a pump?

If so, how long has it been in use?

Has it been overhauled recently?

EXACT SITE SAMPLE TAKEN FROM
(i.e. tap in kitchen, through cistern or direct from mains?)

ARE THERE ANY LATRINES OR OTHER SOURCES OF POLLUTION?

NO

If so, where?

IS IT A CHLORINATED SUPPLY? NO

REPORT PRESUMPTIVE COLIFORM COUNT

COLIFORM COUNT - 1600/100 mls of water

E. COLI COUNT - 80/100 mls of water

Unsatisfactory. The Coliform count should lie between 0-25/100 mls of water

If it should rise above this figure OR E.Coli appears at all, then it should
be considered unsatisfactory for drinking purposes unless further treated.

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KENTATTA UNIVERSITY

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MINISTRY OF HEALTH
P.O BOX 30016
NAIROBI.

Date

27/4/95

PUBLIC HEALTH BACTERIOLOGY

Pathologist

GPK 5013-10m-1/89

REPUBLIC OF KENYA

MBD. 72

NATIONAL PUBLIC HEALTH LABORATORY SERVICES
P.O. BOX 20750
NAIROBI

23rd Nov, 19 95

BACTERIOLOGICAL EXAMINATION OF WATER

Lab. Ref. No. 539/95

Sample No. ANWS CHANIA RIVER

Time and date sample taken 1.15 on 17/11/95

Time and date sample examined

TAKEN BY PROF. F.M. MUTHURI

AUTHORITY KENYATTA UNIVERSITY

REASON FOR SAMPLING INVESTIGATIONS ON WATER QUALITY
(If water is suspected of causing ill health please say so).

SOURCE OF SAMPLE CHANIA RIVER - PUMPING STATION
(State if well, spring, stream or public supply).

Is it protected? NO

If so, how?
(Is it completely covered, or sides only?)

Is there a pump?

If so, how long has it been in use?

Has it been overhauled recently?

EXACT SITE SAMPLE TAKEN FROM
(i.e. tap in kitchen, through cistern or direct from mains?)

ARE THERE ANY LATRINES OR OTHER SOURCES OF POLLUTION?

If so, where?

IS IT A CHLORINATED SUPPLY? NO

REPORT PRESUMPTIVE COLIFORM COUNT

COLIFORM COUNT - 1800/100 mls of water

E. COLI COUNT - 1800/100 MLS OF WATER.

Unsatisfactory. The Coliform Count should lie between 0-25/100 mls of water. If should rise above this figure OR E.Coli appears at all, then it should be considered unsatisfactory for drinking purposes unless further treated.

Copies to: PROF. F.M. MUTHURI
KENYATTA UNIVERSITY

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MINISTRY OF HEALTH
P.O. BOX 30016
NAIROBI.

Date 27/4/95

PUBLIC HEALTH BACTERIOLOGY

Pathologist

GPK 5010-10m-1/89

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P.O. Box 20750
NAIROBI

23rd Nov, 19 95

BACTERIOLOGICAL EXAMINATION OF WATER

Lab. Ref. No. 540/95

Sample No. 5NWS Chania River

Time and date sample taken 1.30 pm 17/11/95

Time and date sample examined

TAKEN BY PROF. F.M MUTHURI

AUTHORITY KENYATTA UNIVERSITY

REASON FOR SAMPLING INVESTIGATIONS ON WATER QUALITY
(If water is suspected of causing ill health please say so).

SOURCE OF SAMPLE CHANIA AT NYERI/NYAHIRURU RD. BRIDGE
(State if well, spring, stream or public supply).

Is it protected? NO

If so, how?
(Is it completely covered, or sides only?)

Is there a pump?

If so, how long has it been in use?

Has it been overhauled recently?

EXACT SITE SAMPLE TAKEN FROM NO
(i.e. tap in kitchen, through cistern or direct from mains?)

ARE THERE ANY LATRINES OR OTHER SOURCES OF POLLUTION?

If so, where?

IS IT A CHLORINATED SUPPLY? NO

REPORT PRESUMPTIVE COLIFORM COUNT

COLIFORM COUNT - 61/100 mls of water


E. COLI COUNT - 51/100 mls of water

UNSATISFACTORY. The Coliform Count should lie between 0-25/100 mls of water. If it should rise above this figure OR E.Coli appears at all, then it should be considered unsatisfactory for drinking purposes unless further treated.

Copies to: PROF. MUTHURI
KENYATTA UNIVERSITY.

THE PERMANENT SECRETARY
MINISTRY OF HEALTH
P.O BOX 30016
NAIROBI.

Date 27/11/95


PUBLIC HEALTH BACTERIOLOGY
Pathologist

GPK 5016-10m-1/89

REPUBLIC OF KENYA

MBD. 72

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P.O. Box 20750
NAIROBI

26 november, 19 95

BACTERIOLOGICAL EXAMINATION OF WATER

Lab. Ref. No. 543/95

Sample No. 8

Time and date sample taken 8.15

Time and date sample examined

TAKEN BY pro. M.P. MUTHURI

AUTHORITY KENYATTA UNIVERSITY

REASON FOR SAMPLING INVESTIGATION ON WATER QUANTITY
(If water is suspected of causing ill health please say so).

SOURCE OF SAMPLE CHANIA RIVER AT BLUE VALLEY
(State if well, spring, stream or public supply).

Is it protected? NO

If so, how? -
(Is it completely covered, or sides only?)

Is there a pump? -

If so, how long has it been in use?

Has it been overhauled recently?

EXACT SITE SAMPLE TAKEN FROM
(i.e. tap in kitchen, through cistern or direct from mains?)

ARE THERE ANY LATRINES OR OTHER SOURCES OF POLLUTION?

If so, where?

IS IT A CHLORINATED SUPPLY? no

REPORT PRESUMPTIVE COLIFORM TEST

COLIFORM COUNT - 1800+/100mls water

E. COLI COUNT - 1800/100 mls water
UNSATISFACTORY

NOTE REFER.

Copies to:

PERMANENT SECRETARY
MINISTRY OF HEALTH HQ
P.O. BOX 30016,
NAIROBI. (ATT CPHO/PHO)

PUBLIC HEALTH LABORATORY

Pathologist

Date 27/11/95

CPK 5016-10m-1/89

NATIONAL PUBLIC HEALTH LABORATORY SERVICES
P.O. Box 20750
NAIROBI

26 november, 1995

BACTERIOLOGICAL EXAMINATION OF WATER

Lab. Ref. No. 542/95

Sample No. 7 chania river.

Time and date sample taken 7.30

Time and date sample examined

TAKEN BY PRO. F.M. MUTHURI

AUTHORITY KENYATTA UNIVERSITY

REASON FOR SAMPLING Investigate on water quality
(If water is suspected of causing ill health please say so).SOURCE OF SAMPLE chania river at Thunguma
(State if well, spring, stream or public supply).

Is it protected? no

If so, how? -
(Is it completely covered, or sides only?)

Is there a pump? -

If so, how long has it been in use? -

Has it been overhauled recently? -

EXACT SITE SAMPLE TAKEN FROM -
(i.e. tap in kitchen, through cistern or direct from mains?)

ARE THERE ANY LATRINES OR OTHER SOURCES OF POLLUTION?

If so, where?

Is it a chlorinated supply? no

REPORT presumptive coliform test

coliform count - 1800+/100 mls water.

e.coli count - 1600 /100 "

Unsatisfactory

note refer

Copies to:

PERMANENT SECRETARY,
MINISTRY OF HEALTH HQQ.,
P.O. BOX 30016
NAIROBI
PUBLIC HEALTH BACTERIOLOGY

Date 27/11/95

Pathologist

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P.O. BOX 20750
NAIROBI

26.11.1995

BACTERIOLOGICAL EXAMINATION OF WATER

Lab. Ref. No. 550/95

Sample No. 15

Time and date sample taken 11.00am 20.11.95

Time and date sample examined

Taken By F.M. MUTHURI

AUTHORITY KENYATTA UNIVERSITY,

REASON FOR SAMPLING

(If water is suspected of causing ill health please say so).

SOURCE OF SAMPLE AMBONI RIVER AT THE GAUGING STN ON THE ARK ROAD
(State if well, spring, stream or public supply).

Is it protected?

NO

If so, how?

(Is it completely covered, or sides only?)

Is there a pump?

If so, how long has it been in use?

Has it been overhauled recently?

EXACT SITE SAMPLE TAKEN FROM

(i.e. tap in kitchen, through cistern or direct from mains?)

ARE THERE ANY LATRINES OR OTHER SOURCES OF POLLUTION?

If so, where?

IS IT A CHLORINATED SUPPLY?

NO

REPORT PRESUMPTIVE COLIFORM TEST

COLIFORM COUNT-1800+/100mls water.

E. COLI COUNT- 2/ # "

UNSATISFACTORY

NOTE REFER.

Copies to:

PERMANENT SECRETARY,
MINISTRY OF HEALTH HDQS.,
P.O. BOX 30016,

NAIROBI (ATT. CHG/PHG).
PUBLIC HEALTH BACTERIOLOGY

Date 27/11/95

PUBLIC HEALTH BACTERIOLOGY

Pathologist

GP/K 5016-10m-1/89

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NATIONAL PUBLIC HEALTH LABORATORY SERVICES
P.O. Box 20750
NAIROBI

4 december, 1995

BACTERIOLOGICAL EXAMINATION OF WATER

Lab. Ref. No. 585/95

Sample No. 29

Time and date sample taken 1.30

Time and date sample examined

TAKEN BY pro. F.M. MUTHURI

AUTHORITY KENYATTA UNIVERSITY

REASON FOR SAMPLING

(If water is suspected of causing ill health please say so).

SOURCE OF SAMPLE AMBONI RIVER AT NYERI KIGANJO ROAD BRIDGE

(State if well, spring, stream or public supply).

Is it protected?

If so, how?

(Is it completely covered, or sides only?)

Is there a pump?

If so, how long has it been in use?

Has it been overhauled recently?

SAMPLE TAKEN FROM THE RIVER

EXACT SITE SAMPLE TAKEN FROM

(i.e. tap in kitchen, through cistern or direct from mains?)

ARE THERE ANY LATRINES OR OTHER SOURCES OF POLLUTION?

If so, where?

IS IT A CHLORINATED SUPPLY?

NO.

PRESUMPTIVE COLIFORM TEST

REPORT

COLIFORM COUNT - 57 / 100 mls water.

E. COLI COUNT - 51 "

UNSATISFACTORY .

NOTE - REFER

Copies to:

PERMANENT SECRETARY,
MINISTRY OF HEALTH HDQ.,
P.O. BOX 30016,
NAIROBI

Date

4/DEC/1995

PUBLIC HEALTH BACTERIOLOGY

Pathologist

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P.O. Box 20750
NAIROBI

4 december, 1995

BACTERIOLOGICAL EXAMINATION OF WATER

Lab. Ref. No. 583/95 Sample No. 25
Time and date sample taken 12.30 pm 26.11.95
Time and date sample examined

TAKEN BY pro. F.M. MUTHURI

AUTHORITY KENYATTA UNIVERSITY

REASON FOR SAMPLING
(If water is suspected of causing ill health please say so).

SOURCE OF SAMPLE NAIROBI RIVER (MT. KENYA FOREST ON PODOCARPUS/ BAMBOO FOREST
(State if well, spring, stream or public supply).

Is it protected?

If so, how?
(Is it completely covered, or sides only?)

Is there a pump?

If so, how long has it been in use?

Has it been overhauled recently?

EXACT SITE SAMPLE TAKEN FROM RIVER WATER
(i.e. tap in kitchen, through cistern or direct from mains?)

ARE THERE ANY LATRINES OR OTHER SOURCES OF POLLUTION?

If so, where?

IS IT A CHLORINATED SUPPLY? NO

REPORT PRESUMPTIVE COLIFORM TEST

COLIFORM COUNT -1800+/ 100 mls water.

E. COLI COUNT - 5 / "

UNSATISFACTORY

NOTE - REFER

Copies to:

PERMANENT SECRETARY,
MINISTRY OF HEALTH HDQS.,
P.O. BOX 30016,
NAIROBI
PUBLIC HEALTH LABORATORY
Pathologist

Date 4/12/1995

GPK 5016-10m-1/89

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P.O. Box 20750
NAIROBI

26 november 1995

BACTERIOLOGICAL EXAMINATION OF WATER

Lab. Ref. No. 551/95

Sample No. 16

Time and date sample taken 11.30am 20.11.95

Time and date sample examined

TAKEN BY F.M. MUTHURI

AUTHORITY KENYATTA UNIVERSITY

REASON FOR SAMPLING
(If water is suspected of causing ill health please say so).

SOURCE OF SAMPLE NAIROBI RIVER (WISOI PRY. SCHOOL)
(State if well, spring, stream or public supply).

Is it protected? NO

If so, how?
(Is it completely covered, or sides only?)

Is there a pump?

If so, how long has it been in use?

Has it been overhauled recently?

EXACT SITE SAMPLE TAKEN FROM
(i.e. tap in kitchen, through cistern or direct from mains?)

ARE THERE ANY LATRINES OR OTHER SOURCES OF POLLUTION?

If so, where?

IS IT A CHLORINATED SUPPLY? NO
PRESUMPTIVE COLIFORM TEST

REPORT

COLIFORM COUNT -41/100mls water

E.COLI COUNT -29/100mls water
unsatisfactory.

note refer.

Copies to:

PERMANENT SECRETARY,
MINISTRY OF HEALTH HDQS.,
P.O. BOX 30016,
NAIROBI (ATT, CPHO/PHO).

Date 27/4/95

PUBLIC HEALTH BACTERIOLOGY
Pathologist

GP/K 5016-10m-1/89

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NAIROBI

26 november, 1995

BACTERIOLOGICAL EXAMINATION OF WATER

Lab. Ref. No. 555/95

Sample No. 20

Time and date sample taken 12.30

Time and date sample examined

TAKEN BY F.M.MUTHURI

AUTHORITY KENYATTA UNIVERSITY

REASON FOR SAMPLING
(If water is suspected of causing ill health please say so).

SOURCE OF SAMPLE NAIROBI RIVER(SAGANA CONFLUENCE)
(State if well, spring, stream or public supply).

Is it protected? NO

If so, how?
(Is it completely covered, or sides only?)

Is there a pump?

If so, how long has it been in use?

Has it been overhauled recently?

EXACT SITE SAMPLE TAKEN FROM
(i.e. tap in kitchen, through cistern or direct from mains?)

ARE THERE ANY LATRINES OR OTHER SOURCES OF POLLUTION?

If so, where?

Is it a chlorinated supply? NO

REPORT PRESUMPTIVE COLIFORM TEST

COLIFORM COUNT - 425 / 100 mls water

E. coli count - 51 / 100 mls water

UNSATISFACTORY

NOTE REFER

Copies to:

PERMANENT SECRETARY,
MINISTRY OF HEALTH HDQS.,
P.O. BOX 30016,
NAIROBI. (ATT. CPHO/PHO)

Date 22/11/95

M. A. A. A.
PUBLIC HEALTH BACTERIOLOGY
Pathologist

GPK 5016-10m-1/89

REPUBLIC OF KENYA

MED. 72

NATIONAL PUBLIC HEALTH LABORATORY SERVICES
P.O. Box 20750
NAIROBI

26 November, 1995

BACTERIOLOGICAL EXAMINATION OF WATER

Lab. Ref. No. 549/95 Sample No. 14
Time and date sample taken 10.45am 20.11.95
Time and date sample examined

TAKEN BY PRO. F. M. MUTHURI
AUTHORITY KENYATTA UNIVERSITY

REASON FOR SAMPLING
(If water is suspected of causing ill health please say so).

SOURCE OF SAMPLE NAIROBI RIVER, AT INTAKE AT KISAKO
(State if well, spring, stream or public supply).

Is it protected? NO

If so, how?
(Is it completely covered, or sides only?)

Is there a pump?

If so, how long has it been in use?

Has it been overhauled recently?

EXACT SITE SAMPLE TAKEN FROM
(i.e. tap in kitchen, through cistern or direct from mains?)

ARE THERE ANY LATRINES OR OTHER SOURCES OF POLLUTION?

If so, where?

IS IT A CHLORINATED SUPPLY? NO

REPORT PRESUMPTIVE COLIFORM TEST

COLIFORM COUNT - 1800+ / 100mls water.

E. COLI COUNT - 1600 / 100mls water.

unsatisfactory

note refer

Copies to:

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MINISTRY OF HEALTH HDQS.,
P.O. BOX 30016,
NAIROBI (ATT. CPHO/PHO).

Date 27/4/95

PUBLIC HEALTH BACTERIOLOGY
Pathologist

GPK 5016-10m-1/89

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26 november, 1995

BACTERIOLOGICAL EXAMINATION OF WATER

Lab. Ref. No. 556/95

Sample No. 21

Time and date sample taken

Time and date sample examined

TAKEN BY F.M. MUTHURI

AUTHORITY KENYATTA UNIVERSITY

REASON FOR SAMPLING

(If water is suspected of causing ill health please say so).

SOURCE OF SAMPLE SAGANA RIVER AT RAILWAYS CROSSING BRIDGE

(State if well, spring, stream or public supply).

Is it protected? NO

If so, how?

(Is it completely covered, or sides only?)

Is there a pump?

If so, how long has it been in use?

Has it been overhauled recently?

EXACT SITE SAMPLE TAKEN FROM

(i.e. tap in kitchen, through cistern or direct from mains?)

ARE THERE ANY LATRINES OR OTHER SOURCES OF POLLUTION?

If so, where?

IS IT A CHLORINATED SUPPLY?

NO

REPORT PRESUMPTIVE COLIFORM TEST

COLIFORM COUNT - 1800 / 100 mls of water

E. COLI COUNT - 6 / 100 mls water

UNSATISFACTORY

NOTE - refer

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MINISTRY OF HEALTH HDQS.,
P.O. BOX 30016,
NAIROBI, (ATT. CPHO/PHO).

Date 27/4/95

[Signature]
PUBLIC HEALTH BACTERIOLOGY
Pathologist

GPK 5016-10m-1/89

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NAIROBI

26 november, 1995

BACTERIOLOGICAL EXAMINATION OF WATER

Lab. Ref. No. 558/95 Sample No. 23

Time and date sample taken 1.00 20.11.95

Time and date sample examined

Taken By F.M. MUTHURI

AUTHORITY KENYATTA UNIVERSITY

REASON FOR SAMPLING
(If water is suspected of causing ill health please say so).

SOURCE OF SAMPLE SAGANA RIVER AT NYERI ROAD.
(State if well, spring, stream or public supply).

Is it protected? NO

If so, how?
(Is it completely covered, or sides only?)

Is there a pump?

If so, how long has it been in use?

Has it been overhauled recently?

EXACT SITE SAMPLE TAKEN FROM
(i.e. tap in kitchen, through cistern or direct from mains?)

ARE THERE ANY LATRINES OR OTHER SOURCES OF POLLUTION?

If so, where?

IS IT A CHLORINATED SUPPLY? NO

REPORT PRESUMPTIVE COLIFORM TEST

COLIFORM COUNT - 1800 / 100 mls water

E. COLI COUNT - 59 / 100 mls water

UNSATISFACTORY

NOTE REFER

Copies to:

Date 27/11/95

GPK 5016-10m-1/89

PERMANENT SECRETARY,
MINISTRY OF HEALTH HDQS.,
P.O. BOX 30016,
NAIROBI
PUBLIC HEALTH BACTERIOLOGY
ATT. CPHO/PHO
Pathologist

Appendix 7

Bacteriological examination of treated water

REPUBLIC OF KENYA

MED. 72

NATIONAL PUBLIC HEALTH LABORATORY SERVICES
P.O. BOX 20750
NAIROBI

23 RD NOV 19 95

BACTERIOLOGICAL EXAMINATION OF WATER

Lab. Ref. No. 546/95

Sample No. 11

Time and date sample taken 9.45 am on 20/11/95

Time and date sample examined

TAKEN BY PROF. F.M. MUTHURI

AUTHORITY KENYATTA UNIVERSITY

REASON FOR SAMPLING INVESTIGATIONS ON WATER QUALITY
(If water is suspected of causing ill health please say so).

SOURCE OF SAMPLE TREATED WATER FROM KAMAKWA TREATMENT WORKS - NYERI
(State if well, spring, stream or public supply).

Is it protected? YES

If so, how? IN A PIPE
(Is it completely covered, or sides only?)

Is there a pump? NO

If so, how long has it been in use?

Has it been overhauled recently?

EXACT SITE SAMPLE TAKEN FROM ~~PIPE LEADING TO MINICA (DISTILLATION)~~
(i.e. tap in kitchen, through cistern or direct from mains?)

ARE THERE ANY LATRINES OR OTHER SOURCES OF POLLUTION?
NO

If so, where?

IS IT A CHLORINATED SUPPLY? YES

REPORT PRESUMPTIVE COLIFORM COUNT

COLIFORM COUNT - NIL

E. COLI COUNT - NIL

CLASS I - HIGHLY SATISFACTORY.

Copies to: PROF. MUTHURI
KENYATTA UNIVERSITY

THE PERMANENT SECRETARY
MINISTRY OF HEALTH
P.O BOX 30016
NAIROBI

PUBLIC HEALTH BACTERIOLOGY
M. Muthuri
Pathologist

Date 22/11/95

GPK 5016-10m-1/89

REPUBLIC OF KENYA

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NATIONAL PUBLIC HEALTH LABORATORY SERVICES
P.O. BOX 20750
NAIROBI

23rd Nov., 1995

BACTERIOLOGICAL EXAMINATION OF WATER

Lab. Ref. No. 547/95

Sample No. 13

Time and date sample taken 10.15 am on 20/11/95

Time and date sample examined

TAKEN BY PROF. F.M. MUTHURI

AUTHORITY KENYATTA UNIVERSITY

REASON FOR SAMPLING INVESTIGATIONS ON WATER QUALITY
(If water is suspected of causing ill health please say so).

SOURCE OF SAMPLE KICANJO TREATMENT WORKS - TREATED WATER - NYERI
(State if well, spring, stream or public supply).

Is it protected? YES

If so, how? FROM A TAP
(Is it completely covered, or sides only?)

Is there a pump?

If so, how long has it been in use?

Has it been overhauled recently?

EXACT SITE SAMPLE TAKEN FROM
(i.e. tap in kitchen, through cistern or direct from mains?)

ARE THERE ANY LATRINES OR OTHER SOURCES OF POLLUTION?

If so, where?

IS IT A CHLORINATED SUPPLY? YES

REPORT PRESUMPTIVE COLIFORM COUNT

COLIFORM COUNT - NIL

E. COLI COUNT - NIL

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KENYATTA UNIVERSITY

THE PERMANENT SECRETARY
MINISTRY OF HEALTH
P.O. BOX 30016
NAIROBI

Date 27/11/95

Pathologist

CPK 501 (10m-1/89)

REPUBLIC OF KENYA

MSD. 72

NATIONAL PUBLIC HEALTH LABORATORY SERVICES
P.O. Box 20750
NAIROBI

23 rd Nov , 19 95

BACTERIOLOGICAL EXAMINATION OF WATER

Lab. Ref. No. 541/95 Sample No. 6

Time and date sample taken. 6.30 am On 20/11/95

Time and date sample examined

TAKEN BY PROF. F.M. MUTHURI

AUTHORITY KENYATTA UNIVERSITY

REASON FOR SAMPLING INVESTIGATIONS ON WATER QUALITY
(If water is suspected of causing ill health please say so).

SOURCE OF SAMPLE TAP WATER - GREEN HILLS HOTEL - NYRI
(State if well, spring, stream or public supply).

Is it protected?

If so, how?
(Is it completely covered, or sides only?)

Is there a pump?

If so, how long has it been in use?

Has it been overhauled recently?

EXACT SITE SAMPLE TAKEN FROM BATHROOM OF HOTEL ROOM (SENEGAL)
(i.e. tap in kitchen, through cistern or direct from mains?)

ARE THERE ANY LATRINES OR OTHER SOURCES OF POLLUTION?

If so, where?

IS IT A CHLORINATED SUPPLY? YES

REPORT PRESUMPTIVE COLIFORM COUNT

COLIFORM COUNT - NIL
E. COLI COUNT - NIL

CLASS I - HIGHLY SATISFACTORY.

Copies to: PROF. F.M. MUTHURI
KENYATTA UNIVERSITY

THE PERMANENT SECRETARY
MINISTRY OF HEALTH
P.O. BOX 30016
NAIROBI.

PUBLIC HEALTH LABORATORY
[Signature]
Pathologist

Date. 27/11/95

GPK 5016-10m-1/89

REPUBLIC OF KENYA

MED. 72

NATIONAL PUBLIC HEALTH LABORATORY SERVICES

P.O. Box 20750

NAIROBI

26 november 95

19

BACTERIOLOGICAL EXAMINATION OF WATER

Lab. Ref. No. 554/95

Sample No. 19

Time and date sample taken 12.00 20.11.95

Time and date sample examined

TAKEN BY F.M. MUTHURI

AUTHORITY KENYATTA UNIVERSITY

REASON FOR SAMPLING

(If water is suspected of causing ill health please say so)

SOURCE OF SAMPLE

TAP WATER KIGANJO ^{sewage} TREATMENT WORKS

(State if well, spring, stream or public supply).

Is it protected? YES

TAP

If so, how?

(Is it completely covered, or sides only?)

Is there a pump?

If so, how long has it been in use?

Has it been overhauled recently?

EXACT SITE SAMPLE TAKEN FROM

KITCHEN

(i.e. tap in kitchen, through cistern or direct from mains?)

ARE THERE ANY LATRINES OR OTHER SOURCES OF POLLUTION?

If so, where?

IS IT A CHLORINATED SUPPLY?

YES

REPORT

PRESUMPTIVE COLIFORM TEST

COLIFORM COUNT - 180+/100mls water

E. COLI COUNT - 35 /100mls water

CLASS IV - UNSATISFACTORY.

Copies to:

PERMANENT SECRETARY,
MINISTRY OF HEALTH HDQS.,
P.O. BOX 30016,
NAIROBI (ATT. CDHO/PHO).

Date

27/11/95

Pathologist

GP/K 5010-10m-1/89

REPUBLIC OF KENYA

MED. 72

NATIONAL PUBLIC HEALTH LABORATORY SERVICES
P.O. Box 20750
NAIROBI

26.11.95

19

BACTERIOLOGICAL EXAMINATION OF WATER

Lab. Ref. No. 557/95

Sample No. 22

Time and date sample taken 12.50 20.11.95

Time and date sample examined

TAKEN BY F.M. MUTIURI

AUTHORITY KENYATTA UNIVERSITY

REASON FOR SAMPLING

(If water is suspected of causing ill health please say so).

SOURCE OF SAMPLE TREATED WATER AT KIRICHO TOWN -NYERI

(State if well, spring, stream or public supply).

Is it protected? /NYERI/ yes

If so, how? TAP ON AN OPEN SPACE
(Is it completely covered, or sides only?)

Is there a pump?

If so, how long has it been in use?

Has it been overhauled recently?

EXACT SITE SAMPLE TAKEN FROM

(i.e. tap in kitchen, through cistern or direct from mains?)

ARE THERE ANY LATRINES OR OTHER SOURCES OF POLLUTION?

If so, where?

IS IT A CHLORINATED SUPPLY? YES

REPORT PRESUMPTIVE COLIFORM TEST

COLIFORM COUNT - 17 / 100 mls water

E. COLI COUNT - 2 / 100 mls water.

UNSATISFACTORY CLASS I IV

Copies to:

PERMANENT SECRETARY,
MINISTRY OF HEALTH HDQS.,
P.O. BOX 30016,
NAIROBI (ATT. CHHO/PHO).

Date 27/4/95

PUBLIC HEALTH BACTERIOLOGY

Pathologist

GPK 5016-10m-1/89

REPUBLIC OF KENYA
MINISTRY OF WATER DEVELOPMENT
Water Testing Laboratory
BACTERIOLOGICAL EXAMINATION OF WATER

(A) Lab. Ref. No. 58/95 Sample No. 58/95
Time, Date of sampling 19/4/95 Sample submitted by D. U. E.
Address NYERI

(B) REASON FOR SAMPLING MONITORING
(If water is suspected of causing ill health please say so)
SOURCE OF SAMPLE PUBLIC SUPPLY KAMUKUWA WATER SUPPLY
(State if well, spring, stream or public supply)
Is it protected? yes
If so, how? COMPLETELY COVERED WITH PIPES.
(Is it completely covered, or sides only?)
Is there a pump? no
If so, how long has it been in use? n/a
Has it been overhauled recently? n/a
EXACT SITE SAMPLE TAKEN FROM KITCHEN TAP AT D.C.'S HOUSE
(i.e. tap in kitchen, through cistern or direct from mains?)
POSSIBLE SOURCES OF POLLUTION? IMPROPER TREATMENT
If so, where? LEAKAGES WITHIN MAINS
IS IT A CHLORINATED SUPPLY (Indicate Residual Levels) YES, 0 ppm

EXAMINATION RESULTS:

MPN of Coliform Organisms 80 per 100 ml
E. Coli. —
Faecal Coliforms 17 per 100 ml
Standard Plate Count —

MINISTRY OF WATER DEVELOPMENT
WATER QUALITY AND POLLUTION CONTROL
NYSISTON

COMMENTS:—

Presence of both total and faecal
coliform organisms indicates water is
ineffectively chlorinated.
No Residual Chlorine level
detected during sampling.

O/c. D. MASOGU
Water Testing Laboratory—NYERI

REPUBLIC OF KENYA
MINISTRY OF WATER DEVELOPMENT
Water Testing Laboratory
BACTERIOLOGICAL EXAMINATION OF WATER

(A) Lab. Ref. No. 57/95 Sample No. 57/95
Time, Date of sampling 19/4/95 Sample submitted by D.W.E
Address Nyeri

(B) REASON FOR SAMPLING MONITORING

(If water is suspected of causing ill health please say so)
SOURCE OF SAMPLE KA Public Supply KAMUKWA WATER SUPPLY

(State if well, spring, stream or public supply)
Is it protected? YES

If so, how? PIPES - COMPLETELY COVERED

(Is it completely covered, or sides only?)
Is there a pump? NO

If so, how long has it been in use? N/A

Has it been overhauled recently? N/A

EXACT SITE SAMPLE TAKEN FROM TAP AT P's HOUSE

(i.e. tap in kitchen, through cistern or direct from mains?)
POSSIBLE SOURCES OF POLLUTION? LEAKAGES WITHIN MAINS, IMPROPER TREATMENT.

If so, where? 0 P.P.M
IS IT A CHLORINATED SUPPLY (Indicate Residual Levels)

EXAMINATION RESULTS:

MPN of Coliform Organisms 20 PER 100 ml

E. Coli. -

Feacal Coliforms 11 PER 100 ml

Standard Plate Count -

COMMENTS:- Presence of both total and feacal coliform organisms indicates water is not effectively disinfected.
Residual Chlorine level too low (when tested) during Sampling.
Oilc. 10.1450140
Water Testing Laboratory - Nyeri

24/4/95

D-6

REPUBLIC OF KENYA
MINISTRY OF WATER DEVELOPMENT
Water Testing Laboratory
BACTERIOLOGICAL EXAMINATION OF WATER

(A) Lab. Ref. No.
Time, Date of sampling 21/2/95

Sample No. 47/95
Sample submitted by DWE-NYERI
Address

(B) REASON FOR SAMPLING MONITORING

(If water is suspected of causing ill health please say so)
SOURCE OF SAMPLE Indoor tap kitchen tap in the DC's house

(State if well, spring, stream or public supply)

Is it protected?

If so, how?

(Is it completely covered, or sides only?)

Is there a pump?

If so, how long has it been in use?

Has it been overhauled recently?

EXACT SITE SAMPLE TAKEN FROM Tap

(i.e. tap in kitchen, through cistern or direct from mains?)

POSSIBLE SOURCES OF POLLUTION? NONE

If so, where?

IS IT A CHLORINATED SUPPLY (Indicate Residual Levels)

EXAMINATION RESULTS:

MPN of Coliform Organisms 0

E. Coli.

Feacal Coliforms 0

Standard Plate Count

COMMENTS:—

Water Safe for Domestic use.
O/c W. S. M. M. M.
for Water Testing Laboratory

Appendix 8

Chemical and bacteriological analysis of ground waters

NYERIA

REPUBLIC OF KENYA
MINISTRY OF WATER DEVELOPMENT
Water Testing Laboratory
BACTERIOLOGICAL EXAMINATION OF WATER

(A) Lab. Ref. No. 115/93 Sample No. 115/93
 Time, Date of sampling 30/11/93 Sample submitted by Green hills
 Address Hotel - Nyeri

(B) REASON FOR SAMPLING Quality Check

(If water is suspected of causing ill health please say so)
 SOURCE OF SAMPLE Shallow well (30 ft)

(State if well, spring, stream or public supply)
 Is it protected? Yes

If so, how? Completely covered

(Is it completely covered, or sides only?)
 Is there a pump? Yes (portable)

If so, how long has it been in use? —

Has it been overhauled recently? —

EXACT SITE SAMPLE TAKEN FROM Direct from well

(i.e. tap in kitchen, through cistern or direct from mains?)
 POSSIBLE SOURCES OF POLLUTION? None

If so, where? —

IS IT A CHLORINATED SUPPLY (Indicate Residual Levels) No

EXAMINATION RESULTS:

MPN of Coliform Organisms 1800 +

E. Coli —

Faecal Coliforms 542 225

Standard Plate Count —

COMMENTS:— Presence of faecal Coliforms indicates water requires disinfection before use for domestic purposes

MINISTRY OF WATER DEVELOPMENT
 WATER QUALITY AND POLLUTION CONTROL
 DIVISION
 For 01/6 Mohamed Y. Ali
 Water Testing Laboratory
 Nyeri

REPUBLIC OF KENYA
MINISTRY OF WATER DEVELOPMENT
Water Testing Laboratory
BACTERIOLOGICAL EXAMINATION OF WATER

(A) Lab. Ref. No. 115/93 Sample No. 115/93
Time, Date of sampling 30/11/93 Sample submitted by Green hills
Address Hotel - Nyeri

(B) REASON FOR SAMPLING Quality Check

(If water is suspected of causing ill health please say so)

SOURCE OF SAMPLE Shallow well (30 ft.)

(State if well, spring, stream or public supply)

Is it protected? Yes

If so, how? Completely Covered

(Is it completely covered, or sides only?)

Is there a pump? Yes (portable)

If so, how long has it been in use? —

Has it been overhauled recently? —

EXACT SITE SAMPLE TAKEN FROM Direct from well

(i.e. tap in kitchen, through cistern or direct from mains?)

POSSIBLE SOURCES OF POLLUTION? None

If so, where? —

IS IT A CHLORINATED SUPPLY (Indicate Residual Levels) No

EXAMINATION RESULTS:

MPN of Coliform Organisms 1800 +

E. Coli. —

Faecal Coliforms 225

Standard Plate Count —

COMMENTS:— Presence of faecal Coliforms indicates water requires disinfection before use for domestic purposes.

MINISTRY OF WATER DEVELOPMENT
WATER SUPPLY AND POLLUTION CONTROL
DIVISION

For: Mohamed Y. Ali
Water Testing Laboratory
Nyeri

MINISTRY OF WATER DEVELOPMENT
WATER QUALITY MONITORING PROGRAMME
(WATER ANALYSIS REPORT SHEET)



Lab. Ref. No. 69/95 Date of Sampling 6/7/95
 Source Well 23ft (Muruguru high school) Date Received 6/7/95
 Purpose Domestic Submitted by District Water Engineer
 RGS or B/H No. Domestic (Flowmeter) P.O. Box 475 Nyeri

Parameter	Unit	Results
Temperature	°C	<u>18</u>
pH	pH Scale	<u>7.4</u>
Colour	mg/Pl/l	<u>—</u>
Turbidity	N.T.U./J.T.U.	<u>14.0</u>
Conductivity	umhos/cm	<u>683.4</u>
Iron	mg/l	<u>0.02</u>
Manganese	mgMn/l	<u>—</u>
Calcium	mgCa/l	<u>42.4</u>
Magnesium	mgMg/l	<u>NIL</u>
Sodium	mgNa/l	<u>—</u>
Potassium	mgK/l	<u>—</u>
Silica	mg/SiO ₂ /l	<u>—</u>
Copper	mgCu/l	<u>—</u>
Lead	mgPb/l	<u>—</u>
Boron	mgB/l	<u>—</u>
Total Hardness	mg/CaCO ₃ /l	<u>94.0</u>
Total Alkalinity	mg/CaCO ₃ /l	<u>40.0</u>
Chloride	mgCl/l	<u>49.5</u>
Fluoride	mgF/l	<u>—</u>
Nitrate	mgN/l	<u>—</u>
Sulphate	mgSO ₄ /l	<u>4.2</u>
Orthophosphate	mgP/l	<u>—</u>
Total Suspended solids	mg/l	<u>—</u>
Total Dissolved solids	mg/l	<u>444.2</u>
BOD (5 days 20°C)	mgO ₂ /l	<u>—</u>
Dissolved oxygen	mgO ₂ /l	<u>—</u>
20min P.V.	mgKmnO ₄ /L	<u>31.6</u>
Free CO ₂	mg/L	<u>2.0</u>

COMMENTS:— Neutral water and soft
water of good chemical
quality.

O/C D. MASONGO
 Water Testing Laboratory,
 NYERI

Appendix 9

Chemical analysis of natural (river) waters

REPUBLIC OF KENYA

OFFICE OF THE PRESIDENT

GOVERNMENT CHEMIST'S DEPARTMENT

Telephone: 725806/7

P.O. Box 20753

NAIROBI, KENYA

REPORT ON CHEMICAL ANALYSIS OF WATER

Report Reference: P/WAT/VOL.V/95/65

Date: 13/12/95

Laboratory Sample No. 764/95

Date Received: 29/11/95

Sender: Prof. Muthuri, Box 43844, NAIROBI

Date Sample Taken:

Source: Sample No. 24 Chania River Falls
Abardares National Park, NYERI.

RESULTS

PHYSICAL TESTS

Colour: 30 (Hazen Units)

Turbidity: Nil (J.T.U.'s)

Deposit: Debris

Odour: Nil (T.O.N.)

Taste:-

Electrical Conductivity at 25°C (micro mhos/cm³)

pH: 6.8

20

CHEMICAL TESTS

	mg/l(ppm)	me/l
Total Alkalinity as CaCO ₃	12.0	
Phenolphthalein (CO ₃)=	Nil	
Methyl Orange (HCO ₃)=	12.0	
Chloride (Cl)-	2.0	
Sulphate (SO ₄)=	Nil	
Nitrate (NO ₃)	Nil	
Nitrite (NO ₂)=	Nil	
Fluoride (F)-	0.1	
Total Anions	-	
Sodium (Na)+	1.6	
Potassium (K)+	1.1	
Calcium (Ca)++	2.4	
Magnesium (Mg)++	0.5	
Iron (Total) (Fe)+++	0.17	
Manganese (Mn)++	0.03	
Ammonia-Free & Saline (NH ₄)+	Nil	
Ammonia-Albuminoid (NH ₄)+	Nil	
(Pb Cu Zn)	-	
Total Cations	-	

	mg/l (ppm)
Carbonate Hardness as (CaCO ₃)	8.0
Non-Carbonate Hardness as (CaCO ₃)	Nil
Total Hardness as (CaCO ₃)	8.0
Free Carbon Dioxide	6.0
Silica (SiO ₂)	20.0
Oxygen absorbed. 4 hr. at 27°C (P.V.)	3.9
Total Dissolved Solids, residue dried at 180°C	14.0

REMARKS: Although this water is neutral and soft, it is highly polluted with organic matter. Further treatment (Chlorination) is necessary. Bacteriological examination is also recommended.

Date 13th December, 1995

D. N. Wamuti
(D. N. WAMUTI)
for: Government Chemist

DNW/SNK.

REPUBLIC OF KENYA
OFFICE OF THE PRESIDENT
GOVERNMENT CHEMIST'S DEPARTMENT

Telephone: 725806/7
P.O. Box 20753
NAIROBI, KENYA

REPORT ON CHEMICAL ANALYSIS OF WATER

Report Reference: P/WAT/VOL.V/95/44

Date: 7/12/95

Laboratory Sample No. 721/95

Date Received: 17/11/95

Sender: Proff. Muthuli, Box 43844, NAIROBI

Date Sample Taken:

Source: R.Chania (10.15am)-Aberdare Forest No.1

NYERI

RESULTS

PHYSICAL TESTS

Colour: 43 (Hazen Units)

Turbidity: clear (J.T.U.'s)

Deposit: none

Odour: none (T.O.N.)

Taste: -

Electrical Conductivity at 25°C (micro mhos/cm³)

pH: 6.5

23

CHEMICAL TESTS

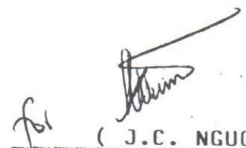
	mg/l(ppm)	me/l
Total Alkalinity as CaCO ₃	14.0	
Phenolphthalein (CO ₃)=	NIL	
Methyl Orange (HCO ₃)—	14.0	
Chloride (Cl)—	2.0	
Sulphate (SO ₄)=	5.0	
Nitrate (NO ₃)	NIL	
Nitrite (NO ₂)—	NIL	
Fluoride (F)—	0.2	
Total Anions	-	
Sodium (Na)+	1.9	
Potassium (K)+	1.3	
Calcium (Ca)++	3.2	
Magnesium (Mg)++	0.5	
Iron (Total) (Fe)+++	0.1	
Manganese (Mn)++	TRACE	
Ammonia—Free & Saline (NH ₄) +	NIL	
Ammonia—Albuminoid (NH ₄) +	NIL	
(Pb Cu Zn)	-	
Total Cations	-	

	mg/l (ppm)
Carbonate Hardness as (CaCO ₃)	10.0
Non-Carbonate Hardness as (CaCO ₃)	NIL
Total Hardness as (CaCO ₃)	10.0
Free Carbon Dioxide	23.0
Silica (SiO ₂)	10.0
Oxygen absorbed. 4 hr. at 27°C (P.V.)	2.9
Total Dissolved Solids, residue dried at 180°C	18.0

REMARKS:

Acidic and coloured water that is polluted with organic matter. Treatment to remove the organic matter is recommended before the water is used for human consumption.

Date 7th December, 1995

for:  (J.C. NGUGI)
Government Chemist

JCN/MWK.

REPUBLIC OF KENYA

OFFICE OF THE PRESIDENT

GOVERNMENT CHEMIST'S DEPARTMENT

Telephone: 725806/7

P.O. Box 20753

NAIROBI, KENYA

REPORT ON CHEMICAL ANALYSIS OF WATER

Report Reference: P/WAT/VOL.V/95/45

Date: 7/12/95

Laboratory Sample No. 722/95

Date Received: 17/11/95

Sender: Proff. Muthuli, Box 43844, NAIROBI

Date Sample Taken:

Source: R. Chania (12.30pm) - MAGUINI BRIDGE (NO.2)

NYERI

RESULTS

PHYSICAL TESTS

Colour: 30 (Hazen Units)

Turbidity: slightly turbid (I.T.U.'s)

Deposit: Silt

Odour: None (T.O.N.)

Taste: -

Electrical Conductivity at 25°C (micro mhos/cm³)

pH: 6.4

34

CHEMICAL TESTS

	mg/l (ppm)	me/l
Total Alkalinity as CaCO ₃	22.0	
Phenolphthalein (CO ₃)=	NIL	
Methyl Orange (HCO ₃)—	22.0	
Chloride (Cl)—	3.0	
Sulphate (SO ₄)=	5.0	
Nitrate (NO ₃)	NIL	
Nitrite (NO ₂)—	NIL	
Fluoride (F)—	0.2	
Total Anions	-	
	2.8	
Sodium (Na)+	1.7	
Potassium (K)+	3.2	
Calcium (Ca)++	1.4	
Magnesium (Mg)++	0.1	
Iron (Total) (Fe)+++	0.01	
Manganese (Mn)++	NIL	
Ammonia—Free & Saline (NH ₄) +	NIL	
Ammonia—Albuminoid (NH ₄) +	-	
(Pb Cu Zn)	-	
Total Cations		


	<i>mg/l (ppm)</i>
Carbonate Hardness as (CaCO ₃)	14.0
Non-Carbonate Hardness as (CaCO ₃)	NIL
Total Hardness as (CaCO ₃)	14.0
Free Carbon Dioxide	22.0
Silica (SiO ₂)	16.0
Oxygen absorbed. 4 hr. at 27°C (P.V.)	2.65
Total Dissolved Solids, residue dried at 180°C	24.0

REMARKS:

Comments similar to sample No.721/95 .

Date 7th December, 1995

for:


(J.C. NGUGI)
Government Chemist

JCN/MWK.

REPUBLIC OF KENYA
OFFICE OF THE PRESIDENT
GOVERNMENT CHEMIST'S DEPARTMENT

Telephone: 725806/7
P.O. Box 20753
NAIROBI, KENYA

REPORT ON CHEMICAL ANALYSIS OF WATER

Report Reference: P/WAT/VOL.V/95/46
Laboratory Sample No. 723/95
Sender: Proff. Muthuli, Box 43844, NAIROBI
Source: R.Chania-Ihwa intake gravity (No.3)
NYERI

Date: 7/12/95
Date Received: 17/11/95
Date Sample Taken:

RESULTS

PHYSICAL TESTS

Colour: 40 (Hazen Units)	Turbidity: clear (J.T.U.'s)
Deposit: Silt	Odour: none (T.O.N.)
Taste: -	Electrical Conductivity at 25°C (micro mhos/cm ³)
pH: 6.8	29

CHEMICAL TESTS

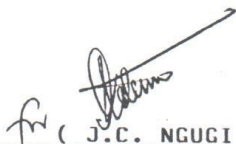
	mg/l(ppm)	me/l
Total Alkalinity as CaCO ₃	20.0	
	NIL	
Phenolphthalein (CO ₃)=	20.0	
Methyl Orange (HCO ₃)—	2.0	
Chloride (Cl)—	5.0	
Sulphate (SO ₄)=	NIL	
Nitrate (NO ₃)	NIL	
Nitrite (NO ₂)—	0.2	
Fluoride (F)—	-	
Total Anions	2.4	
Sodium (Na)+	1.6	
Potassium (K)+	3.2	
Calcium (Ca)++	1.0	
Magnesium (Mg)++	0.1	
Iron (Total) (Fe)+++	TRACE	
Manganese (Mn)++	NIL	
Ammonia—Free & Saline (NH ₄) +	NIL	
Ammonia—Albuminoid (NH ₄) +	-	
(Pb Cu Zn)	-	
Total Cations		

	mg/l (ppm)
Carbonate Hardness as (CaCO ₃)	12.0
Non-Carbonate Hardness as (CaCO ₃)	NIL
Total Hardness as (CaCO ₃)	12.0
Free Carbon Dioxide	5.0
Silica (SiO ₂)	16.0
Oxygen absorbed, 4 hr. at 27°C (P.V.)	2.35
Total Dissolved Solids, residue dried at 180°C	19.5

REMARKS:

Coloured and very soft water that shows a high degree of organic pollution. Treatment (chlorination) is recommended before the water is used for human consumption.

Date 7th December, 1995


for: (J.C. NGUGI)
Government Chemist

JCN/MWK.

REPUBLIC OF KENYA
OFFICE OF THE PRESIDENT
GOVERNMENT CHEMIST'S DEPARTMENT

Telephone: 725806/7
P.O. Box 20753
NAIROBI, KENYA

REPORT ON CHEMICAL ANALYSIS OF WATER

Report Reference: P/WAT/VOL.V/95/47

Date: 7/12/95

Laboratory Sample No. 724/95

Date Received: 17/11/95

Sender: Proff. Muthuli, BQx 43844, NAIROBI

Date Sample Taken:

Source: R.Chania (1.15pm) Intake pumping stn (No.4)
NYERI

RESULTS

PHYSICAL TESTS

Colour: 45 (Hazen Units)
Deposit: Silt
Taste: -
pH: 6.6

Turbidity: clear (J.T.U.'s)
Odour: none (T.O.N.)
Electrical Conductivity at 25°C (micro mhos/cm³)
29.5

CHEMICAL TESTS

	mg/l(ppm)	me/l
Total Alkalinity as CaCO ₃	12.0	
Phenolphthalein (CO ₃)=	NIL	
Methyl Orange (HCO ₃)—	12.0	
Chloride (Cl)—	4.0	
Sulphate (SO ₄)=	7.0	
Nitrate (NO ₃)	NIL	
Nitrite (NO ₂)—	NIL	
Fluoride (F)—	0.2	
Total Anions	-	
Sodium (Na)+	2.7	
Potassium (K)+	1.6	
Calcium (Ca)++	2.4	
Magnesium (Mg)++	1.4	
Iron (Total) (Fe)+++	0.2	
Manganese (Mn)++	TRACE	
Ammonia—Free & Saline (NH ₄) +	NIL	
Ammonia—Albuminoid (NH ₄) +	NIL	
(Pb Cu Zn)	-	
Total Cations	-	


	mg/l (ppm)
Carbonate Hardness as (CaCO ₃)	12.0
Non-Carbonate Hardness as (CaCO ₃)	NIL
Total Hardness as (CaCO ₃)	12.0
Free Carbon Dioxide	18.0
Silica (SiO ₂)	16.0
Oxygen absorbed. 4 hr. at 27°C (P.V.)	2.3
Total Dissolved Solids, residue dried at 180°C	20.5

REMARKS:

Comments similar to sample No. 721/95.

Date 7th December, 1995

for:


(J.C. NGUGI)
Government Chemist

JCN/MWK.

REPUBLIC OF KENYA
OFFICE OF THE PRESIDENT
GOVERNMENT CHEMIST'S DEPARTMENT

Telephone: 725806/7
P.O. Box 20753
NAIROBI, KENYA

REPORT ON CHEMICAL ANALYSIS OF WATER

Report Reference: P/WA1/VOL.V/95/48

Date: 7/12/95

Laboratory Sample No. 725/95

Date Received: 17/11/95

Sender Proff. F.M., Box 43844, NAIROBI

Date Sample Taken:

Source: R.Chania (1.50pm) Nyahururu No. 5 Bridge
~~NYERI~~

RESULTS

PHYSICAL TESTS

Colour: 30 (Hazen Units)

Turbidity: slightly turb (J.T.U.'s)

Deposit: Silt

Odour: None (T.O.N.)

Taste: -

Electrical Conductivity at 25°C (micro mhos/cm³)

pH: 7.9

32.0

CHEMICAL TESTS

	mg/l(ppm)	me/l
Total Alkalinity as CaCO ₃	16.0	
Phenolphthalein (CO ₃)=	NIL	
Methyl Orange (HCO ₃)—	16.0	
Chloride (Cl)—	1.0	
Sulphate (SO ₄)=	TRACE	
Nitrate (NO ₃)	NIL	
Nitrite (NO ₂)—	NIL	
Fluoride (F)—	NIL	
Total Anions	-	
Sodium (Na)+	2.8	
Potassium (K)+	1.7	
Calcium (Ca)++	3.2	
Magnesium (Mg)+++	NIL	
Iron (Total) (Fe)+++	0.09	
Manganese (Mn)++	TRACE	
Ammonia—Free & Saline (NH ₄) +	NIL	
Ammonia—Albuminoid (NH ₄) +	-	
(Pb Cu Zn)	-	
Total Cations	-	


	<i>mg/l (ppm)</i>
Carbonate Hardness as (CaCO ₃)	8.0
Non-Carbonate Hardness as (CaCO ₃)	NIL
Total Hardness as (CaCO ₃)	8.0
Free Carbon Dioxide	2.0
Silica (SiO ₂)	20.0
Oxygen absorbed. 4 hr. at 27°C (P.V.)	1.95
Total Dissolved Solids, residue dried at 180°C	22.0

REMARKS:

Alkaline and very soft water of low mineral content.
The water is polluted with organic matter and treatment
(chlorination) is recommended before the water is used
ofr human consumption.

Date 7th December, 1995

for:


J.C. NGUGI
Government Chemist

JCN/MWK.

REPUBLIC OF KENYA
OFFICE OF THE PRESIDENT
GOVERNMENT CHEMIST'S DEPARTMENT

Telephone: 725806/7
P.O. Box 20753
NAIROBI, KENYA

REPORT ON CHEMICAL ANALYSIS OF WATER

Report Reference: P/WAT/VOL.V/95/51
Laboratory Sample No. 729/95
Sender: Prof. Muthuri, Box 43844, NAIROBI
Source: No. 8 Chania River below old sewage treatment works.

Date: 11/12/95
Date Received: 20/11/95
Date Sample Taken:

RESULTS

PHYSICAL TESTS

Colour: 10.0 (Hazen Units) Turbidity: Turbid (J.T.U.'s)
Deposit: Silt Odour: None (T.O.N.)
Taste: - Electrical Conductivity at 25°C (micro mhos/cm³)
pH: 6.6 39.0

CHEMICAL TESTS

	mg/l(ppm)	me/l
Total Alkalinity as CaCO ₃	14.0	
Phenolphthalein (CO ₃)=	Nil	
Methyl Orange (HCO ₃)—	14.0	
Chloride (Cl)—	2.0	
Sulphate (SO ₄)=	0.30	
Nitrate (NO ₃)	Trace	
Nitrite (NO ₂)—	Nil	
Fluoride (F)—	0.2	
Total Anions		
Sodium (Na)+	3.2	
Potassium (K)+	2.0	
Calcium (Ca)++	3.2	
Magnesium (Mg)++	1.4	
Iron (Total) (Fe)+++	0.1	
Manganese (Mn)++	Trace	
Ammonia—Free & Saline (NH ₄)+	0.20	
Ammonia—Albuminoid (NH ₄)+	Nil	
(Pb Cu Zn)		
Total Cations		

	mg/l (ppm)
Carbonate Hardness as (CaCO ₃)	14.0
Non-Carbonate Hardness as (CaCO ₃)	Nil
Total Hardness as (CaCO ₃)	14.0
Free Carbon Dioxide	5.0
Silica (SiO ₂)	10.0
Oxygen absorbed. 4 hr. at 27°C (P.V.)	2.9
Total Dissolved Solids, residue dried at 180°C	27.0

REMARKS: Acidic but soft water. The water is organically polluted and should be treated (Chlorination) if it is to be used for human consumption.

Date 11th December, 1995


M. KASINA)
for: Government Chemist

MK/SNK.

REPUBLIC OF KENYA

OFFICE OF THE PRESIDENT

GOVERNMENT CHEMIST'S DEPARTMENT

Telephone: 725806/7

P.O. Box 20753

NAIROBI, KENYA

REPORT ON CHEMICAL ANALYSIS OF WATER

Report Reference: P/WAT/VOL.V/95/50

Date: 7/12/95

Laboratory Sample No. 728/95

Date Received: 20/11/95

Sender: Professor Muthuli, Box 43844, NAIROBI

Date Sample Taken:

Source: No. 7: Quarry below sewage
treatment works

RESULTS

PHYSICAL TESTS

Colour: 10.0 (Hazen Units)

Turbidity: clear (J.T.U.'s)

Deposit: silts

Odour: none (T.O.N.)

Taste: -

Electrical Conductivity at 25°C (micro mhos/cm³)

pH: 6.7

43.0

CHEMICAL TESTS

	mg/l(ppm)	me/l
Total Alkalinity as CaCO ₃	8.0	
Phenolphthalein (CO ₃)=	NIL	
Methyl Orange (HCO ₃)—	8.5	
Chloride (Cl)—	2.0	
Sulphate (SO ₄)=	0.5	
Nitrate (NO ₃)	TRACE	
Nitrite (NO ₂)—	NIL	
Fluoride (F)—	0.1	
Total Anions		
Sodium (Na)+	3.4	
Potassium (K)+	2.2	
Calcium (Ca)++	4.4	
Magnesium (Mg)++	1.0	
Iron (Total) (Fe)+++	0.10	
Manganese (Mn)++	NIL	
Ammonia—Free & Saline (NH ₄) +	0.3	
Ammonia—Albuminoid (NH ₄) +	NIL	
(Pb Cu Zn)		
Total Cations		

	mg/l (ppm)
Carbonate Hardness as (CaCO ₃)	8.0
Non-Carbonate Hardness as (CaCO ₃)	7.0
Total Hardness as (CaCO ₃)	15.0
Free Carbon Dioxide	6.0
Silica (SiO ₂)	20.0
Oxygen absorbed, 4 hr. at 27°C (P.V.)	3.1
Total Dissolved Solids, residue dried at 180°C	30.0

REMARKS:

Slightly acidic and soft water of low mineral content. The water is organically polluted. Treatment is recommended if the water is to be used for human consumption.

Date 7th December, 1995

for:


(M. KASINA)
Government Chemist

MK/MWK.

REPUBLIC OF KENYA
OFFICE OF THE PRESIDENT
GOVERNMENT CHEMIST'S DEPARTMENT

Telephone: 725806/7
P.O. Box 20753
NAIROBI, KENYA

REPORT ON CHEMICAL ANALYSIS OF WATER

Report Reference: P/WAT/VOL. V/95/59
Laboratory Sample No. 734/95
Sender: Prof. Muthuli
Source: Amboni (Gangging Stn) No. 15
NYERI

Date: 13th December, 95
Date Received: 20/11/95
Date Sample Taken:

RESULTS

PHYSICAL TESTS

Colour: 140 (Hazen Units)	Turbidity: Slightly Turbid (P.P.U.'s)
Deposit: Silt	Odour: None (T.O.N.)
Taste: -	Electrical Conductivity at 25°C (micro mhos/cm ³)
pH: 7.0	55.5

CHEMICAL TESTS

	mg/l(ppm)	me/l
Total Alkalinity as CaCO ₃	30.0	
Phenolphthalein (CO ₃)=	Nil	
Methyl Orange (HCO ₃)=	30.0	
Chloride (Cl)-	5.0	
Sulphate (SO ₄)=	10.0	
Nitrate (NO ₃)	Nil	
Nitrite (NO ₂)=	Nil	
Fluoride (F)-	0.4	
Total Anions	-	
Sodium (Na)+	5.8	
Potassium (K)+	2.3	
Calcium (Ca)++	5.6	
Magnesium (Mg)++	1.9	
Iron (Total) (Fe)+++	1.0	
Manganese (Mn)++	0.02	
Ammonia-Free & Saline (NH ₄) +	Nil	
Ammonia-Albuminoid (NH ₄) +	Nil	
(Pb Cu Zn)	-	
Total Cations	-	

	mg/l (ppm)
Carbonate Hardness as (CaCO ₃)	22.0
Non-Carbonate Hardness as (CaCO ₃)	Nil
Total Hardness as (CaCO ₃)	22.0
Free Carbon Dioxide	4.0
Silica (SiO ₂)	22.0
Oxygen absorbed. 4 hr. at 27°C (P.V.)	3.5
Total Dissolved Solids, residue dried at 180°C	38.5

REMARKS: Neutral and very coloured water due to the presence of excessive iron in it. The water is also highly polluted with organic matter.

Removal of iron and treatment (chlorination) are recommended before this water is used for human consumption.

Date 13th December, 95

For:

J. G. NGELI
Government Chemist

JCN/lwm
GPK 6586-10m-9/94

REPUBLIC OF KENYA

OFFICE OF THE PRESIDENT

GOVERNMENT CHEMIST'S DEPARTMENT

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P.O. Box 20753

NAIROBI, KENYA

REPORT ON CHEMICAL ANALYSIS OF WATER

Report Reference: P/WAT./VOL.V/95/64

Date: 13th December, 95

Laboratory Sample No. 766/95

Date Received: 29-11-95

Sender: Prof. F. M. Muthuri, Box 43844,

Date Sample Taken:

Source: Sample No. 29

Amboni River at Nyeri/Kigumo Bridge

RESULTS

PHYSICAL TESTS

Colour: 20 (Hazen Units)

Turbidity: Nil (J.T.U.'s)

Deposit: debris

Odour: Nil (T.O.N.)

Taste:

Electrical Conductivity at 25°C (micro mhos/cm³)

pH: 7.0

100

CHEMICAL TESTS

	mg/l(ppm)	me/l
Total Alkalinity as CaCO ₃	36.0	
Phenolphthalein (CO ₃)=	Nil	
Methyl Orange (HCO ₃)—	36.0	
Chloride (Cl)—	4.0	
Sulphate (SO ₄)=	Nil	
Nitrate (NO ₃)	Nil	
Nitrite (NO ₂)—	Trace	
Fluoride (F)—	0.2	
Total Anions	—	
Sodium (Na)+	7.0	
Potassium (K)+	3.6	
Calcium (Ca)++	6.0	
Magnesium (Mg)++	2.2	
Iron (Total) (Fe)+++	0.83	
Manganese (Mn)++	0.01	
Ammonia—Free & Saline (NH ₄) +	Nil	
Ammonia—Albuminoid (NH ₄) +	Nil	
(Pb Cu Zn)	—	
Total Cations	—	

	mg/l (ppm)
Carbonate Hardness as (CaCO ₃)	24.0
Non-Carbonate Hardness as (CaCO ₃)	Nil
Total Hardness as (CaCO ₃)	24.0
Free Carbon Dioxide	8.0
Silica (SiO ₂)	25.0
Oxygen absorbed, 4 hr. at 27°C (P.V.)	2.3
Total Dissolved Solids, residue dried at 180°C	70.0

REMARKS: Soft water containing low mineral matter. The water is organically polluted. Further treatment (chlorination) is necessary. The water should be checked for bacteriological contamination.

Date 13th December, 95


(D. N. WAMITI)
For: Government Chemist

DNW/lwm.

GPK 6586-10m-9/94

REPUBLIC OF KENYA

OFFICE OF THE PRESIDENT

GOVERNMENT CHEMIST'S DEPARTMENT

Telephone: 725806/7

P.O. Box 20753

NAIROBI, KENYA

REPORT ON CHEMICAL ANALYSIS OF WATER

Report Reference: P/WAT. VOL.V/95/63
Laboratory Sample No. 765/95
Sender: Prof. F. M. Muthuli, Box 43844
Source: Sample No. 25 NAIROBI

Date: 13th December, 95

Date Received: 29-11-95

Date Sample Taken:

River Nairobi-Mt. Kenya Forest.
NYERI RESULTS

PHYSICAL TESTS

Colour: 10 (Hazen Units) Turbidity: Nil (J.T.U.'s)
Deposit: Silt Odour: Nil (T.O.N.)
Taste: - Electrical Conductivity at 25°C (micro mhos/cm³)
pH: 7.4 20

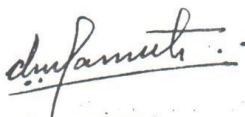
CHEMICAL TESTS

	mg/l(ppm)	me/l
Total Alkalinity as CaCO ₃	8.0	
Phenolphthalein (CO ₃)=	Nil	
Methyl Orange (HCO ₃)—	8.0	
Chloride (Cl)—	3.0	
Sulphate (SO ₄)=	Nil	
Nitrate (NO ₃)	Nil	
Nitrite (NO ₂)—	Nil	
Fluoride (F)—	0.1	
Total Anions	-	
Sodium (Na)+	2.7	
Potassium (K)+	1.7	
Calcium (Ca)++	1.6	
Magnesium (Mg)+++	Nil	
Iron (Total) (Fe)+++	0.02	
Manganese (Mn)++	0.003	
Ammonia—Free & Saline (NH ₄) +	Nil	
Ammonia—Albuminoid (NH ₄) +	Nil	
(Pb Cu Zn)	-	
Total Cations	-	

	mg/l (ppm)
Carbonate Hardness as (CaCO ₃)	4.0
Non-Carbonate Hardness as (CaCO ₃)	Nil
Total Hardness as (CaCO ₃)	4.0
Free Carbon Dioxide	3.0
Silica (SiO ₂)	30.0
Oxygen absorbed, 4 hr. at 27°C (P.V.)	2.6
Total Dissolved Solids, residue dried at 180°C	14.0

REMARKS: Very soft water containing low mineral matter. The Water is polluted with organic matter. Further treatment (chlorination) is necessary. The water should be checked for bacteriological contamination.

Date 13th December, 95


 (D. N. WAMUTI)
 For: Government Chemist

DNW./lwm
 GPK 6386-10m-9/94

REPUBLIC OF KENYA

OFFICE OF THE PRESIDENT

GOVERNMENT CHEMIST'S DEPARTMENT

Telephone: 725806/7

P.O. Box 20753

NAIROBI, KENYA

REPORT ON CHEMICAL ANALYSIS OF WATER

Report Reference: P/WAT/VOL.V/95/61

Date: 13th December, 95

Laboratory Sample No. 735/95

Date Received: 20/11/95

Sender: Prof. Muthuli

Date Sample Taken:

Source: R. NBI(Lusoi Primary) No. 16
NYERI

RESULTS

PHYSICAL TESTS

Colour: 160 (Hazen Units)

Turbidity: Slightly Turbid (P.T.U.s)

Deposit: Silt

Odour: None (T.O.N.)

Taste: -

Electrical Conductivity at 25°C (micro mhos/cm³)

pH: 6.5

34

CHEMICAL TESTS

	mg/l(ppm)	me/l
Total Alkalinity as CaCO ₃	14.0	
Phenolphthalein (CO ₃)=	Nil	
Methyl Orange (HCO ₃)=	14.0	
Chloride (Cl)-	4.0	
Sulphate (SO ₄)=	3.5	
Nitrate (NO ₃)	Nil	
Nitrite (NO ₂)=	Nil	
Fluoride (F)-	0.3	
Total Anions	-	
Sodium (Na)+	4.1	
Potassium (K)+	2.9	
Calcium (Ca)++	2.4	
Magnesium (Mg)++	1.0	
Iron (Total) (Fe)+++	0.7	
Manganese (Mn)++	Nil	
Ammonia-Free & Saline (NH ₄) +	Nil	
Ammonia-Albuminoid (NH ₄) +	Nil	
(Pb Cu Zn)	-	
Total Cations	-	

	mg/l (ppm)
Carbonate Hardness as (CaCO ₃)	10.0
Non-Carbonate Hardness as (CaCO ₃)	Nil
Total Hardness as (CaCO ₃)	10.0
Free Carbon Dioxide	23.0
Silica (SiO ₂)	24.0
Oxygen absorbed. 4 hr. at 27°C (P.V.)	3.65
Total Dissolved Solids, residue dried at 180°C	24.0

REMARKS: Neutral and very coloured water due to the presence of excessive iron in it. The water is also highly polluted with organic matter.

Removal of iron and treatment (chlorination) are recommended before this water is used for human consumption.

Date 13th December, 95


J.C. NAGI
For: Government Chemist

JCN/lwm.
GPK 6586-10m-9/94

REPUBLIC OF KENYA
OFFICE OF THE PRESIDENT
GOVERNMENT CHEMIST'S DEPARTMENT

Telephone: 725806/7
P.O. Box 20753
NAIROBI, KENYA

REPORT ON CHEMICAL ANALYSIS OF WATER

Report Reference: P/WAT/VOL.V/95/62
Laboratory Sample No. 733/95
Sender: Prof. F.M. Muthuli
Source: Intake from Nbi-River - near Railway

Date: 13th December, 95
Date Received: 20/11/95
Date Sample Taken: 14 Kigango

RESULTS

PHYSICAL TESTS

Colour: 500 (Hazen Units)
Deposit: Silt
Taste: -
pH: 6.7

Turbidity: Turbid (J.T.U.'s)
Odour: Nil (T.O.N.)
Electrical Conductivity at 25°C (micro mhos/cm³)
59.0

CHEMICAL TESTS

	mg/l(ppm)	me/l
Total Alkalinity as CaCO ₃	28.0	
Phenolphthalein (CO ₃)=	Nil	
Methyl Orange (HCO ₃)=	28.0	
Chloride (Cl)-	4.0	
Sulphate (SO ₄)=	3.0	
Nitrate (NO ₃)	Nil	
Nitrite (NO ₂)=	Nil	
Fluoride (F)-	1.2	
Total Anions	-	
Sodium (Na)+	9.5	
Potassium (K)+	5.7	
Calcium (Ca)++	4.0	
Magnesium (Mg)++	0.5	
Iron (Total) (Fe)+++	7.4	
Manganese (Mn)++	0.03	
Ammonia-Free & Saline (NH ₄)+	Nil	
Ammonia-Albuminoid (NH ₄)+	0.2	
(Pb Cu Zn)	-	
Total Cations	-	

	mg/l (ppm)
Carbonate Hardness as (CaCO ₃)	12.0
Non-Carbonate Hardness as (CaCO ₃)	Nil
Total Hardness as (CaCO ₃)	12.0
Free Carbon Dioxide	6.0
Silica (SiO ₂)	30.0
Oxygen absorbed. 4 hr. at 27°C (P.V.)	9.25
Total Dissolved Solids, residue dried at 180°C	41.0

REMARKS: Acidic and turbid water that also has a fairly high degree of organic pollution. Removal of colour and chlorination are recommended.

Date 13th December, 95

For: 
J. C. NEUFEL
Government Chemist

JCN/lwm
GPK 6586-10m-9/94

REPUBLIC OF KENYA

OFFICE OF THE PRESIDENT

GOVERNMENT CHEMIST'S DEPARTMENT

Telephone: 725806/7

P.O. Box 20753

NAIROBI, KENYA

REPORT ON CHEMICAL ANALYSIS OF WATER

Report Reference: P/WAT/VOL. V/95/54

Date: 11/12/95

Laboratory Sample No. 737/95

Date Received: 20/11/95

Sender: Prof. Muthuli Box 43844, NAIROBI

Date Sample Taken:

Source: R. NBI after receiving sewage (No. 20)

NYERI (near Sagana Confluence)

RESULTS

PHYSICAL TESTS

Colour: 180.0 (Hazen Units)

Turbidity: Very turbid (J.T.U.'s)

Deposit: Silt

Odour: None (T.O.N.)

Taste: -

Electrical Conductivity at 25°C (micro mhos/cm³)

pH: 6.7


CHEMICAL TESTS

	mg/l(ppm)	me/l
Total Alkalinity as CaCO ₃	24.0	
Phenolphthaleïn (CO ₃)= .. .	Nil	
Methyl Orange (HCO ₃)— .. .	24.0	
Chloride (Cl)— .. .	3.0	
Sulphate (SO ₄)= .. .	2.0	
Nitrate (NO ₃) .. .	Trace	
Nitrite (NO ₂)— .. .	Nil	
Fluoride (F)— .. .	0.4	
Total Anions .. .	-	
Sodium (Na)+ .. .	6.1	
Potassium (K)+ .. .	3.6	
Calcium (Ca)+ + .. .	3.2	
Magnesium (Mg)+ + .. .	0.8	
Iron (Total) (Fe)+ + + .. .	2.4	
Manganese (Mn)+ + .. .	0.02	
Ammonia—Free & Saline (NH ₄)+ .. .	Nil	
Ammonia—Albuminoid (NH ₄)+ .. .	Nil	
(Pb Cu Zn) .. .	-	
Total Cations .. .	-	

	mg/l (ppm)
Carbonate Hardness as (CaCO ₃)	10.0
Non-Carbonate Hardness as (CaCO ₃)	Nil
Total Hardness as (CaCO ₃)	10.0
Free Carbon Dioxide	30.0
Silica (SiO ₂)	22.0
Oxygen absorbed. 4 hr. at 27°C (P.V.)	5.3
Total Dissolved Solids, residue dried at 180°C	29.0

REMARKS: Neutral and very coloured water due to the presence of excessive iron in it. The water is also highly polluted with organic matter. Removal of iron and treatment (Chlorination) are recommended before this water is used for human consumption.

Date 11th December, 1995


M. KASINA)
for: Government Chemist

MK/SNK.

REPUBLIC OF KENYA

OFFICE OF THE PRESIDENT

GOVERNMENT CHEMIST'S DEPARTMENT

Telephone: 725806/7

P.O. Box 20753

NAIROBI, KENYA

REPORT ON CHEMICAL ANALYSIS OF WATER

Report Reference: P/WAT/VOL.V/95/53

Date: 11/12/95

Laboratory Sample No. 742/95

Date Received: 20/11/95

Sender: Prof. Muthuri, Box 43844, NAIROBI

Date Sample Taken: 10/11/95

Source: No. 21: Sagana River near ~~old~~ ^{the} railway station ~~bridge~~ ^{bridge}

RESULTS

PHYSICAL TESTS

Colour: 70.0 (Hazen Units)

Turbidity: Turbid (J.T.U.'s)

Deposit: Silt

Odour: None (T.O.N.)

Taste: -

Electrical Conductivity at 25°C (micro mhos/cm³)

pH: 6.8

59.5


CHEMICAL TESTS

	mg/l(ppm)	me/l
Total Alkalinity as CaCO ₃	20.0	
Phenolphthalein (CO ₃)=	Nil	
Methyl Orange (HCO ₃)—	20.0	
Chloride (Cl)—	2.0	
Sulphate (SO ₄)=	0.2	
Nitrate (NO ₃)	0.6	
Nitrite (NO ₂)—	Nil	
Fluoride (F)—	0.1	
Total Anions	-	
Sodium (Na)+	6.6	
Potassium (K)+	3.7	
Calcium (Ca)++	4.0	
Magnesium (Mg)+++	1.2	
Iron (Total) (Fe)+++	1.5	
Manganese (Mn)++	0.01	
Ammonia—Free & Saline (NH ₄) +	0.10	
Ammonia—Albuminoid (NH ₄) +	Nil	
(Pb Cu Zn)	-	
Total Cations	-	

	mg/l (ppm)
Carbonate Hardness as (CaCO ₃)	15.0
Non-Carbonate Hardness as (CaCO ₃)	Nil
Total Hardness as (CaCO ₃)	15.0
Free Carbon Dioxide	6.0
Silica (SiO ₂)	25.0
Oxygen absorbed. 4 hr. at 27°C (P.V.)	5.0
Total Dissolved Solids, residue dried at 180°C	41.50

REMARKS: Slightly acid and soft water containing a low amount of dissolved mineral matter. The turbidity of the water is due to the high iron content which exceeds the maximum permissible level of 0.3 ppm in drinking water. The water is also organically polluted. The water is unsuitable for drinking unless it is treated.

Date 11th December, 1995


(M. KASINA)
for: Government Chemist

MK/SNK.

REPUBLIC OF KENYA

OFFICE OF THE PRESIDENT

GOVERNMENT CHEMIST'S DEPARTMENT

Telephone: 725806/7

P.O. Box 20753

NAIROBI, KENYA

REPORT ON CHEMICAL ANALYSIS OF WATER

Report Reference: P/WAT/VOL.V/95/57

Date: 13/12/95

Laboratory Sample No. 744/95

Date Received: 20/11/95

Sender: Prof. Muthuri, Box 43844, NAIROBI

Date Sample Taken:

Source: Sagana River at Marua.

RESULTS

PHYSICAL TESTS

Colour: 60.0 (Hazen Units)

Turbidity: Turbid (J.T.U.'s)

Deposit: Silt

Odour: None (T.O.N.)

Taste: -

Electrical Conductivity at 25°C (micro mhos/cm³)

pH: 6.8

63.0

CHEMICAL TESTS

	mg/l(ppm)	me/l
Total Alkalinity as CaCO ₃	22.0	
Phenolphthalein (CO ₃)=	Nil	
Methyl Orange (HCO ₃)—	22.0	
Chloride (Cl)—	3.0	
Sulphate (SO ₄)=	0.2	
Nitrate (NO ₃)	Trace	
Nitrite (NO ₂)—	Nil	
Fluoride (F)—	0.10	
Total Anions	-	
Sodium (Na)+	6.0	
Potassium (K)+	3.2	
Calcium (Ca)++	5.2	
Magnesium (Mg)++	1.7	
Iron (Total) (Fe)+++	1.5	
Manganese (Mn)++	Trace	
Ammonia—Free & Saline (NH ₄) +	0.10	
Ammonia—Albuminoid (NH ₄) +	Nil	
(Pb Cu Zn)	-	
Total Cations	-	

	mg/l (ppm)
Carbonate Hardness as (CaCO ₃)	20.0
Non-Carbonate Hardness as (CaCO ₃)	Nil
Total Hardness as (CaCO ₃)	20.0
Free Carbon Dioxide	6.0
Silica (SiO ₂)	25.0
Oxygen absorbed, 4 hr. at 27°C (P.V.)	3.9
Total Dissolved Solids, residue dried at 180°C	45.0

REMARKS: Slightly acidic and soft water of low mineral content.
The water is also organically polluted. Treatment
of the water is recommended.

Date 13th December, 1995


(M. KASINA)
for : Government Chemist

MK/SNK.

MINISTRY OF WATER DEVELOPMENT
WATER QUALITY MONITORING PROGRAMME
(WATER ANALYSIS REPORT SHEET)

Lab. Ref. No. 6/94 Date of Sampling 28/2/94
Source Ambani River Date Received 28/2/94
RGS or B/H No. 4AB5 Submitted by DWE - NYERI
(Flow(m³)) Box 475 NYERI

Parameter	Unit	Results
Temperature	°C	21.0
pH	pH Scale	7.4
Colour	mg/Pl/l	—
Turbidity	N.T.U./J.T.U.	20.0
Conductivity	μmhos/cm	256.3
Iron	mg/l	0.02
Manganese	mgMn/l	—
Calcium	mgCa/l	15.2
Magnesium	mgMg/l	5.3
Sodium	mgNa/l	—
Potassium	mgK/l	—
Silica	mg/SiO ₂ /l	—
Copper	mgCu/l	—
Lead	mgPb/l	—
Boron	mgB/l	—
Total Hardness	mg/CaCO ₃ /l	60.0
Total Alkalinity	mg/CaCO ₃ /l	10.0
Chloride	mgCl/l	8.9
Fluoride	mgF/l	—
Nitrate	mgN/l	—
Sulphate	mgSO ₄ /l	1.8
Orthophosphate	mgP/l	—
Total Suspended solids	mg/l	—
Total Dissolved solids	mg/l	166.6
BOD (5 days 20°C)	mgO ₂ /l	—
Dissolved oxygen	mgO ₂ /l	—
Free CO ₂	mg/l	1.0
20 min P.V.	mgO ₂ /l	22.1

COMMENTS:— Neutral Water of good
good chemical quality

MINISTRY OF WATER DEVELOPMENT
WATER QUALITY MONITORING CONTROL
DIVISION
B/C O. M. M. S. G.
Water Testing Laboratory.

17/2/94

MINISTRY OF WATER DEVELOPMENT
WATER QUALITY MONITORING PROGRAMME
(WATER ANALYSIS REPORT SHEET)

Lab. Ref. No. 37/94 Date of Sampling 8/6/94
Source River, Amberi, Hs Bridge. Date Received 8/6/94
RGS or B/H No. Honi water Project Submitted by D.W.E. NYERI
(Flow(m³)) PLANNING & DESIGN SECTION

Parameter	Unit	Results	Remarks
Temperature	°C	<u>20</u>	
pH	pH Scale	<u>7.4</u>	
Colour	mg/Pt/l		
Turbidity	N.T.U./J.T.U.	<u>6.4</u>	
Conductivity	umhos/cm	<u>99.7</u>	
Iron	mg/l	<u>0.04</u>	
Manganese	mgMn/l		
Calcium	mgCa/l		
Magnesium	mgMg/l		
Sodium	mgNa/l		
Potassium	mgK/l		
Silica	mg/SiO ₂ /l		
Copper	mgCu/l		
Lead	mgPb/l		
Boron	mgB/l		
Total Hardness	mg/CaCO ₃ /l	<u>NIL</u>	
Total Alkalinity	mg/CaCO ₃ /l	<u>16</u>	
Chloride	mgCl/l	<u>3.0</u>	
Fluoride	mgF/l		
Nitrate	mgN/l		
Sulphate	mgSO ₄ /l	<u>0.3</u>	
Orthophosphate	mgP/l		
Total Suspended solids	mg/l		
Total Dissolved solids	mg/l	<u>57.8</u>	
BOD (5 days 20°C)	mgO ₂ /l		
Dissolved oxygen	mgO ₂ /l		

Free Carbon dioxide - 2.0 mg CO₂/l
20 Minute Permanganate value - 9.48 mg O₂/l

COMMENTS: - Neutral water of good chemical quality.
fit for the intended use - purpose.

O/C D. N. S. 270
Water Testing Laboratory.

Appendix 10

Chemical analysis of treated (river) water

REPUBLIC OF KENYA

OFFICE OF THE PRESIDENT

GOVERNMENT CHEMIST'S DEPARTMENT

Telephone: 725806/7

P.O. Box 20753

NAIROBI, KENYA

REPORT ON CHEMICAL ANALYSIS OF WATER

Report Reference: P/WAT/VOL.V/95/56

Date: 13/12/95

Laboratory Sample No. 730/95

Date Received: 20/11/95

Sender: Prof. Muthuli, Box 43844, NAIROBI

Date Sample Taken:

Source: Kamakwa Treatment Plant

No. 11

RESULTS

PHYSICAL TESTS

Colour: 10 (Hazen Units)

Turbidity: Clear (J.T.U.'s)

Deposit: Silt

Odour: None (T.O.N.)

Taste: -

Electrical Conductivity at 25°C (micro mhos/cm³)

pH: 7.1

52

CHEMICAL TESTS

	mg/l(ppm)	me/l
Total Alkalinity as CaCO ₃	10.0	
Phenolphthalein (CO ₃)=	Nil	
Methyl Orange (HCO ₃)=	10.0	
Chloride (Cl)-	4.0	
Sulphate (SO ₄)=	10.0	
Nitrate (NO ₃)	Nil	
Nitrite (NO ₂)=	Nil	
Fluoride (F)-	0.3	
Total Anions	-	
Sodium (Na)+	3.2	
Potassium (K)+	1.9	
Calcium (Ca)++	4.0	
Magnesium (Mg)++	1.0	
Iron (Total) (Fe)+++	0.06	
Manganese (Mn)++	0.01	
Ammonia-Free & Saline (NH ₄)+	Nil	
Ammonia-Albuminoid (NH ₄)+	Nil	
(Pb Cu Zn)	-	
Total Cations	-	

	mg/l (ppm)
Carbonate Hardness as (CaCO ₃)	14.0
Non-Carbonate Hardness as (CaCO ₃)	Nil
Total Hardness as (CaCO ₃)	14.0
Free Carbon Dioxide	4.0
Silica (SiO ₂)	20.0
Oxygen absorbed, 4 hr. at 27°C (P.V.)	0.7
Total Dissolved Solids, residue dried at 180°C	36.0

REMARKS: Neutral and very soft water having a low mineral content. The water is chemically and organically suitable for human consumption.

Date 13th December, 1995

for: J. O. NGUGI
Government Chemist

JCN/SNK.

REPUBLIC OF KENYA

OFFICE OF THE PRESIDENT
GOVERNMENT CHEMIST'S DEPARTMENT

Telephone: 725806/7
P.O. Box 20753
NAIROBI, KENYA

REPORT ON CHEMICAL ANALYSIS OF WATER

Report Reference: P/WAT/VOL.V/95/58

Date: 13/12/95

Laboratory Sample No. 731/95

Date Received: 20/11/95

Sender: Prof. F.M. Muthuli, Box 43844, NBI

Date Sample Taken:

Source: Kiganjo Treatment Works No. 12
NYERI

RESULTS

PHYSICAL TESTS

Colour: 150 (Hazen Units)

Turbidity: Turbid (J.T.U.'s)

Deposit: Silt

Odour: None (T.O.N.)

Taste: -

Electrical Conductivity at 25°C (micro mhos/cm³)
110

pH: 6.3

CHEMICAL TESTS

	mg/l(ppm)	me/l
Total Alkalinity as CaCO ₃	10.0	
Phenolphthalein (CO ₃)=	Nil	
Methyl Orange (HCO ₃)=	10.0	
Chloride (Cl)-	6.0	
Sulphate (SO ₄)=	31.0	
Nitrate (NO ₃)	Nil	
Nitrite (NO ₂)-	Nil	
Fluoride (F)-	0.3	
Total Anions	-	
Sodium (Na)+	9.7	
Potassium (K)+	4.4	
Calcium (Ca)++	7.2	
Magnesium (Mg)++	1.4	
Iron (Total) (Fe)+++	0.6	
Manganese (Mn)++	0.06	
Ammonia-Free & Saline (NH ₄)+	Nil	
Ammonia-Albuminoid (NH ₄)+	Nil	
(Pb Cu Zn)	-	
Total Cations	-	

	mg/l (ppm)
Carbonate Hardness as (CaCO ₃)	24.0
Non-Carbonate Hardness as (CaCO ₃)	Nil
Total Hardness as (CaCO ₃)	24.0
Free Carbon Dioxide	6.0
Silica (SiO ₂)	20.0
Oxygen absorbed, 4 hr. at 27°C (P.V.)	11.15
Total Dissolved Solids, residue dried at 180°C	80.0

REMARKS: Acidic and turbid water that also has a fairly high degree of organic pollution. Removal of colour and chlorination are recommended.

Date 13th December, 1995


for: Government Chemist

JCN/SNK.

REPUBLIC OF KENYA

OFFICE OF THE PRESIDENT

GOVERNMENT CHEMIST'S DEPARTMENT

Telephone: 725806/7

P.O. Box 20753

NAIROBI, KENYA

REPORT ON CHEMICAL ANALYSIS OF WATER

Report Reference: P/WAT/VOL.V/95/60

Date: 13th December, 95

Laboratory Sample No. 736/95

Date Received: 20/11/95

Sender: Prof. Muthuli

Date Sample Taken:

Source: Kiganjo Treatment Works (No. 19)

NYERI

RESULTS

PHYSICAL TESTS

Colour: 170 (Hazen Units)

Turbidity: Very Turbid (J.T.U.'s)

Deposit: Silt

Odour: None (T.O.N.)

Taste: -

Electrical Conductivity at 25°C (micro mhos/cm³)

pH: 5.9

83

CHEMICAL TESTS

	mg/l(ppm)	me/l
Total Alkalinity as CaCO ₃	12.0	
Phenolphthalein (CO ₃)=	Nil	
Methyl Orange (HCO ₃)=	12.0	
Chloride (Cl)-	2.0	
Sulphate (SO ₄)=	33.0	
Nitrate (NO ₃)	Nil	
Nitrite (NO ₂)=	Nil	
Fluoride (F)-	0.4	
Total Anions	-	
Sodium (Na)+	9.9	
Potassium (K)+	4.5	
Calcium (Ca)++	4.0	
Magnesium (Mg)++	1.0	
Iron (Total) (Fe)+++	1.3	
Manganese (Mn)++	0.05	
Ammonia-Free & Saline (NH ₄)+	Nil	
Ammonia-Albuminoid (NH ₄)+	Nil	
(Pb Cu Zn)	-	
Total Cations	-	

	mg/l (ppm)
Carbonate Hardness as (CaCO ₃)	14.0
Non-Carbonate Hardness as (CaCO ₃)	Nil
Total Hardness as (CaCO ₃)	14.0
Free Carbon Dioxide	30.0
Silica (SiO ₂)	20.0
Oxygen absorbed, 4 hr. at 27°C (P.V.)	1.45
Total Dissolved Solids, residue dried at 180°C	59.5

REMARKS: Neutral and very coloured water due to the presence of excessive iron in it. The water is also highly polluted with organic matter.

Removal of iron and treatment (chlorination) are recommended before this water is used for human consumption.

Date 13th December, 95

For:  J. C. (GUGI)
Government Chemist

JCN/lwm
GPK 6586-10m-9/94

REPUBLIC OF KENYA

OFFICE OF THE PRESIDENT

GOVERNMENT CHEMIST'S DEPARTMENT

Telephone: 725806/7

P.O. Box 20753

NAIROBI, KENYA

REPORT ON CHEMICAL ANALYSIS OF WATER

Report Reference: P/WAT/VOL.V/95/52

Date: 11/12/95

Laboratory Sample No. 743/95

Date Received: 20/11/95

Sender: Prof. Muthuri, Box 43844, NAIROBI

Date Sample Taken:

Source: Kerichu Town (Treated)

RESULTS

PHYSICAL TESTS

Colour: 5.0 (Hazen Units)

Turbidity: Slight (J.T.U.'s)

Deposit: None

Odour: None (T.O.N.)

Taste: -

Electrical Conductivity at 25°C (micro mhos/cm³)

pH: 5.9

110

CHEMICAL TESTS

	mg/l(ppm)	me/l
Total Alkalinity as CaCO ₃	8.0	
Phenolphthalein (CO ₃)= .. .	Nil	
Methyl Orange (HCO ₃)— .. .	8.0	
Chloride (Cl)— .. .	3.0	
Sulphate (SO ₄)= .. .	0.20	
Nitrate (NO ₃) .. .	0.40	
Nitrite (NO ₂)— .. .	Nil	
Fluoride (F)— .. .	0.10	
Total Anions .. .	-	
Sodium (Na)+ .. .	8.50	
Potassium (K)+ .. .	3.90	
Calcium (Ca)++ .. .	7.2	
Magnesium (Mg)+++ .. .	1.4	
Iron (Total) (Fe)+++ .. .	0.6	
Manganese (Mn)++ .. .	0.10	
Ammonia—Free & Saline (NH ₄)+ .. .	0.10	
Ammonia—Albuminoid (NH ₄)+ .. .	Nil	
(Pb Cu Zn) .. .	-	
Total Cations .. .	-	

	mg/l (ppm)
Carbonate Hardness as (CaCO ₃)	8.0
Non-Carbonate Hardness as (CaCO ₃)	16.0
Total Hardness as (CaCO ₃)	24.0
Free Carbon Dioxide	7.0
Silica (SiO ₂)	10.0
Oxygen absorbed. 4 hr. at 27°C (P.V.)	1.50
Total Dissolved Solids, residue dried at 180°C	75.0

REMARKS: Acidic water containing a low amount of dissolved mineral matter. The water is of good chemical quality but is organically polluted. The water is unsuitable for drinking unless it is treated.

Date 11th December, 1995



(M. KASINA)

for: Government Chemist

MK/SNK.

REPUBLIC OF KENYA

OFFICE OF THE PRESIDENT

GOVERNMENT CHEMIST'S DEPARTMENT

Telephone: 725806/7

P.O. Box 20753

NAIROBI, KENYA

REPORT ON CHEMICAL ANALYSIS OF WATER

Report Reference: P/WAT/VOL.V/95/49

Date: 7/12/95

Laboratory Sample No. 727/95

Date Received: 20/11/95

Sender: Professor Muthuli, Box 43844, NAIROBI

Date Sample Taken:

Source: No.6 Green Hills Hotel

RESULTS

PHYSICAL TESTS

Colour: less than 5 (Hazen Units)

Deposit: some silt

Taste: -

pH: 7.3

Turbidity: clear (J.T.U.'s)

Odour: none (T.O.N.)

Electrical Conductivity at 25°C (micro mhos/cm³)

47.0

CHEMICAL TESTS

	mg/l(ppm)	me/l
Total Alkalinity as CaCO ₃	10.0	
Phenolphthalein (CO ₃)=	NIL	
Methyl Orange (HCO ₃)—	10.0	
Chloride (Cl)—	2.0	
Sulphate (SO ₄)=	NIL	
Nitrate (NO ₃)	TRACE	
Nitrite (NO ₂)—	NIL	
Fluoride (F)—	0.1	
Total Anions		
Sodium (Na)+	3.2	
Potassium (K)+	1.7	
Calcium (Ca)++	4.0	
Magnesium (Mg)++	1.0	
Iron (Total) (Fe)+++	0.01	
Manganese (Mn)++	0.02	
Ammonia—Free & Saline (NH ₄) +	NIL	
Ammonia—Albuminoid (NH ₄) +	NIL	
(Pb Cu Zn)		
Total Cations		

	mg/l (ppm)
Carbonate Hardness as (CaCO ₃)	10.0
Non-Carbonate Hardness as (CaCO ₃)	4.0
Total Hardness as (CaCO ₃)	14.0
Free Carbon Dioxide	7.0
Silica (SiO ₂)	20.0
Oxygen absorbed, 4 hr. at 27°C (P.V.)	0.50
Total Dissolved Solids, residue dried at 180°C	33.0

REMARKS:

Soft water of low mineral content. The water is of good organic and chemical qualities.

Date 7th December, 1995


 (M. KASINA)
 for: Government Chemist

MK/MWK.

MINISTRY OF WATER DEVELOPMENT
WATER QUALITY MONITORING PROGRAMME
(WATER ANALYSIS REPORT SHEET)

Lab. Ref. No. 68/95 Date of Sampling 15/6/95
Source Kanakwa W/Supply at Skuta Date Received 15/6/95
RGS or B/H No. Monitoring Submitted by P.J. - HYERI
(Flow(m³)) BOX 1343, NYERI

Parameter	Unit	Results
Temperature	20	°C
pH	7.0	pH Scale
Colour	-	mg/Pt/l
Turbidity	2.8	N.T.U./J.T.U.
Conductivity	74.5	µmhos/cm
Iron	0.02	mg/l
Manganese	-	mgMn/l
Calcium	5.6	mgCa/l
Magnesium	NIL	mgMg/l
Sodium	-	mgNa/l
Potassium	-	mgK/l
Silica	-	mg/SiO ₂ /l
Copper	-	mgCu/l
Lead	-	mgPb/l
Boron	-	mgB/l
Total Hardness	NIL	mg/CaCO ₃ /l
Total Alkalinity	8.0	mg/CaCO ₃ /l
Chloride	3.5	mgCl/l
Fluoride	-	mgF/l
Nitrate	-	mgN/l
Sulphate	1.2	mgSO ₄ /l
Orthophosphate	-	mgP/l
Total Suspended solids	-	mg/l
Total Dissolved solids	48.4	mg/l
BOD (5 days 20°C)	-	mgO ₂ /l
Dissolved oxygen	-	mgO ₂ /l
Free CO ₂	2.0	mg/l
20 min. PV	15.3	mgMnO ₄ /L

COMMENTS:—

Neutral water of good chemical quality.

O. NASONGO
Oil/C
Water Testing Laboratory. NYERI

APPENDIX 11
Guidelines for Drinking Water Quality for Kenya and World Health Organization (WHO)

Water Constituent	Units	Guideline Value	
		Kenya	WHO
Colour	mg Pt/l	<25	15 TCU
Turbidity	NTU	15	5
Odour	TON		inoffensive
Electrical Conductivity at 25°C	micromhos/cm	2000	
pH	pH	6.5-8.5	6.5-8.5
Total Alkalinity (CaCO ₃)	mg/l (ppm)	500	
Chloride (Cl)-	"	250	250
Sulphate (SO ₄)=	"	400	400
Nitrate (NO ₃)-	"	10	10
Nitride (NO ₂)	"		
Fluoride (F)-	"	1.5	1.5
Sodium (Na)+	"	200	200
Potassium (K)+	"		
Calcium (Ca)++	"		
Magnesium (Mg)++	"		
Manganese	"	0.1	0.1
Iron-Total (Fe)+++	"	0.3	0.3
Ammonia-Free & Saline (NH ₄)+	"		
Phosphate (P)	"		
Carbonate Hardness as CaCO ₃)	"		
Total Hardness	"	250	250
Free Carbon Dioxide	"		
Silica (SiO ₂)	"		
Oxygen Absorbed 4 hr. at 27°C (P.V.)	"		
Total Dissolved Solids, residue at 180°C	"		
Suspended Solids (S.S.)	"	1000	1000
	"	Free of S.S.	

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ANNEX 4

COST AND FINANCIAL DETAILS

VOLUME II
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Table 1.1
RAW WATER MAIN COSTS

Option	Town	Dia. (mm)	Length (m)	Rate KShs.	Amount KShs.	Total KShs.
A1	Nyeri & Kiganjo Combined	500	6,100	8,205	50,050,500	
A2	Nyeri	500	1,753	8,205	14,383,365	47,157,755
	Kiganjo	450	4,447	7,370	32,774,390	
B1	Nyeri & Kiganjo Combined	300	2,000	4,225	8,450,000	
B2	Nyeri	650	2,300	13,340	30,682,000	
	Kiganjo	600	2,300	12,305	28,301,500	
		300	2,000	4,225	8,450,000	

Table 1.2
TREATMENT WORKS COST ESTIMATES
YEAR 2010 WORKS

Item No.	Item Description	Estimated Cost [KShs]					
		Option A1	Option A2		Option B1	Option B2	
			Nyeri	Kiganjo		Nyeri	Kiganjo
1	Site Works	4,476,200	4,476,200	4,322,300	4,828,900	4,828,900	4,322,300
2	Treatment Units	49,361,100	38,824,400	15,603,200	49,422,700	38,701,400	15,603,200
3	Chemical Building	3,929,000	3,245,700	2,045,800	3,929,000	3,245,700	2,045,800
4	Pump House	1,648,400	1,557,700	2,934,500	1,648,400	1,557,700	2,934,500
5	Administration Building	-	-	1,787,300	2,502,100	2,502,100	1,787,300
6	Staff Quarters	8,618,100	8,618,100	4,154,900	9,049,000	9,049,000	4,154,900
7	Backwash Tank	2,466,500	2,081,700	1,687,500	2,466,500	2,081,700	1,687,500
8	Electrical Installation	400,000	400,000	3,000,000	4,000,000	4,000,000	3,000,000
9	Land Acquisition	-	-	500,000	1,200,000	1,200,000	500,000
TOTAL		70,899,300	59,203,800	36,035,500	79,046,600	67,166,500	36,035,500
				95,239,300			103,202,000

Table 1.3
TREATMENT WORKS COST ESTIMATES
YEAR 2020 WORKS

Item No.	Item Description	Estimated Cost [KShs]					
		Option A1	Option A2		Option B1	Option B2	
			Nyeri	Kiganjo		Nyeri	Kiganjo
1	Site Works	4,476,200	4,476,200	4,322,300	4,828,900	4,828,900	4,322,300
2	Treatment Units	74,523,300	57,971,400	20,478,300	74,347,700	57,816,100	20,478,300
3	Chemical Building	3,929,000	3,245,700	2,045,800	3,929,000	3,245,700	2,045,800
4	Pump House	1,883,900	1,747,900	3,985,700	1,884,000	1,747,900	3,985,700
5	Administration Building	-	-	1,787,300	2,502,100	2,502,100	1,787,300
6	Staff Quarters	8,618,100	8,618,100	4,154,900	9,049,000	9,049,000	4,154,900
7	Backwash Tank	2,466,500	2,081,700	1,687,500	2,466,500	2,081,700	1,687,500
8	Electrical Installation	400,000	400,000	3,000,000	4,000,000	4,000,000	3,000,000
9	Land Acquisition	-	-	500,000	1,200,000	1,200,000	500,000
TOTAL		96,297,000	78,541,000	41,961,800	104,207,200	86,471,400	41,961,800
				120,502,800			128,433,200

Table 1.4
STORAGE COSTS

Option	Description	Tank Location	Year 2020' Required Storage	Proposed Tank(s)	Dimensions of Single Tank		Cost/Tank KShs. (x10 ⁶)	Total Cost KShs. (x10 ⁶)
					Int. Dia. (m)	h _{well} (m)		
A1	KAMAKWA FOR NYERI & KIGANJO	KAMAKWA	21920	6 x 3500	35.7	3.5	76.8	102.9
		KAMUYU	1640	1 x 1750	25.2	3.5	7.0	
		MATHARI	820	1 x 1000	19.1	3.5	4.5	
		KING'ONG'O	4605	1 x 4500	37.9	4.0	14.6	
A2	KAMAKWA FOR NYERI	KAMAKWA	23440	6 x 3500	35.7	3.5	76.8	88.3
		KAMUYU	1680	1 x 1750	25.2	3.5	7.0	
		MATHARI	820	1 x 1000	19.1	3.5	4.5	
		IHWA (CONTACT)	830	1 x 1000	19.1	3.5	4.5	
B1	IHWA/KAMAKWA FOR NYERI & KIGANJO	MATHARI	4255	1 x 4500	37.9	4.0	14.6	112.0
		KAMUYU	225	1 x 250	10.3	3.0	1.5	
		KING'ON'GO	4765	1 x 4500	37.9	4.0	14.6	
		KAMAKWA	20580	6 x 3500	35.7	3.5	76.8	
B2	IHWA/KAMAKWA FOR NYERI	IHWA (CONTACT)	680	1 x 750	16.5	3.5	3.5	96.4
		MATHARI	4255	1 x 4500	37.9	4.0	14.6	
		KAMUYU	225	1 x 250	10.3	3.0	1.5	
		KAMAKWA	20580	6 x 3500	35.7	3.5	76.8	
A2 & B2	AMBONI FOR KIGANJO	CHAKA	4165	1 x 4500	37.9	4.0	14.6	20.2
		AMBONI (CONTACT AND SUMP)	150	1 x 500	14.6	3.0	2.8	
		KIRICHU	520	1 x 500	14.6	3.0	2.8	

Table 1.5
OPTIONS A1 - RETICULATION COSTS
YEAR 2010 WORKS

PIPE MATERIAL	PIPE DIA. (mm)	PIPE CLASS	LENGTH (m)	RATE KShs.	AMOUNT KShs.
uPVC	250	B	2,025	1,984	4,017,600
		C	570	2,849	1,623,930
		D	425	3,423	1,454,775
		E	2,300	4,454	10,244,200
	200	B	3,765	1,362	5,127,930
		C	-	1,887	-
		D	1,710	2,489	4,256,190
		E	1,100	2,849	3,133,900
	150	B	7,035	700	4,924,500
		C	2,270	1,021	2,317,670
		D	2,150	1,292	2,777,800
		E	800	1,575	1,260,000
	100	B	2,082	340	707,880
		C	280	495	138,600
		D	2,025	603	1,221,075
		E	3,280	768	2,519,040
	75	B	215	263	56,545
		C	80	330	26,400
		D	215	408	87,720
		E	-	506	-
	50	B	-	107	-
		C	-	175	-
		D	-	214	-
		E	685	272	186,320
FERROUS	700	-	-	14,665	-
	500	-	6,105	8,305	50,702,025
	450	-	-	7,465	-
	400	-	800	5,970	4,776,000
	350	-	4,320	5,220	22,550,400
	300	-	11,120	4,225	46,982,000
	250	-	850	3,550	3,017,500
	200	-	-	2,845	-
	150	-	680	1,400	952,000
	100	-	1,465	1,315	1,926,475
TOTAL			58,352		176,988,475

Table 1.6
OPTIONS A1 - RETICULATION COSTS
YEAR 2020 WORKS

PIPE MATERIAL	PIPE DIA. (mm)	PIPE CLASS	LENGTH (m)	RATE KShs.	AMOUNT KShs.
uPVC	250	B	2,025	1,984	4,017,600
		C	570	2,849	1,623,930
		D	425	3,423	1,454,775
		E	2,300	4,454	10,244,200
	200	B	3,765	1,362	5,127,930
		C	-	1,887	-
		D	2,110	2,489	5,251,790
		E	1,100	2,849	3,133,900
	150	B	7,790	700	5,453,000
		C	2,270	1,021	2,317,670
		D	2,505	1,292	3,236,460
		E	800	1,575	1,260,000
	100	B	3,179	340	1,080,860
		C	280	495	138,600
		D	4,495	603	2,710,485
		E	3,280	768	2,519,040
	75	B	450	263	118,350
		C	160	330	52,800
		D	400	408	163,200
		E	-	506	-
	50	B	-	107	-
		C	-	175	-
		D	-	214	-
		E	745	272	202,640
FERROUS	700	-	-	14,665	-
	500	-	6,105	8,305	50,702,025
	450	-	-	7,465	-
	400	-	800	5,970	4,776,000
	350	-	4,640	5,220	24,220,800
	300	-	11,120	4,225	46,982,000
	250	-	850	3,550	3,017,500
	200	-	-	2,845	-
	150	-	680	1,400	952,000
	100	-	1,820	1,315	2,393,300
TOTAL			64,664		183,150,855

Table 1.7
OPTIONS A2 - NYERI RETICULATION COSTS
YEAR 2010 WORKS

PIPE MATERIAL	PIPE DIA. (mm)	PIPE CLASS	LENGTH (m)	RATE KShs.	AMOUNT KShs.
uPVC	250	B	815	1,984	1,616,960
		C	-	2,849	-
		D	425	3,423	1,454,775
		E	3,150	4,454	14,030,100
	200	B	1,980	1,362	2,696,760
		C	20	1,887	37,740
		D	1,710	2,489	4,256,190
		E	1,100	2,849	3,133,900
	150	B	3,755	700	2,628,500
		C	2,205	1,021	2,251,305
		D	2,150	1,292	2,777,800
		E	1,480	1,575	2,331,000
	100	B	1,647	340	559,980
		C	280	495	138,600
		D	1,470	603	886,410
		E	4,175	768	3,206,400
	75	B	215	263	56,545
		C	-	330	-
		D	215	408	87,720
		E	-	506	-
	50	B	-	107	-
		C	-	175	-
		D	-	214	-
		E	625	272	170,000
FERROUS	700	-	-	14,665	-
	500	-	4,905	8,305	40,736,025
	450	-	-	7,465	-
	400	-	800	5,970	4,776,000
	350	-	6,510	5,220	33,982,200
	300	-	3,370	4,225	14,238,250
	250	-	-	3,550	-
	200	-	-	2,845	-
	150	-	-	1,400	-
	100	-	-	1,315	-
TOTAL			43,002		136,053,160

Table 1.8
OPTIONS A2 - NYERI RETICULATION COSTS
YEAR 2020 WORKS

PIPE MATERIAL	PIPE DIA. (mm)	PIPE CLASS	LENGTH (m)	RATE KShs.	AMOUNT KShs.
uPVC	250	B	815	1,984	1,616,960
		C	570	2,849	1,623,930
		D	425	3,423	1,454,775
		E	3,150	4,454	14,030,100
	200	B	1,980	1,362	2,696,760
		C	-	1,887	-
		D	2,110	2,489	5,251,790
		E	1,150	2,849	3,276,350
	150	B	3,755	700	2,628,500
		C	2,325	1,021	2,373,825
		D	3,285	1,292	4,244,220
		E	1,480	1,575	2,331,000
	100	B	2,184	340	742,560
		C	280	495	138,600
		D	5,160	603	3,111,480
		E	8,795	768	6,754,560
	75	B	450	263	118,350
		C	160	330	52,800
		D	400	408	163,200
		E	-	506	-
	50	B	-	107	-
		C	-	175	-
		D	-	214	-
		E	745	272	202,640
FERROUS	700	-	-	14,665	-
	500	-	4,905	8,305	40,736,025
	450	-	-	7,465	-
	400	-	800	5,970	4,776,000
	350	-	6,510	5,220	33,982,200
	300	-	3,370	4,225	14,238,250
	250	-	-	3,550	-
	200	-	-	2,845	-
	150	-	-	1,400	-
	100	-	-	1,315	-
TOTAL			54,804		146,544,875

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Table 1.10
OPTIONS B1 - RETICULATION COSTS
YEAR 2020 WORKS

PIPE MATERIAL	PIPE DIA. (mm)	PIPE CLASS	LENGTH (m)	RATE KShs.	AMOUNT KShs.
uPVC	250	B	2,370	1,984	4,702,080
		C	1,570	2,849	4,472,930
		D	425	3,423	1,454,775
		E	600	4,454	2,672,400
	200	B	4,695	1,362	6,394,590
		C	-	1,887	-
		D	250	2,489	622,250
		E	400	2,849	1,139,600
	150	B	5,520	700	3,864,000
		C	1,570	1,021	1,602,970
		D	3,455	1,292	4,463,860
		E	1,180	1,575	1,858,500
	100	B	6,610	340	2,247,400
		C	2,110	495	1,044,450
		D	820	603	494,460
		E	2,855	768	2,192,640
	75	B	1,730	263	454,990
		C	160	330	52,800
		D	370	408	150,960
		E	4,590	506	2,322,540
	50	B	-	107	-
		C	-	175	-
		D	-	214	-
		E	1,095	272	297,840
FERROUS	600	-	2,000	12,565	25,130,000
	550	-	1,640	11,502	18,863,280
	500	-	4,685	8,305	38,908,925
	450	-	3,795	7,465	28,329,675
	400	-	3,650	5,970	21,790,500
	350	-	2,580	5,220	13,467,600
	300	-	7,750	4,225	32,743,750
	250	-	1,400	3,550	4,970,000
	200	-	1,750	2,845	4,978,750
	150	-	880	1,400	1,232,000
	100	-	1,110	1,315	1,459,650
	75	-	710	908	644,680
TOTAL			74,325		235,024,845

Table 1.11
OPTIONS B2 - NYERI RETICULATION COSTS
YEAR 2010 WORKS

PIPE MATERIAL	PIPE DIA. (mm)	PIPE CLASS	LENGTH (m)	RATE KShs.	AMOUNT KShs.
uPVC	250	B	1,170	1,984	2,321,280
		C	570	2,849	1,623,930
		D	2,675	3,423	9,156,525
		E	600	4,454	2,672,400
	200	B	1,740	1,362	2,369,880
		C	-	1,887	-
		D	3,500	2,489	8,711,500
		E	1,180	2,849	3,361,820
	150	B	3,520	700	2,464,000
		C	1,720	1,021	1,756,120
		D	2,905	1,292	3,753,260
		E	1,180	1,575	1,858,500
	100	B	3,934	340	1,337,560
		C	1,480	495	732,600
		D	460	603	277,380
		E	2,430	768	1,866,240
	75	B	1,265	263	332,695
		C	-	330	-
		D	705	408	287,640
		E	1,500	506	759,000
	50	B	-	107	-
		C	-	175	-
		D	-	214	-
		E	1,095	272	297,840
FERROUS	600	-	2,000	12,565	25,130,000
	550	-	1,640	11,502	18,863,280
	500	-	4,055	8,305	33,676,775
	450	-	-	7,465	-
	400	-	2,450	5,970	14,626,500
	350	-	630	5,220	3,288,600
	300	-	1,535	4,225	6,485,375
	250	-	1,400	3,550	4,970,000
	200	-	1,750	2,845	4,978,750
	150	-	200	1,400	280,000
	100	-	3,285	1,315	4,319,775
	75	-	125	908	113,500
TOTAL			52,699		162,672,725

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Table 1.12
OPTIONS B2 - NYERI RETICULATION COSTS
YEAR 2020 WORKS

PIPE MATERIAL	PIPE DIA. (mm)	PIPE CLASS	LENGTH (m)	RATE KShs.	AMOUNT KShs.
uPVC	250	B	1,170	1,984	2,321,280
		C	1,570	2,849	4,472,930
		D	2,695	3,423	9,224,985
		E	600	4,454	2,672,400
	200	B	1,760	1,362	2,397,120
		C	-	1,887	-
		D	1,250	2,489	3,111,250
		E	1,180	2,849	3,361,820
	150	B	4,020	700	2,814,000
		C	1,720	1,021	1,756,120
		D	3,455	1,292	4,463,860
		E	1,180	1,575	1,858,500
	100	B	3,090	340	1,050,600
		C	2,110	495	1,044,450
		D	990	603	596,970
		E	2,685	768	2,062,080
	75	B	1,480	263	389,240
		C	2,125	330	701,250
		D	705	408	287,640
		E	2,290	506	1,158,740
	50	B	-	107	-
		C	-	175	-
		D	-	214	-
		E	1,095	272	297,840
FERROUS	600	-	2,000	12,565	25,130,000
	550	-	1,640	11,502	18,863,280
	500	-	4,685	8,305	38,908,925
	450	-	-	7,465	-
	400	-	2,450	5,970	14,626,500
	350	-	-	5,220	-
	300	-	1,525	4,225	6,443,125
	250	-	1,400	3,550	4,970,000
	200	-	1,750	2,845	4,978,750
	150	-	880	1,400	1,232,000
	100	-	3,285	1,315	4,319,775
	75	-	2,610	908	2,369,880
TOTAL			59,395		167,885,310

Table 1.18
OPTIONS A2 AND B2 - KIGANJO RETICULATION COSTS
YEAR 2010 WORKS

PIPE MATERIAL	PIPE DIA. (mm)	PIPE CLASS	LENGTH (m)	COST / M KShs.	TOTAL COST KShs.
uPVC	250	B	4,600	1,984	9,126,400
		C	-	2,849	-
		D	-	3,423	-
		E	-	4,454	-
	200	B	105	1,362	143,010
		C	-	1,887	-
		D	-	2,489	-
		E	-	2,849	-
	150	B	1,046	700	732,200
		C	-	1,021	-
		D	-	1,292	-
		E	-	1,575	-
	100	B	930	340	316,200
		C	-	495	-
		D	-	603	-
		E	-	768	-
	75	B	175	263	46,025
		C	-	330	-
		D	-	408	-
		E	-	506	-
	50	B	-	107	-
		C	-	175	-
		D	-	214	-
		E	-	272	-
FERROUS	700	-	-	14,665	-
	500	-	-	8,305	-
	450	-	-	7,465	-
	400	-	-	5,970	-
	350	-	-	5,220	-
	300	-	1,000	4,225	4,225,000
	250	-	2,400	3,550	8,520,000
	200	-	-	2,845	-
	150	-	-	1,400	-
	100	-	-	1,315	-
TOTAL			10,256		23,108,835

Table 1.14
OPTIONS A2 AND B2 - KIGANJO RETICULATION COSTS
YEAR 2020 WORKS

PIPE MATERIAL	PIPE DIA. (mm)	PIPE CLASS	LENGTH (m)	COST / M KShs.	TOTAL COST KShs.
uPVC	250	B	4,600	1,984	9,126,400
		C	-	2,849	-
		D	-	3,423	-
		E	-	4,454	-
	200	B	105	1,362	143,010
		C	-	1,887	-
		D	-	2,489	-
		E	-	2,849	-
	150	B	1,046	700	732,200
		C	-	1,021	-
		D	-	1,292	-
		E	-	1,575	-
	100	B	1,560	340	530,400
		C	-	495	-
		D	-	603	-
		E	-	768	-
	75	B	175	263	46,025
		C	-	330	-
		D	-	408	-
		E	-	506	-
	50	B	-	107	-
		C	-	175	-
		D	-	214	-
		E	-	272	-
FERROUS	700	-	-	14,665	-
	500	-	-	8,305	-
	450	-	-	7,465	-
	400	-	-	5,970	-
	350	-	-	5,220	-
	300	-	1,000	4,225	4,225,000
	250	-	2,400	3,550	8,520,000
	200	-	-	2,845	-
	150	-	-	1,400	-
	100	-	-	1,315	-
TOTAL			10,886		23,323,035

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Table 2.1
ENERGY REQUIREMENTS

Option	Year	Pump Power Cons. (kWh)	Site Power Cons. (kWh)	Total Daily Power Cons. (kWh)	Yearly Power Cons. (kWh)
A1	2010	581.2	450	1031.2	376,377
	2020	832.4	600	1432.4	522,833
A2	2010	1744.2	600	2344.2	855,638
	2020	2635.6	750	3385.6	1,235,744
B1	2010	102.4	450	552.4	201,642
	2020	114.3	600	714.3	260,731
B2	2010	1265.5	600	1865.5	680,903
	2020	1917.5	750	2667.5	973,642

Table 2.2
DETAILS OF PUMPING POWER REQUIREMENTS

Pumping Mains	Options	Q (l/s)	Length (m)	Dia. (mm)	V (m/s)	H _w (m)	H _p (m)	H _{int} (m)	H _{total} (m)	Power (kW)	P. Cons. (kWh)
Gitathi-ini	A1/A2	2010	750	200	0.86	53	2.2	0.2	55.4	20.4	489.1
		2020	750	200	1.25	53	4.3	0.4	57.7	30.8	740.4
	B1/B2	2010	200	80	1.27	42	3.7	0.4	46.1	1.3	10.4
		2020	200	80	1.24	42	3.5	0.4	45.9	1.9	22.3
Amboni	A2/B2	2010	1000	250	0.98	71	2.8	0.3	74.1	49.1	1177.6
		2010	1000	250	1.45	71	5.8	0.6	77.4	75.7	1817.7
Backwash	A1/B1	2010/20							15	5.1	92.0
	A2/B2	2010/20							15	4.3	77.5

[illegible][illegible][illegible]

Table 3.2
STAFFING LEVELS: OPTION A2 YEAR 2010

POSITION	STAFF NUMBERS							ANNUAL COST [KShs]	
	Head Office and General	Ihwa Intake and Kirti TW	Kamakwa TW	Nyeri Reticulation	Amboni Intake and TW	Kiganjo Reticulation	Total	Each	Total

BOTH WATER AND SANITATION DUTIES

General Manager	1						1	308,760	308,760
Deputy General Manager	1						1	256,200	256,200
Ast. General Manager	2						2	238,830	477,660
Senior Superintendent	-						-	202,020	-
Revenue Officer	1						1	140,850	140,850
Public Relations Officer	1						1	140,850	140,850
Accountant	1						1	202,020	202,020
PC Operators & Clerks	6						6	102,000	612,000
Secretary	1						1	172,260	172,260
Copy Typist	1						1	76,980	76,980
E&M Technicians	3						3	140,850	422,550
Maintenance Artisans	14						14	102,000	1,428,000
Draughtsmen	4						4	129,450	517,800
Storemen	4						4	76,980	307,920
Drivers	4						4	76,980	307,920
Subordinate Staff	2						2	58,140	116,280
Sub-Total								5,488,050	

WATER SPECIFIC DUTIES

Superintendent	-	2	1	1	1	5	202,020	1,010,100
Senior Operator	-	4	2	2	1	9	140,850	1,267,650
Technician	-	2	1	1	-	4	140,850	563,400
Operator	2	12	-	6	-	20	76,980	1,539,600
Foreman	-	4	3	2	2	11	112,140	1,233,540
Laboratory Assistant	-	2	-	2	-	4	76,980	307,920
Chemical Attendant	-	12	-	6	-	18	62,880	1,131,840
Pump Attendant	-	6	-	6	-	12	62,880	754,560
Line Patroller	2	-	8	-	3	13	58,140	755,820
Plumbers	-	3	10	2	5	20	85,860	1,717,200
Meter Readers	-	-	8	-	3	11	62,880	691,680
Subordinate Staff / Watchmen	3	12	10	10	5	40	62,880	2,515,200
Sub-Total							13,488,510	

Table 3.3
STAFFING LEVELS: OPTION B1 YEAR 2010

POSITION	STAFF NUMBERS							ANNUAL COST [KShs]	
	Head Office and General	Ihwa Intake and Kiriti TW	Kamakwa TW	Nyeri Reticulation	Amboni Intake and TW	Kiganjo Reticulation	Total	Each	Total

BOTH WATER AND SANITATION DUTIES

General Manager	1						1	308,760	308,760
Deputy General Manager	1						1	256,200	256,200
Ast. General Manager	2						2	238,830	477,660
Senior Superintendent	-						-	202,020	-
Revenue Officer	1						1	140,850	140,850
Public Relations Officer	1						1	140,850	140,850
Accountant	1						1	202,020	202,020
PC Operators & Clerks	6						6	102,000	612,000
Secretary	1						1	172,260	172,260
Copy Typist	1						1	76,980	76,980
E&M Technicians	3						3	140,850	422,550
Maintenance Artisans	14						14	102,000	1,428,000
Draughtsmen	4						4	129,450	517,800
Storemen	4						4	76,980	307,920
Drivers	4						4	76,980	307,920
Subordinate Staff	2						2	58,140	116,280
Sub-Total								5,488,050	

WATER SPECIFIC DUTIES

Superintendent		2	1	1		1	5	202,020	1,010,100
Senior Operator		4	2	2		1	9	140,850	1,267,650
Technician		2	1	1		-	4	140,850	563,400
Operator		12	6	-	-	-	18	76,980	1,385,640
Foreman		4	2	3		2	11	112,140	1,233,540
Laboratory Assistant		2	2	-	-	-	4	76,980	307,920
Chemical Attendant		12	6	-	-	-	18	62,880	1,131,840
Pump Attendant		-	6	-	-	-	6	62,880	377,280
Line Patroller		2	-	8		3	13	58,140	755,820
Plumbers		3	2	10		5	20	85,860	1,717,200
Meter Readers		-	-	8		3	11	62,880	691,680
Subordinate Staff / Watchmen		15	10	10		5	40	62,880	2,515,200
Sub-Total								12,957,270	

[illegible][illegible]

Superintendent		2	1	1	1	1	6	202,020	1,212,120
Senior Operator		4	2	2	2	1	11	140,850	1,549,350
Technician		2	1	1	1	-	5	140,850	704,250
Operator		12	6	-	6	-	24	76,980	1,847,520
Foreman		4	2	3	2	2	13	112,140	1,457,820
Laboratory Assistant		2	2	-	2	-	6	76,980	461,880
Chemical Attendant		12	6	-	6	-	24	62,880	1,509,120
Pump Attendant		-	6	-	6	-	12	62,880	754,560
Line Patroller		2	-	8	-	3	13	58,140	755,820
Plumbers		3	2	10	2	5	22	85,860	1,888,920
Meter Readers		-	-	8	-	3	11	62,880	691,680
Subordinate Staff / Watchmen		15	10	10	10	5	50	62,880	3,144,000
Sub-Total								15,977,040	

ANNEX 4
CORRESPONDENCE

Gauff Ingenieure

Beratende
Ingenieure
Consulting
Engineers
Ingénieurs
Conseils

H P GAUFF KG — CONSULTING ENGINEERS — P.O. BOX 49817 NAIROBI/KENYA. 14th July, 1995
KW/bn/K1083/572

Branch Office

NAIROBI
EAST CHURCH RD
WESTLANDS
TEL: 445288
FAX: 446124

Permanent Secretary
Ministry of Local Government
P.O. Box 30004
NAIROBI

Attn: Eng. Mwaura



Dear Sir,

RE: NYERI WATER SUPPLY FEASIBILITY STUDY
INCEPTION REPORT

We are pleased to submit 3 copies of the draft report on the Assessment of the Situation (Inception Report) for the above project, each copy being in three volumes.

As has been discussed, we trust you will forward a copy to the Financier, and one to the Nyeri Municipal Council.

We look forward to the opportunity of discussing any comments you may have, in the near future. Upon receipt of your comments and/or approval, we shall submit the final version of the report for your retention and distribution to other parties.

Yours faithfully,
H.P. GAUFF KG
Consulting Engineers


L. Laubert
GENERAL MANAGER


D. Baker
HEAD, WATER & SANITATION

cc: Gauff - Frankfurt

Encl

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Passauer Strasse 7
D-90480 Nuernberg
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Telefax: (0911) 9409174

H.P. Gauff GmbH & Co.
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Bayrische Vereinsbank Nuernberg 2 011 406
Stadtsparkasse Nuernberg 1 186 442
Commerzbank AG Nuernberg 5 111 141
Postsparkasse Nuernberg 93318-859

Commercial Bank of Africa
Nairobi/Kenya No. 10020
Stanbic Bank Kenya
Nairobi/Kenya No. 151010 890 400

NYERI MUNICIPAL COUNCIL

ALL CORRESPONDENCE TO BE
ADDRESSED TO THE TOWN CLERK



P.O. Box 180
Telephone 2583
2457
2518
NYERI.

YOUR REF.

Date 2nd August, 19 95

OUR REF. NMC/WDD/639/

M/S H.P. Gauff KG.,
Consulting Engineers,
P.O. Box 49817,
NAIROBI.



Dear Sirs,

RE: NYERI WATER SUPPLY - FEASIBILITY STUDY

I refer to the discussions held in our Mayors Parlour during a visit on 21st March, 1995 by your Messrs Baker and Wangombe and Eng. Muriuki from the Ministry of Local Government and enclose herewith views from some of the Councillors.

The delay in sending the views which has been caused by delays in their preparations is regretted but it is hoped that they will be looked into and be incorporated in the study.

Yours faithfully,

ENG. J. NGUIGUTI
DEPUTY GENERAL MANAGER (E)

JN/nn

c.c.

Director,
Department of Urban Development,
Ministry of Local Government,
P.O. Box 30004,
NAIROBI.

NYERI WATER SUPPLY - EXTENSIONS - REQUESTS/RECOMMENDATIONS FROM
COUNCILLORS

1. A. WARDS WITHIN THE OLD TOWN BOUNDARY (KIMATHI, CHANIA, MT.KENYA,
KANGEMI BLUE VALLEY AND MAJENGO/KIAWARA, RURINGU, NGANGARITHI(PART))

The existing water supply is not adequate and areas seriously affected, include Kangemi, Provincial General Hospital, Town Centre, Blue Valley, Kingongo, Njengu and Mathari, Ruringu, Skuta and Ngangarithi.

B. OTHER WARDS

- (a) Githiru/Muruguru/Marua. *tanks*
(i) The ward requires 6no. storage, two in each of the three sublocations namely Muruguru, Githiru and Marua to store water for domestic use supplied by the water corporation.

- (ii) Assistance is requested to construct a pumping station to pump water for irrigation from Sagana Dam to Muruguru sublocation.

(b) NGONDE WARD

The requests are for the provision of 2no. water storage tanks each with a capacity of 910m³. These will serve a population of about 5,000 people. Constructions of the intake and pipelines are going on.

(c) KIRICHU/GACHIKA WARD

- (a) Part of the area around Kirichu Market including the market are served by the Councils Kiganjo Water Supply. The supply is inadequate (existing production 1000m³/day against a demand of 3000m³/day) and most of the residents fetch water from Honi and Sagana Rivers. If possible water for the area should come from Nyeri Town since the Nairobi River where the Kiganjo water is pumped from dries during droughts. Water storage tanks should be constructed at strategic points (Kombu, Gachika, Ndurutu and Kahiga) to serve the entire population. The existing water pipeline from the Kiganjo Water Supply will require enlargement.

...../2

- (2) -

(d) NYARIBO WARD

(i) NYARIBO WATER PROJECTS

Requests are for a pump, drive and additional pumps to supplement the already laid 75mm pipes.

(ii) NJENGU/NYARIBO WATER PROJECT

This project will supply water for domestic and irrigation purposes when completed. The request is for additional funds to complete the project.

(e) KIHUYO/MATHARI WARD

- (i) KIHUYO SUB-LOCATION - Muhoya water project. Requests are for the construction of a water storage tank with a capacity of 46m³ and laying of water pipelines of varying diameters estimated at Kshs 2.0 million.

(ii) MATHARI & NJENGU

Some residents of Mathari and Njengu are supplied with water by the Municipality. The supply is inadequate. Extensions of the existing pipework to cover the areas is requested. Boosting of the water supply is also necessary.

(c) WARDS SERVED WITH WATER FROM THE WATER CORPORATION

These are Tetu, Ngangarithi(part), Thunguma, Gatitu and Muruguru.

The water supply to these wards is inadequate and is rationed. This should be looked into with a view to taking over extending and augmenting the supply.

.....O.....O.....

21st July, 1995

JN/nn

MINISTRY OF LOCAL GOVERNMENT

Telephone: 28411

When replying please quote

Ref. NGPD/158/A/111/57
and date



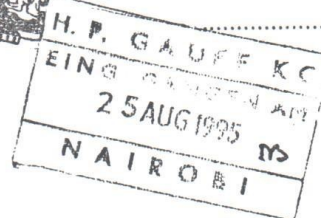
DEPARTMENT OF URBAN DEVELOPMENT

P.O. Box 30004

NAIROBI

22nd AUGUST 1995

THE TOWN CLERK
NYERI MUNICIPAL COUNCIL
P.O. BOX 180
NYERI



ATTN. ENG. NGUIGUTI.

NYERI WATER SUPPLY FEASIBILITY STUDY
INCEPTION REPORT MEETING/SEMINAR

The consulting Engineers appointed to undertake the Nyeri water supply feasibility study completed the Inception stage after which the copies of the report were sent to Nyeri municipal council and the KfW.

We hereby propose a 3 day seminar in Nyeri involving the Municipal council, Ministry of Local Government and the consultant. This is in order to formulate recommendations for the next stage i.e Preliminary Design.

Please prepare comments in anticipation of this seminar.

ENG. F.N. MWAURA
DEPUTY DIRECTOR TECHNICAL SERVICES
For: DIRECTOR URBAN DEVELOPMENT.

✓ c.c. H.P. GAUFF CONSULTING ENGINEERS
ATTN. MR. BAKER

c.c. URBAN WATER SUPPLY AND SANITATION MANAGEMENT PROJECT
ATTN. MR. MACDOUGALL

cc:nyeri22-8-95

MINISTRY OF LOCAL GOVERNMENT

Telephone: 28411

When replying please quote

Ref. No. DPD/158/A/61...
and date



DEPARTMENT OF URBAN DEVELOPMENT

P.O. Box 30004

NAIROBI

....., 19.....

5th September, 1995

H.P. Gauff Consulting Engineers
P.O. Box
NAIROBI

Attn: Mr. Wangombe

NYERI WATER SUPPLY FEASIBILITY STUDY INCEPTION REPORT
SEMINAR ON ADOPTION OF THE REPORT

Following discussions held on the above mentioned Nyeri seminar we hereby propose that a seminar be held on the 14th to 15th September, 1995.

This is in order to facilitate progress into the next stage of the feasibility study i.e. Preliminary Design. It would be preferable if the workshop/seminar is to be held in Nyeri.

Please arrange accordingly.

Nduti Mwaura

for

Eng. F.N. Mwaura
DEPUTY DIRECTOR TECHNICAL SERVICES
for: DIRECTOR URBAN DEVELOPMENT

Gauff Ingenieure

5th September, 1995
KW/bn/K1083/750

H P GAUFF KG — CONSULTING ENGINEERS — P.O. BOX 49817 NAIROBI/KENYA.

Permanent Secretary
Ministry of Local Government
P.O. Box 30004
NAIROBI

Attn: Eng. F.N. Mwaura

Beratende
Ingenieure
Consulting
Engineers
Ingénieurs
Conseils

Branch Office

NAIROBI
EAST CHURCH ROAD
WESTLANDS
TEL: 445288
FAX: 446124



Dear Sir,

RE: NYERI WATER SUPPLY - FEASIBILITY STUDY
Inception Report

Further to your letter DPD/158/A/111/57 dated 22nd August, 1995, and the telephone discussion of Nduati/Wangombe on 4th September, 1995, we confirm the proposal that the seminar be held in Nyeri at the Green Hills Hotel on 14th and 15th September, 1995.

Please confirm the names (or numbers) of those who will be participating from Ministry of Local Government and the Council so that we can finalise arrangements.

Yours faithfully,
H.P. GAUFF KG
Consulting Engineers

A handwritten signature in dark ink, appearing to read 'L. Laubert', is written over the printed name and title.

L. Laubert
GENERAL MANAGER

A handwritten signature in dark ink, appearing to read 'D. Baker', is written over the printed name and title.

D. Baker
HEAD, WATER & SANITATION

cc: The Town Clerk - Nyeri
The Engineer - Nyeri
MOLG - Mr. Nduati
MOLG - Mr. MacDougal

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Commercial Bank of Africa
Nairobi/Kenya No. 10020
Stanbic Bank Kenya
Nairobi/Kenya No. 151010 880 4001

MINISTRY OF LAND RECLAMATION, REGIONAL AND WATER DEVELOPMENT

Telegrams: "WATER", Nairobi
Telephone: Nairobi 716103
If calling or telephoning please ask for

.....
When replying please quote
Ref. No. MWD/010A/12/ (25)
and date



OFFICE OF THE PERMANENT SECRETARY
MAJI HOUSE
NGONG ROAD
P.O. Box 30521
NAIROBI
30th August, 1995

M/s H. P. Gauff,
Consulting Engineers,
P.O. Box 49817,
NAIROBI.

CONFIDENTIAL

H. P. GAUFF KG
EINGEGANGEN AM
18 SEP 1995
NAIROBI

Dear Sirs,

RESTORATION OF THE 'ENGINEER' SERVICES
- NYERI WATER SUPPLY PROJECT CONSULTANCY SERVICES

Further to your Firm having been commissioned by the Ministry of Local Government to undertake Consultancy Services for the above named Project, I wish to inform you that it has been decided that the Director of Water Development is the Engineer for this Project. In this regard, therefore you should refer all matters related to this Project to the Engineer from now on.

2. Please take the necessary action accordingly.

Yours Faithfully,

E. K. MWONGERA
PERMANENT SECRETARY

CC.

Mr. R. K. A. Siele,
Permanent Secretary,
Minsitry of Local Government
NAIROBI. - To see for information

CONFIDENTIAL

Gauff Ingenieure

19th September, 1995
KW/bn/K1083/819

H P GAUFF KG — CONSULTING ENGINEERS — P.O. BOX 49817 NAIROBI/KENYA.

Permanent Secretary
Ministry of Local Government
P.O. Box 30004
NAIROBI

Beratende
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Consulting
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Ingénieurs
Conseils

Branch Office

NAIROBI
EAST CHURCH ROAD
WESTLANDS
TEL: 445288
FAX: 446124



Dear Sir,

RE: NYERI WATER SUPPLY - FEASIBILITY STUDY

On 21st November, 1994, we entered into a Contract with yourselves for the above study. Under that contract, there are only three parties mentioned, and these are:

- | | | | |
|------|--------------------------|---|---|
| i) | the Client | - | Ministry of Local Government on behalf of Nyeri Municipal Council |
| ii) | the Consulting Engineers | - | H.P. Gauff Ingenieure |
| iii) | the Financier | - | Kreditanstalt fuer Wiederaufbau (KfW) |

On 18th September, 1995, we received a letter from the Permanent Secretary, Ministry of Land Reclamation, Regional and Water Development, ref. MWD/01A/12/(25), dated 30th August 1995, and copied to you. This letter informed us that the Director, Water Development was to be the "Engineer" under the study.

In absence of a definition of the "Engineer" under our Contract with you, we request your instructions (in your capacity as the "Client") as to the modalities of implementing these requirements. Please inform us as to whether you would wish to have an Amendment to the Contract entered into, so as to incorporate the role of the Engineer into the study. Under Clause 1.09 of our Contract such an Amendment needs to be made in writing by mutual consent.

We look forward to your instructions in this regard.

Yours faithfully,
H.P. GAUFF KG
Consulting Engineers


L. Laubert
GENERAL MANAGER


D. Baker
HEAD, WATER & SANITATION

cc: MOLG - Eng. Mwaura
Gauff - Frankfurt

H.P. Gauff GmbH & Co.
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Telefax (0911) 9409174

H.P. Gauff GmbH & Co.
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Stadtsparkasse Nuernberg 1 186 442
Commerzbank AG Nuernberg 5 111 141
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Commercial Bank of Africa
Nairobi/Kenya No. 10020
Stanbic Bank Kenya
Nairobi/Kenya No. 151010 880 4001

Gauff Ingenieure

19th September, 1995
KW/bn/K1083/818

H P GAUFF KG — CONSULTING ENGINEERS — P.O. BOX 49817 NAIROBI/KENYA.

Permanent Secretary
Ministry of Local Government
P.O. Box 30004
NAIROBI

Attn: Eng. F.N. Mwaura

Beratende
Ingenieure
Consulting
Engineers
Ingénieurs
Conseils

Branch Office

NAIROBI
EAST CHURCH ROAD
WESTLANDS
TEL: 445288
FAX: 446124



Dear Sir,

RE: NYERI WATER SUPPLY - FEASIBILITY STUDY

Our services under the above study are being executed in three stages, and these stages were to be separated by 6 week periods of review, comment and approval of the reports submitted.

The report for the first stage (Review of Existing Situation) were submitted under cover of our letter KW/bn/K1083/572 dated 14th July, 1995. It had been planned that we would meet in Nyeri on 20th and 21st September in order to discuss and agree upon that report, so that the next stage can proceed.

It has however been necessary to postpone these discussions. We believe however that the second stage of the study can proceed without any difficulties, if there are no major aspects of the Situation Assessment which you would wish to have resolved in advance.

We therefore request your written authorisation that we may proceed with the next stage of the study. In such an event, any comments on the Situation Assessment Report can be dealt with when they arise.

If you authorise us to proceed with the next stage, we would request that you also release the Advance Payment Bonds, which were to be retained by you until approval of the Situation Assessment Report

Yours faithfully,
H.P. GAUFF KG
Consulting Engineers


L. Laubert
GENERAL MANAGER


D. Baker
HEAD, WATER & SANITATION

cc: The Town Clerk - Nyeri
Gauff - Frankfurt

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Telefax (0911) 9409174

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Stadtsprasse Nuernberg 1.188.442
Commerzbank AG Nuernberg 5.111.141
Postchekamt Nuernberg 93318.859

Commercial Bank of Africa
Nairobi/Kenya No. 10020
Stanbic Bank Kenya
Nairobi/Kenya No. 151010 880 4001

Gauff Ingenieure

Free

Beratende
Ingenieure
Consulting
Engineers
Ingénieurs
Conseils

19th September, 1995
KW/bn/KW/817

H P GAUFF KG — CONSULTING ENGINEERS — P.O. BOX 49817 NAIROBI/KENYA.

Permanent Secretary
Ministry of Local Government
P.O. Box 30004
NAIROBI

Attn: Eng. F.N. Mwaura

Branch Office

NAIROBI
EAST CHURCH ROAD
WESTLANDS
TEL: 445288
FAX: 446124



Dear Sir,

RE: **NYERI WATER SUPPLY - FEASIBILITY STUDY**
Situation Assessment

We confirm that due to recent developments, and in consultation with yourselves, it has been necessary for the seminar at Nyeri to be postponed.

New dates for these discussions will be mutually agreed and notified to all parties.

Yours faithfully,
H.P. GAUFF KG
Consulting Engineers


L. Laubert
GENERAL MANAGER


D. Baker
HEAD, WATER & SANITATION

cc: Town Clerk - Nyeri
Engineer - Nyeri
MOLG - Mr. Nduati

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Postchekamt Nuernberg 93318 859

Commercial Bank of Africa
Nairobi/Kenya No. 10020
Stanbic Bank Kenya
Nairobi/Kenya No. 151010 880 4001

Gauff Ingenieure

file

Beratende
Ingenieure
Consulting
Engineers
Ingénieurs
Conseils

19th September, 1995
KW/bn/K1083/810

H P GAUFF KG — CONSULTING ENGINEERS — P.O. BOX 49817 NAIROBI/KENYA.

The Director of Water Development,
Ministry of Land Reclamation
Regional and Water Development
P.O. Box 30521
NAIROBI

Branch Office

NAIROBI
EAST CHURCH ROAD
WESTLANDS
TEL: 445288
FAX: 446124



Dear Sir,

RE: NYERI WATER SUPPLY - FEASIBILITY STUDY

In order to execute the services under the above study, it is necessary for us to have access to existing drawings for Nyeri Water Supply. We therefore again request that you:

- i) give authority to M/s. Sir Alexander Gibb & Partners for them to release to us the drawings for the study executed by them in the early 1980's under a contract where your Ministry was the Client, and
- ii) provide us with copies of the drawings in your possession for the Nyeri Water Supply, or allow us to borrow these drawings and produce copies for ourselves.

Your early favourable response on these two matters would be appreciated.

Yours faithfully,
H.P. GAUFF KG
Consulting Engineers


L. Laubert
GENERAL MANAGER


D. Baker
HEAD, WATER & SANITATION

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Stadtsparkasse Nuernberg 1 188 442
Commerzbank AG Nuernberg 5 111 141
Postchebank Nuernberg 93318 859

Commercial Bank of Africa
Nairobi/Kenya No. 10020
Stanbic Bank Kenya
Nairobi/Kenya No. 151010 880 4001

Gauff Ingenieure

Beratende
Ingenieure
Consulting
Engineers
Ingénieurs
Conseils

22nd September, 1995
DB/bn/K1083/828

H.P. GAUFF KG — CONSULTING ENGINEERS — P.O. BOX 49817 NAIROBI/KENYA.

Branch Office

NAIROBI
EAST CHURCH ROAD
WESTLANDS
TEL: 445288
FAX: 446124

Permanent Secretary
Ministry of Local Government
P.O. Box 30004
NAIROBI

Attn: Eng. F. Mwaura



Dear Sir,

RE: NYERI WATER SUPPLY - FEASIBILITY STUDY

Commencement of Pre-feasibility Study

Further to our letter ref.KW/bn/K1083/818 dated 19th September, 1995 on this subject we would advise you as follows.

Contractually the time set aside for review and comment on the assessment stage report was 6 weeks, on which basis we were anticipating a pre-feasibility stage start up at the beginning of September, 1995.

Due to other work, we have until now been able to keep our Kenya based staff allocated to this project occupied elsewhere. This is no longer the case and we therefore need an early commencement if schedules etc. are to be reasonably maintained and demobilisation and hence additional costs avoided.

During the pre-feasibility stage we shall be utilising short term sub-consultancy services of 4 persons, two of whom do not reside in Kenya. Because of their other commitments we have had to agree timing with them for the period late October to late November, commensurate with an immediate in-house start up.

It is essential that our in-house staff commence now if the necessary background and other information is to be available for these specialist sub-consultants at the scheduled time of their involvement. Should, through a delay in commencement, the specialist services have to be postponed, this could be by months rather than weeks because of their other commitments.

This would inevitably have both time and increased cost implications for our services.

Under these circumstances we consider it to be in the interest of all parties to this Study for us to proceed with the pre-feasibility stage now.

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Telex Nr. 646333 GAUFF D

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Nairobi Kenya No. 10020
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22.09.95 to PS - MOLG

The necessary office preparatory work is therefore commencing on 25th September 1995 with field trips scheduled for the period 2nd October through 14th October.

Unless therefore we have your specific instructions not to do so we shall proceed accordingly. We confirm we would welcome the further secondment of your Mr. Nduati for the pre-feasibility stage.

Yours faithfully,
H.P. GAUFF KG
Consulting Engineers

L. Laubert
GENERAL MANAGER


D. Baker
HEAD, WATER & SANITATION

cc: KfW - Frankfurt
Attn: - Mr. Parvisi
Gaufl - Frankfurt

Enc

KfW Kreditanstalt
für Wiederaufbau

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Ministry of Local Government
Urban Development Dept.
Attn: Eng. Mwaura
Nairobi / Kenya

H. P. GAUFF KG	
EINGEGANGEN	26 SEP 1995
NAIROBI	

Officer in charge: Mr. Parvisi
our ref.: Pv/Ghd
Attention: 2108
date: 25.09.95

L2b3 / German Financial Cooperation with KENYA
Nyeri Water Supply Feasibility Study

Dear Sir,

we refer to the assessment report submitted recently by M/S Gauff for your and our comments.

In chapter 2.1 the Consultant complains about the fact that a number of important drawings could not be obtained either from the Ministry of Land Reclamation, Regional and Water Development (MoLR, R & WD) or from M/S Gibb who require the latter's authority. It seems to us quite unusual that your partner ministry is not willing to give the necessary backing to a government project.

The Consultant has pointed out that if this situation prevails, it will have time and cost implications in the next study stage. It is quite obvious that German funds will not be available to cover such unnecessary cost increases. They will have to be borne by your government.

We, therefore, wish to kindly ask you to urge MoLR, R & WD to release the drawings required by the Consultant without further delay.

Thank you for your cooperation.

Yours faithfully,
KREDITANSTALT FÜR WIEDERAUFBAU

Ms. Li. Parvisi

JAL2B3\PARVIGEHE0100.DOC

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Gauff Ingenieure

H.P. GAUFF KG - CONSULTING ENGINEERS - P.O. BOX 49817 NAIROBI/KENYA.

9th October, 1995
DB/bn/K1083/888

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Kreditanstalt fuer Wiederaufbau
Postfach 11 11 41
60040 Frankfurt/Main
FEDERAL REPUBLIC OF GERMANY

Attn: Mr. W. Parvisi



Dear Sir,

RE: **NIYERI WATER SUPPLY - FEASIBILITY STUDY**

Commencement of Second Stage (Pre-Feasibility)

Further to the telecon M/s. Parvisi/Baker of 9th October, 1995, we confirm that in order to keep reasonably to schedule and to ensure that the three sub-consultants included in the pre-feasibility phase participate at the optimum time, we have commenced the pre-feasibility study stage.

It is further confirmed that having perused our first stage assessment report, KfW has no objection to this.

Yours faithfully,
H.P. GAUFF KG
Consulting Engineers

L. Lambert
L. Lambert
GENERAL MANAGER

D. Baker
D. Baker
HEAD, WATER & SANITATION

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Gauff Ingenieure

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11th October, 1995
DB/bn/K1083/890

H.P. GAUFF KG — CONSULTING ENGINEERS — P.O. BOX 49817 NAIROBI/KENYA.

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FAX: 446124

Permanent Secretary
Ministry of Local Government
P.O. Box 30004
NAIROBI



Dear Sir,

RE: NYEHI WATER SUPPLY - FEASIBILITY STUDY

Further to our letter KW/bn/K1083/818 dated 19th September, 1995, we acknowledge the returned secondment of your engineer Mr. Nduati Mwangi for the pre-feasibility stage of this consultancy with effect from 2nd October, 1995.

We confirm that we have commenced this second consultancy stage as of that date and look forward to your early release of the Advance Payment Bonds.

Yours faithfully,
H.P. GAUFF KG
Consulting Engineers


L. Faubert
GENERAL MANAGER


D. Baker
HEAD, WATER & SANITATION

cc. Gauff - Frankfurt

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Ministry of Local Government
Urban Development Dept.
Attn. Eng. Mwaura
Nairobi / Kenya

officer in charge: Mr. Parvisi
our ref.: Pv/Ghd
extension: 2108
date: 16.10.95

cc/ Telefax number: 002542/446 124

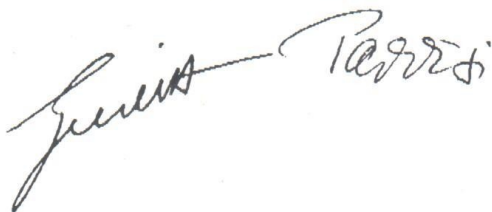
M/S Gauff Consult
Nairobi / Kenya

L2b3 / German Financial Cooperation with KENYA
Nyeri Water Supply Feasibility Study

Dear Mr. Mwaura,

we refer to the letter of M/S Gauff dated 22 September 1995 and wish to advise that we have
no objection to a commencement of the pre-feasibility stage.

Yours faithfully,
KREDITANSTALT FÜR WIEDERAUFBAU



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6th November, 1995
DB/bn/K1083/972

H P GAUFF KG — CONSULTING ENGINEERS — P.O. BOX 49817 NAIROBI/KENYA.

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The Director, Water Development
Ministry of Land Reclamation
Regional and Water Development
P.O. Box 30521
NAIROBI



Dear Sir,

RE: NYERI WATER SUPPLY - FEASIBILITY STUDY

We wish to correct a misdated letter of reference DB/bn/K1083/935 which was improperly dated 23rd May, 1995 instead of 23rd October, 1995.

We regret any inconvenience caused.

Yours faithfully,
H.P. GAUFF KG
Consulting Engineers

A handwritten signature in dark ink, appearing to read 'L. Laubert'.

L. Laubert
GENERAL MANAGER

A handwritten signature in dark ink, appearing to read 'D. Baker'.

D. Baker
HEAD, WATER & SANITATION

cc: MOLG - Attn: Eng. F.N. Mwaura

Encl

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The Director, Water Development
Ministry of Land Reclamation
Regional and Water Development
P.O. Box 30521
NAIROBI

Orl,
23rd May, 1995
DB/bn/K1083/935

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Dear Sir,

RE: NYERI WATER SUPPLY - FEASIBILITY STUDY

Reference is made to our letter KW/bn/K1083/810 dated 19th September, 1995, a copy of which is enclosed for ease of reference.

We would be grateful for your early favourable response to the two matters raised so that we can proceed without further unnecessary impediment in our Consultancy under this project.

Yours faithfully,
H.P. GAUFF KG
Consulting Engineers

L. Laubert
GENERAL MANAGER

D. Baker
HEAD, WATER & SANITATION

cc: MOLG - Attn: Eng. F.N. Mwaura

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Gauff Ingenieure

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10th November, 1995
DB/bn/K1083/980

H P GAUFF KG — CONSULTING ENGINEERS — P.O. BOX 49817 NAIROBI/KENYA.

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Permanent Secretary
Ministry of Local Government
P.O. Box 30004
NAIROBI



Dear Sir,

RE: NYERI WATER SUPPLY - FEASIBILITY STUDY

KfW Mission Visit to Nyeri on 6th November, 1995
RECORD OF DISCUSSIONS

We enclose herewith the minutes of the meetings held in Nyeri with the visiting KfW mission on 6th November, 1995, for your perusal and retention.

Yours faithfully,
H.P. GAUFF KG
Consulting Engineers

P. L. Laubert
GENERAL MANAGER

D. Baker
HEAD, WATER & SANITATION

cc:	Eng. Mwaura	-	MOLG
	Mr. Muriuki	-	MOLG
	Mr. McDougall	-	MOLG
	HW the Mayor	-	Nyeri
	Town Clerk	-	Nyeri
	Engineer	-	Nyeri
	Treasurer	-	Nyeri
	KfW	-	Frankfurt
	Gauff	-	Frankfurt

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NYERI WATER SUPPLY FEASIBILITY STUDY
KfW MISSION OF NOVEMBER 1995

Record of Discussions Held in Nyeri on 6th November 1995

The visiting KfW mission called upon the Nyeri Municipal Council at 9.15 am on 6th November 1995. The mission accompanied by the Council's officers and representatives of the Consultant first met together in the Town Clerk's office, and then called upon His Worship the Mayor in his Parlour. Thereafter the mission, Council officers and the consultant retired again to the Town Clerk's office for further detailed discussions.

The following were present, with the Councillors only being present in the discussions in the Mayor's Parlour.

Kreditanstalt fuer Wiederaufbau (KfW)

- | | | |
|----|----------------|-------------------|
| 1. | Mr. W. Parvisi | Mission Leader |
| 2. | Mr. S. Mueller | Technical Advisor |

Ministry of Local Government (MOLG)

- | | | |
|----|----------------|-------------------------------|
| 1. | Eng. F. Mwaura | Chief Superintending Engineer |
|----|----------------|-------------------------------|

Deutsche Gesellschaft fuer Technische Zusammenarbeit (GTZ)

- | | | |
|----|--------------------|---------------------------|
| 1. | Mr. N.A. McDougall | German Water Team in MOLG |
|----|--------------------|---------------------------|

Nyeri Municipality Councillors (NMC)

- | | | |
|----|------------------|------------------------------------|
| 1. | Cllr. J. Wanjage | His Worship the Mayor |
| 2. | Cllr. J.N. Kigo | Deputy Mayor |
| 3. | Cllr. B. Mahan | Chairman Debt Collection Committee |
| 4. | Cllr. N. Kamotho | Chairman Finance Committee |

Nyeri Municipal Council Officers (NMC)

- | | | |
|----|-----------------|-------------------------------|
| 1. | Mr. R.K. Gikuhi | Town Clerk |
| 2. | Mr. J. Nguiguti | Engineer |
| 3. | Mr. P.K. Gaku | ag Treasurer |
| 4. | Ms. S. Wamai | Senior Administrative Officer |
| 5. | Mr. P. Ng'ania | Chief Internal Auditor |

H.P. Gauff Consulting Engineers (HPG)

- | | | |
|----|-----------------|---------------------------|
| 1. | Mr. D. Baker | Head Water and Sanitation |
| 2. | Mr. B. Wangombe | Project Engineer |

1. INITIAL MEETING IN TOWN CLERK'S OFFICE

1.1 Introduction

The Town Clerk received the visitors in his office and welcomed them to Nyeri. Brief introductions were made.

1.2 Programme

A proposed programme for the mission visit to Nyeri was put forward by the Town Clerk. It was noted that site visits were proposed, but the mission felt there may not be sufficient time, considering that only one morning had been allocated to the mission's time in Nyeri.

It was agreed to proceed with the call on HW the Mayor, then hold substantive discussions. If there was time thereafter, site visits could be made.

2. CALL ON HW THE MAYOR

2.1 Introductions

On proceeding to the Parlour, HW the Mayor received the mission and accompanying officials. HW the Mayor was in the company of key Council members.

Brief introductions were made by the Town Clerk.

2.2 Mayor's Welcome

HW the Mayor welcomed the mission and expressed delight at their visit. He noted that water supply in Nyeri had been a big problem for many years which had plagued the Council. The resolution of the difficulties had not been possible due to financial constraints. HW the Mayor was pleased that KfW had now come to the Council's assistance.

HW the Mayor noted that with the dense urban population in Nyeri, lack of potable water constituted a health hazard. In some areas the Council had had to resort to the use of fire engines for emergency supplies, whereas these vehicles should be on standby for their intended purpose.

HW the Mayor appreciated that any investment would have to be paid for by the consumers, and pledged the Council's support in propagating this to the populace and ensuring their co-operation.

HW the Mayor acknowledged the assistance already availed by KfW through the purchase of personal computers for water billing, and expressed the Council's gratitude.

2.3 KfW Introductory Remarks

Mr. Parvisi thanked the Mayor for receiving the mission. The last mission visit had been in March 1992, and he was pleased the feasibility study had now started, and was in progress. There was the possibility that the project appraisal could be towards the end of 1996, after completion of the study and consideration of its findings.

KfW had considered the request for personal computers to be a good initiative by the Council, and this showed concern for improving revenue collection. KfW had been pleased to assist as requested.

Mr. Parvisi pointed out that whereas KfW may assist in financing new investment in water supply infrastructure, they could not participate in the equally important subsequent maintenance and in the collection of resultant revenue. These aspects would have to be addressed and adequately managed by the Council.

The significant water and sanitation tariff increases of 1994 were noted by KfW and considered a good step. Mr. Parvisi however advised that stepped increases at routine intervals would be a better approach than having to make large increases after a long period of applying the same rates. The Council will need to generate sufficient revenue to not only cover routine running costs, but also to repay the central government for project finance on-lending.

Mr. Parvisi appreciated that there were critical water problems in Nyeri. He felt however that there were some aspects that could be addressed by the Council to reduce the extent of the problem.

2.4 Introductory Comments by MOLG

Eng. Mwaura pointed out the concern of both KfW and GTZ over efficient utility management. He emphasised the need for water and sanitation departments in urban councils to be given full autonomy. This had been a problem in many local authorities, due to the magnitude of revenue generated by these services, compared to other council revenue sources.

He was authorised to state that his Permanent Secretary required that these departments be given the necessary support and goodwill for them to function effectively.

Eng. Mwaura noted that during the project appraisal by KfW, which would precede financing for any new investment, there will be critical examination of the Council's management, financial control and the like.

Eng. Mwaura also emphasised the need for infrastructure and equipment to be put to their best possible usage.

2.5 Utility Management

HW the Mayor explained that there had been several previous discussions on the management of water and sanitation services. He gave assurances that the political goodwill existed in Nyeri, and there was full support for effective management of the services. The Council intended to move these services out of Town Hall, in order to emphasise their increasing autonomy. Buildings were available and steps in that direction were in hand.

HW the Mayor expressed the need for guidance and support from MOLG in the continued improvement of the management of water and sanitation services.

HW the Mayor also made it clear that whatever the situation in other local authorities, the Nyeri Municipal Council did not utilise water revenues in subsidising other services. He stated that the Council had other revenue sources which were applied towards these other services.

The Town Clerk lent support to the comments of HW the Mayor. He stated that Council officers were satisfied with the co-operation of the Councillors. When the Councillors were approached regarding tariff increases, with supporting justification, support was readily given. Expenditure related to GTZ organised training courses had been approved expeditiously. The Council had readily authorised creation of a separate Water and Sanitation Department and had also set up a separate Water and Sanitation Committee to support the new department.

The Town Clerk also supported HW the Mayor's comments regarding diversion of water revenues. He stated that, in fact, it had only gone the other way. In 1993/94, the Water Fund had "borrowed" KShs 3.5 million from the General Fund of the Council, to finance a new pipeline to the Skuta area. These monies had since been "repaid" from water revenue.

Eng. Mwaura supported the planned movement of the Water and Sanitation Department from Town Hall. MOLG may be able to assist in the provision of facilities for the new offices.

HW the Mayor explained to the mission that there was continued planning by the Council for the future, both by the present Councillors and their predecessors. He was happy with the calibre and commitment of his fellow Councillors. He informed the mission that the Council had acquired the land that was considered necessary for future expansion of services so as to ensure this did not prove a problem in future. Sufficient land had been acquired around the present intake, even for the construction of a dam if need be. The site identified in previous studies as being suitable for expansion of the existing Treatment Works had

been bought. There were other land parcels in town which had been acquired by the Council for future stores, workshops and the like.

2.6 German Technical Assistance

Mr. McDougall noted that GTZ was very active in Nyeri, providing technical and managerial training and support. Mr. Parvisi was gratified to learn this. He said that the German Ministry responsible for overseas development liked to see GTZ and KfW operations proceeding together so as to obtain maximum sustainable impact.

2.7 Inter-Ministerial Responsibilities

The Town Clerk noted the increased interest of the Kenyan Ministry responsible for water development (MoLRRWD) in council run water services. The scope of participation of MoLRRWD in the present study was not however clear.

Eng. Mwaura noted that MoLRRWD participation in local authority water supplies in general had been discussed in a meeting the previous week. It was easier to pre-determine their role in new projects and studies, but this was more difficult where work was already on-going. These aspects were however intricate and were expected to be resolved in due course.

HW the Mayor stated that the roles of various parties needed clear definition if there was to be success in studies and projects. He was quite clear on the roles of KfW, the Council, MOLG and the Consultants. Similar clarity was needed regarding the role of MoLRRWD. The Council had had problems in earlier projects, largely attributable to ill defined delineation of responsibilities. This had lead to financial commitments which had not been considered by the Council to have been fully justified.

It was noted that MOLG now had an adequately staffed technical wing, unlike in the past.

2.8 Closure of Courtesy Call

The courtesy call was closed by HW the Mayor expressing gratitude for the visit, and by his invitation to the mission for lunch after conclusion of discussions.

All except the Councillors then took their leave, and proceeded to the Town Clerk's office.

3. PRINCIPAL DISCUSSIONS

3.1 Introduction by Town Clerk

The Town Clerk suggested that the detailed discussions be preceded by presentation of reports by the Council Engineer and Treasurer. It was explained that Mr. Gaku was the Chief Accountant, but acting as the Treasurer during the Treasurer's leave.

The meeting then received and discussed the Engineer's report, then the Treasurer's report, before moving on to other matters of interest to the mission.

3.2 Interministerial Responsibilities

Mr. Parvisi asked for clarification on the present status of MoLRRWD's involvement in this study. It was explained that HPG had received a letter from the Permanent Secretary MoLRRWD stating that they were assuming the role of the "Engineer" under the Feasibility Study. The actual consequences of this had not yet been fully explained particularly as there was no "Engineer" under the Consultancy Agreement. The meeting between MOLG and MoLRRWD in the previous week had been attended by the Council Engineer, but it had not been fully conclusive. KfW asked MOLG to arrange a meeting early the following week so that KfW could clarify these matters with MoLRRWD. They would prefer to meet the Permanent Secretary, but if the notice was too short to allow this, a meeting with the Director of Water Development would suffice.

3.3 Computers

The Town Clerk expressed gratitude for the assistance by KfW in the provision of computers for water billing. He however raised the omission of the provision for computerization of the complementary work in revenue collection. The Council would be able to integrate the whole billing/revenue collection process if they had some "dummy" terminals networked with the new computers, which could be used by revenue clerks to enter money receipts upon collection. Management access was also limited due to the expected use of both computers at most times for billing data entry, and bill production. The Council would consider that six people should be able to have computer access at one time.

Mr Baker explained that the hardware purchased had been selected on the basis of the present minimum requirements. That is what KfW had provided. It was agreed hardware augmentation would improve the usage possibilities, but that the Council would best get the present new system in operation and working smoothly. It was noted that the provision of the present hardware was the most that KfW could do without stretching the definition of financial assistance in execution of a study, rather than a procurements contract. The Council appreciated this reality. They did however request that if possible, further assistance in this regard could be considered at a later date.

3.4 Tariffs

The Town Clerk noted that the water tariff increase of 1994 had been very substantial but not adequate in terms of covering all existing obligations. It was not however possible to have a higher increase due to the extent of public reaction that it was possible to contain. The Council was not able, for example, to make provision for repayment of the loan for the sewerage project, within the present tariff. The Council planned to raise tariffs again in mid 1996, after allowing time for consumers to adjust to the present level of charges.

Mr. Parvisi enquired into the level of tariff increases that were intended. Mr Baker explained that the consultant was required to examine the costs of operation and investment as part of the on-going study, and recommend the appropriate tariffs. This information would be available to the Council before they needed to decide on the increase to effect. It was pointed out by Mr. Nguiguti that the Council already had authority to at least equal the present NWCPD tariffs immediately. This would not be sufficient however, for the next intended tariff increase.

Mr. Parvisi noted the present lack of differentiation of consumer categories in the billing tariffs. He advised that commercial properties should be billed at higher rates if effective cross-subsidization was to be achieved. He informed the meeting that Eldoret Municipal Council had agreed on staged increases in tariffs which were planned in advance. Nyeri should develop a similar long term plan.

Mr. Parvisi also pointed out that in the project appraisal, KfW will need to be satisfied that steps were in place for attaining cost covering tariffs by the time of project completion.

3.5 Staffing

The Council presented a diagram showing the planned organisation for the water and sanitation department. The chart showed the posts presently filled, those for which there was authority to hire suitable staff, and the posts for which authority was awaited before they could be filled.

Mr. Parvisi enquired whether recruitment was on-going.

It was explained that a key post which needed to be filled was that of Town Engineer, so as to leave the General Manager of the Water and Sanitation Department free to concentrate on the water and sanitation services. At present he was performing the duties of both posts. Authority to advertise the Town Engineer's post was awaited.

Staff had been transferred from both the Treasurer's and Engineer's Departments to the new Water and Sanitation Department to make up the present establishment.

The organisation chart had been approved by the Council as the first step, but it still needed the approval of MOLG before key positions could be filled. Many lower positions could however be filled when budgetary provisions for emoluments were approved. Eng. Mwaura advised that MOLG approval would be more readily obtained if channeled through the technical department, rather than directly to administrative officials. He requested a copy of the Council application for approval of the proposed establishment so as to assist in expediting approval.

Mr. Parvisi asked whether the Council had the resources to pay all the proposed personnel. Mr. Nguiguti explained that they intended to gradually expand the staffing levels, starting with the key personnel. Eng. Mwaura noted in this regard that there was a very large gap in staffing between the General Manager and artisan level. The overall manager should have at least an assistant engineer and some technicians to run routine operations while he concentrated on management and larger issues. Eng. Mwaura informed the meeting that the Kericho Council had employed young graduate engineers on a casual basis, whilst awaiting formalisation of their appointment on permanent basis. The Town Clerk considered this interesting information and was to follow up on such possibilities. He however informed the meeting that there had been a pre-selection interview in the Public Service Commission for an assistant engineer; one candidate looked promising, and appeared willing to take up the post.

Another category of staff felt to be critical was plumbers. Mr. Nguiguti considered he needed them in adequate numbers if disconnections for non-payment and cleaning of stalled meters was to continue at all times.

Mr. McDougall also explained that it could be possible to obtain the services of experts and/or volunteers through the German Embassy. It was explained that under such arrangements, the Council would be expected to make available the remuneration of equivalent local personnel under Council salary scales, and the balance would be met by the German government. The Council said they would investigate the possibilities in this regard.

3.6 New Works by the Council and Leakage Control

3.6.1 Planned Improvements

The Town Clerk informed the meeting that in 1993/94, the Council had constructed a new pipeline from the Treatment Works to the Ruring'u and Skuta areas, to ease the shortages in that part of the distribution. This investment was

however only an exercise of more equitable distribution of the little water available.

Presently the Council was planning a new pipeline to take water to the Ngangarithi area which had severe problems. Monies from the Service Charge Fund would be "lent" to the Water Fund for this investment.

3.6.2 Priorities

Mr. Parvisi asked why investment was geared towards increasing the consumer base which would have to share the already inadequate water available, rather than the reducing the shortfalls in supply to existing consumers. He advised that it would be more appropriate to take action on physical losses of water, and spend the money on leakage repairs. A well defined programme for continued action in this regard would be the best approach. An appraisal mission would be impressed with tangible efforts in such a direction.

3.6.3 Extent of Water Losses

Mr. Nguiguti noted that there will be losses through leakages, but these may not be as large as the gross figures would indicate. He was not sure that the bulk meters were reading well, and this could account for some of the apparent water losses. Further, when laying the new Skuta line, they had exposed more than 4 km of existing pipework without encountering any leaks.

Mr. Mueller noted that the total unaccounted for water as found in the Consultant's Inception Report was 37% of production. Some estimation was needed to distribute this overall quantity into losses due to:

- (i) faulty meters
- (ii) flat rate billing
- (iii) errors in the reading of meters
- (iv) calculation errors in bill preparation
- (v) unauthorised water usage, and
- (vi) physical water leakages.

The leakages would be either easily identifiable of the surface, and thus readily attended to, or not visible by surface indications, and thus only located with the use of special equipment.

Mr. Mueller requested co-operation between the Council and Consultant in differentiating between these types of losses. It was only after doing so that it would be possible to differentiate between what can be done immediately by the Council, where the Council would have to invest time and money to have an impact, and to what extent a special leakage detection and repair programme would be needed, to deal with leaks that are not readily visible by surface indications.

Mr. Nguiguti noted that in Kiganjo, the Council found it possible to limit losses to about 5%. In that system however, there were two main consumers who accounted for much of the overall consumption. Their meters were checked daily to ensure they were still working, and any problem dealt with urgently. In the Nyeri town system, Mr. Nguiguti said that losses fell to about 25% when most consumer meters were working well.

Mr. Mueller expected that a low rate of water losses would be in the order of 15% of production, given the circumstances. He asked the Council and Consultant to jointly assess the extent of reduction from 37% that could be achieved by the Council on their own resources. A close exchange of knowledge in this regard would be essential. It was noted that the Council Engineer had significant experience in leakage and water loss control, starting with several years concentration on such problems in Nairobi in the early 1970s.

3.6.4 Control of Illegal Consumption

Eng. Mwaura noted a worrying trend towards higher water losses in 1995 than previously. Mr. Nguiguti explained that this arose after commissioning of the new Skuta line. That area had had no water for some time, leading many consumers to close their accounts. When water supply resumed, it was to be expected that some of these consumers had not come forward to re-open their accounts and be officially reconnected through a meter. They would be drawing water illegally by installing a hose or pipe connection at the meter location. Dealing with this problem had been difficult because it coincided with the collapse of the old billing machines. The Council had had to redeploy field staff to the manual billing work so as not to fall behind on billing. Once the computer system was operational, the Council would deal with the illegal connections in that area. Eng. Mwaura emphasised the need for serious investigations and action. He also pointed out the large number of so called "inactive" consumers who could be illegal water users. These were the consumers with a physical connection to the reticulation, but without an account.

Mr. Nguiguti explained that some of these inactive connections were truly inoperational. An example was a connection taken out for construction of several residential properties together, whose account would be closed when construction was over, and new accounts and connections opened for the individual houses. Many other inactive connections were just closed off due to the absence of water in particular areas, and thus the consumers did not want to maintain accounts which would attract at least minimum charges. The Council was not however sure of the status of some of these inactive connections. The step they had taken in May 1995 was to start billing all inactive consumers at minimum consumption rates. This had resulted in many of the affected people coming to complain, and bringing with them explanations and documents. Those who do not come forward will be investigated once the field staff are freed from their manual billing work. Mr. Nguiguti said that the Council, when satisfied that a connection was actually no longer in use, was now disconnecting the premises

altogether, by removing the pipework all the way to the public water mains. This would make illegal use of such connections much more difficult.

3.6.5 Billing Intervals

The Council also explained that they needed to bill regularly, every month, because revenue collection dropped when consumers were billed for two or more months consumption at one time. Some small consumers tended to find it difficult to deal with such irregular financial commitments.

3.6.6 Storage Augmentation

Eng. Mwaura enquired into the status of earlier proposals by the Council to augment their storage capacity. The Town Clerk said that the Council had earlier proposed to build tanks at Ruring'u and King'ong'o. The old tanks at the District Water Office had also been rehabilitated by the Council in readiness for use. The overall assessment then arrived at by the Council was that there was no water to store. The implementation of the planned storage augmentation had therefore not been followed up.

Mr. Mueller enquired whether the storage at the treatment works was ever empty. Mr. Nguiguti said that the Council did not allow this to happen, and controlled the water levels by throttling the outlets. When there was an emergency such a raw water main burst, however, the Council allowed storage levels to drop lower than usual.

3.6.7 Conclusion

Returning to the Council's pipeline augmentation proposals, Mr. Mueller pointed out that dry pipes decayed faster, thus it was not desirable for the network to be augmented, when there was no corresponding increment in production capacity.

The Town Clerk concluded this aspect of discussion by stating that the Council would seriously re-evaluate their priorities to ensure that they obtained the best advantage from the limited monies they had for investment in the water supply infrastructure.

3.7 Metering

Mr. Parvisi asked what the situation was with metering of consumers. Mr. Nguiguti summarised the situation as at September 1995 to be as follows:

- | | | |
|-----|-------------------------------------|-------|
| (i) | Consumers Billed on actual readings | 3,125 |
|-----|-------------------------------------|-------|

(ii)	Consumers Billed on estimates	
(a)	meter present but not working/ buried/access not obtained	847
(b)	unmetered premises	<u>97</u>
	Subtotal	<u>944</u>
(iii)	Number of Bills issued	4089
(iv)	Consumers disconnected for non payment	<u>1322</u>
(v)	Total Consumers with Open Accounts	5431
(vi)	Connections with closed accounts (inactive)	538
(vii)	TOTAL CONNECTIONS MADE TO DATE	<u>5969</u>

It was noted that a discrepancy of 20 consumers in the figures arose through manual preparation of the overall figures. The mission was also shown the historic figures within the reports submitted to them at the meeting.

Overall, Mr. Nguiguti said that 25% of the bills for September 1995 had been based on estimates.

Mr. Mueller asked whether the "stopped" meters were as a result of blockage by impurities. Mr. Nguiguti said this was one cause, but other meters were defective or broken down. On enquiry from KfW, the Council explained that new consumers paid for their meter in full, but defective meters were replaced at the Council's cost. The Council had had an increasing shortfall in stocks of meters, which had built up during the period before tariffs were increased. Mr. Nguiguti said that the Council had recently been trying to catch up with this shortfall, but it would take time, since already about 100 meters failed every month. The Council requested assistance from KfW in purchasing 500 consumer meters. They said this would enable them to remove the present deficit and have some running stock in hand. On an enquiry from Mr. Mueller, they assured KfW that keeping up with normal needs for breakdowns of meters would be fully within their means after that, and there would no longer be any unmetered premises. Mr. Nguiguti also said that installation of these meters could be done at a rate of about 100 per month with existing personnel and resources.

Mr. Parvisi asked Mr. Baker what the approximate cost of such meters were, and what sizes were normally used. Mr. Nguiguti volunteered the information that most connections were 1/2" (15 mm dia.) meters, and these were bought by the Council at a cost of about Shs 2,500 (DM 70) each from local suppliers.

Mr. Parvisi then agreed to the purchase of 500 consumer meters through the Consultant. After the meters were delivered, they would require regular reporting on the installation of the meters, and on reductions in un-metered connections.

Mr. McDougall asked whether the Council conducted routine testing of meters. Mr. Nguiguti said that this was not done on a routine basis, but they did occasionally test meters with a basic volumetric method, particularly when a consumer complained in respect of his meter. Over a period of five years however, no meter had been found inaccurate by more than 5%, and all the meters tested were under registering.

3.8 Debt Servicing

The Council's a.g. Treasurer, Mr. Gaku, reported that although the Council had been making nominal budgetary provisions for servicing debts on past investments, especially the sewerage project loan, they had not been able to make any significant repayments due to the previously very constrained cash flow situation. With the improved position, after the tariff adjustments, the Council would now start significant repayments.

Eng. Mwaura advised caution in this regard. He informed the Council that the Local Government Loans Authority, from whom the Council had obtained the on-lending, no longer existed. It was not clear whom the Council would pay. The Council had not been aware that this was the situation.

Eng. Mwaura asked the Council whether they had undertaken a mutual indebtedness exchange of obligations with the central government. It was explained to the KfW mission that this exercise involved determination of amounts owed by the government to the Council (outstanding rates etc.) and what was owed by the Council to the government (past loans and the like). The debts would cancel each other out, to the extent of overlap.

The Town Clerk said that the mutual indebtedness assessment had started but was never completed, thus it was never implemented.

In view of the present situation, the Town Clerk felt it would be best for the Council to open a new reserve account into which they would pay the monies intended for debt servicing. Eng. Mwaura proposed such monies could be applied by the Council towards buying more computer hardware. Mr Mueller thought the money would be better used in reducing physical water losses.

3.9 Situation Assessment Report

KfW had received the draft Situation Assessment (Inception) Report submitted by the Consultant, and had some comments, which were handed over to Mr. Baker.

Some issues had arisen which he proposed be considered in the remaining part of the meeting. Some aspects had already been discussed in the review of the Councils reports to the meeting.

3.10 Consultant's Access to Drawings

Mr. Mueller was disturbed by the failure of MoLRRWD to release drawings in their custody to the Consultant, and by their not issuing the authority that M/S Sir Alexander Gibb and Partners wanted before releasing documents and drawings relating to the earlier study of Nyeri Water Supply. This had been said by HPG to have cost and time implications. Mr. Mueller would have expected the Council to have obtained all the old records when they took over as the water undertaker.

The Town Clerk explained that when the handing over was done, it had been at the insistence of the African Development Bank (ADB) as a precondition for the financing of the sewerage project. The transfer of the services had not been very smooth, and was not accompanied by complete goodwill.

Mr. Baker said that access to the Gibb proposals was necessary in order to fully assess the proposals which had originally been made, rather than reconstructing alternatives which had already been analysed before.

Mr. Mueller found the MoLRRWD position to be intolerable. The study was government to government assistance, thus he would have expected full cooperation from all Kenyan government arms, including MoLRRWD. Mr. Mueller considered that serious consideration would need to be given to whether continuation of the project was in order if it did not have Kenya government support.

The MoLRRWD position was expected to be discussed further in the planned meeting between KfW, MOLG and MoLRRWD.

Eng. Mwaura also advised that the Council should write to MoLRRWD demanding the drawings, with a copy to MOLG for follow up.

3.11 Water Kiosks

Mr. Parvisi asked the Consultant to elaborate on the need for water kiosks, the best location for them, and how they should be operated, in the on-going study stage.

Eng. Mwaura noted that there seemed to be lack of interest by the Council in water kiosks, and was not sure of the reasons for this. He suggested that the Council should start pilot trials of water kiosks so as to assess the impact and the need for them.

The meeting agreed that the Council would start two pilot kiosks on trial basis. It was also agreed these should be run on private basis, with the operator retailing at a rate set by the Council and clearly advertised to consumers, such as by placing a large notice in front of the kiosk. Mr. Parvisi said that in Eldoret, the Council leased kiosks to the operators. Eng. Mwaura also emphasised the need for close supervision of kiosks. In some towns, kiosk operators had been known to remove the meter and bridge the gap in the pipework with a connector piece, and at the same time, overcharge the consumers.

3.12 Budgeting and Financial Control

Mr. Parvisi felt that the budget provisions made by the Council for preventive maintenance were too low, which would result in the decay of installations. He asked the Council to seriously address the prospects of making substantial allocations for this very important aspect. Mr. Mueller emphasised the need for a programme for routine maintenance.

Mr. Parvisi was also not sure to what extent budgeted provisions translated into actual expenditure being possible. He had noted a significant deviation between past budgeted and actual expenditure. Mr. Nguiguti explained that previously, the budgeted provisions had been strained by low revenues, requiring the prioritisation of expenditure as critical needs arose. Thus some important aspects had had reduced expenditure, when revenue was exhausted on emergencies.

The Town Clerk said the situation with regard to budgeted allocations actually translating into money being available had improved. Revenue had increased, allowing the budgeting to be based more on realities of needs than on cut back nominal figures to meet the projected total revenue. Further, the General Manager of the Water and Sanitation Department was now a co-signatory to the Water Fund, allowing him direct knowledge of day to day expenditure as it occurs. He was therefore able to intervene where he considered expenditure priorities may be misplaced.

3.13 Need for a Project

Mr. Parvisi asked the Consultant to be very clear when drawing up his recommendations on the need for a project.

He said that the water demand was a key issue. Data on and analysis of demography should be set out concisely, and the means of arriving at water demands should be readily apparent. The Consultant should present a clear picture of the assessment of the proportions of demand that are expected to be met by individual connections and by water kiosks, respectively. Some areas

Council had decided to use the one near the sewage works. The Council had already negotiated with the land owner, and acquired the site in exchange for other land owned by the Council. The Council had then mobilised equipment to construct an access road to the site, and it was now in use.

It was noted that the new dump was an abandoned quarry, which was suitable for filling with waste. The only drawback seen by Mr. Nguiguti was that urban development was moving in that direction, and in the long term public pressure over nuisance may force use of the site to be abandoned. Both the Town Clerk and Mr. Parvisi felt this should not arise. The adjacent sewage works were already making the area unattractive to those sensitive to such nuisance, and new developers will already find the dump site in use, and therefore be in a position to evaluate their options early enough.

On being asked by Mr. Parvisi, Mr. Nguiguti said the Council was practicing uncontrolled tipping. He did not see any near term prospects for changing to a sanitary landfill due to the level of equipment that would have to be acquired by the Council. Even the equipment used in preparing the site was actually part of the road maintenance rather than waste disposal unit.

3.16 Utility Management

Mr. Parvisi explained to the Council that KfW and MOLG had had substantive discussions on sustainable management structures for water and sanitation services. Shortcomings had been found in the "water and sanitation department" setup due to the limited autonomy afforded to them, and the extent to which they could exercise internal financial control. The post investment assessments by KfW for Thika, Nyahururu, Kisumu and Kitale had all been negative, meaning that the investments were not seen to have the potential for long term impact. This had been most disappointing.

Eng. Mwaura commented that over the years the German government had invested heavily in infrastructure for several Kenyan towns, but thereafter the facilities had been run down. He had been made to understand that it had become difficult to justify similar expenditure to the German taxpayers.

Mr. Parvisi continued, saying that the existing utility management setups were no longer acceptable to the German government as they were clearly not sustainable. It had therefore been proposed to MOLG that the utilities should be managed by private companies, established under commercial law, and owned by the Council involved. These proposals had been developed and discussed over time. KfW had also discussed the concept with the Omamo Commission on local government reform, which was yet to complete its work, but it was not clear to KfW whether their sentiments would be incorporated into the final commission report.

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It was explained that such a company as proposed would be outside Council budgeting restrictions and be able to operate without constraint by bureaucracy. A pilot scheme in Zambia had worked very well. GTZ were willing to start pilot schemes in Kericho and Eldoret.

The Council was informed by Mr. Parvisi that the German government had decided that new funding for projects will be dependant upon sector reform in the direction of such a sustainable structure. The Permanent Secretary, MOLG would be informed of this decision during meetings scheduled for the following week.

One thing that was clear was that without tangible positive movement on sustainable management structures, no further projects would be appraised, let alone considered for funding.

It was quite apparent to KfW that the Nyeri Municipal Council in itself would not have any direct say in the Kenya government decision on this matter. It had however been considered appropriate that the Council be appraised of the KfW position on this matter. The first reason for this was that, should there be failure to reach agreement between the German and Kenyan authorities on this matter, then Nyeri's water supply would be the first proposed project to be affected. Further, the occasion may arise for these issues to be discussed between MOLG and the Council. As a result of this briefing, the Council would be better able to assess their interests and thus express their preferences.

The Council took note of the German government position.

Eng. Mwaura added that, even if it was agreed that the proposed companies be set up, this could not be achieved directly, without intermediate steps of increasing autonomy for the water and sanitation services. The Council would therefore be advised to proceed with the development of the department as planned. The Town Clerk agreed the setting up of a working water and sanitation department was an immediate necessity.

Mr. McDougall said that GTZ would run a workshop later in November on utility management.

3.17 Consultancy Report Presentation

Mr. Baker noted that one of the KfW comments on the Situation Assessment Report was on the quality of the drawings in Volume III of the report. He assured the meeting that a new volume of this report would be issued in due course. It was explained that the new digitised mapping had not been ready at the submission date, thus, rather than delay the whole report, temporary base maps had been used. The other drawings would also be improved upon in the final submissions.

Mr. Mueller also had had difficulty in following aspects of the report, especially where names of particular areas were the only references given. He considered that visual presentations would greatly assist in clarity of reports to those not very familiar with the area. Mr. Baker suggested that pullout A3 size maps and diagrams, at the end of such reports would help. The drawing would be only on the right hand side of the paper, thus the reader could pull out the relevant map or diagram and refer to it simultaneously with reading of the text of the report. This was considered an interesting and workable suggestion.

3.18 Public Awareness Campaigns

Eng. Mwaura commented that a public awareness exercise in advance of project implementation would be of assistance.

Mr. Parvisi noted that there was increasing questioning of the effectiveness of public hygiene awareness programmes. An assessment was to be made in the near future on whether such programmes had had significant beneficial effects in Kericho and Eldoret.

The Town Clerk however felt that public awareness on the need to conserve water could readily be stimulated. He said residents would be more conscious of the need to attend the leaks in their premises and avoid other wastage, to report any leaks they noticed on water mains, and to discourage vandalism of facilities. The meeting agreed that public awareness on such aspects would be a worthwhile objective.

3.19 Immediate Works Augmentation

Mr. Baker informed the meeting that HPG had proposed certain measures to augment the current water production, as an Immediate Works Programme. Regrettably it was now understood by HPG that KfW would not be able to render any assistance to such a programme, until appraisal had been concluded. Mr. Baker however assured the Council that HPG was willing to assist the Council in identifying the aspects of the proposed Immediate Works that the Council could implement by itself. Mr. Nguiguti said that costing of the proposed works would be of great assistance to the Council in analysing the aspects that were within their means.

Mr. Parvisi confirmed HPG's understanding of the KfW position. He said that it was not possible for KfW to commit any funds on construction work, prior to project appraisal.

3.20 Kiganjo System

Mr. Nguiguti said that the Consultant should look into the possibilities of gravitating water from Nyeri town to Kiganjo, during the Pre-Feasibility stage of the study.

Mr. Baker explained that if HPG were to adhere strictly to the scope of study in the Terms of Reference, then they would not need to consider the future supply for Kiganjo at all. HPG however considered it necessary to address all aspects of the present Municipal water supply in order to provide a clear analysis of the available options. Later, at the final stage of this study (Feasibility Report), only the proposed project as agreed with KfW would be considered. This may or may not include new works for Kiganjo.

Mr. Parvisi had no objections to the Consultant analysing the possibilities with regard to Kiganjo in the Pre-Feasibility Report. He however cautioned that there were limitations in the funding which could possibly be made available, and this could limit the scope of the intended project.

In addition, KfW had been concerned when they understood in their earlier visit that the Kiganjo system largely served government institutions which did not meet their water bills. This did not auger well for Kiganjo being given serious consideration.

The Town Clerk asked that all the facts be compiled to allow a considered decision to be arrived at. In particular, he noted that there were two large consumers in Kiganjo, of which the KCC milk factory was very prompt in paying water bills. The Kenya Police College did delay in making payment but they did eventually meet the bill. Such delays were sometimes over a period of several months and associated with release of budgeted provisions to the College. Further, there were a significant number of small consumers served by that system.

Mr. Parvisi agreed that it would be useful for the facts to be presented. KfW would then be able to judge whether augmentation of the Kiganjo system had been shown to be an investment which would have the potential to be cost covering, and whether the works could be accommodated within the limits of possible funding.

3.21 Conclusion

On conclusion of these discussions, the Town Clerk once again expressed appreciation for the mission having found the time to visit Nyeri. He wished them a safe journey to Kericho that afternoon.

On behalf of the KfW mission, Mr. Parvisi said that the meetings had been very fruitful. They regretted that they had only been able to allocate one morning to the Nyeri visit, but looked forward to future occasions to visit Nyeri.

The meeting was adjourned at 1:00 pm.

The above is the writers recollection of all that transpired in the meetings. Should there be any errors or omissions, please contact H.P. Gauff so that the necessary corrections or inclusions can be notified to all concerned.

Minutes compiled by:

Karingithi Baru Wangombe.

Gauff Ingenieure

Beratende
Ingenieure
Consulting
Engineers
Ingénieurs
Conseils

21st November, 1995
KW/bn/K1083/1020

H P GAUFF KG — CONSULTING ENGINEERS — P.O. BOX 49817 NAIROBI/KENYA.

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The Director, Water Development
Ministry of Land Reclamation
Regional and Water Development
P.O. Box 30521
NAIROBI



Dear Sir,

RE: NYERI WATER SUPPLY - FEASIBILITY STUDY

We confirm the discussions of your Mr. J. Maina and our Mr. K.B. Wangombe on 21st November, 1995 where it was agreed that you will be releasing to us the drawings in your possession for the Nyeri Water Supply, upon our provision of the paper for reproduction. This is in hand.

It was also confirmed that you are writing to Sir Alexander Gibb & Partners informing them that they may release to us the drawings for the earlier study done by them.

Yours faithfully,
H.P. GAUFF KG
Consulting Engineers

L. Laubert
GENERAL MANAGER

D. Baker
HEAD, WATER & SANITATION

cc: MOLG - Eng. Mwaura
Town Clerk - Nyeri
Gauff - Frankfurt

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K1083

MINISTRY OF LAND RECLAMATION, REGIONAL AND WATER DEVELOPMENT

Telegrams: "WATER", Nairobi
Telephone: Nairobi 716103
If calling or telephoning ask for

When replying please quote

Ref. No.
and date



DIRECTOR OF WATER DEVELOPMENT
MAJI HOUSE
NGONG ROAD
P.O. Box 30521
NAIROBI

.....22nd November....., 1995..

M/S Sir Alexander Gibb & Partners,
P. O. Box 30020,
NAIROBI.

Dear Sir,

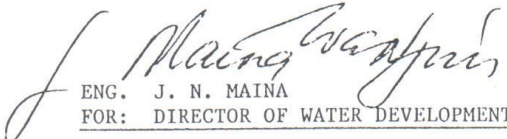
REF: NYERI WATER SUPPLY - FEASIBILITY STUDY

RELEASE OF DRAWINGS

You are hereby given authority to release drawings for the study executed by you in the above water supply project in the early 1980's to M/S Gauff Ingenieur who are the current consultants of the project.

Please deal accordingly.

Yours faithfully,


ENG. J. N. MAINA
FOR: DIRECTOR OF WATER DEVELOPMENT.

C.C.

M/S Gauff Ingenieure
P. O. Box 49817,
NAIROBI.

→ DB → K1083

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DIRECTOR OF WATER DEVELOPMENT
MAJI HOUSE

NGONG ROAD

P.O. Box 30521

NAIROBI

1st December, 1995.

When replying please quote
Ref. No. WD/2/2/25/122
and date

H. P. GAUFF,
CONSULTING ENGINEERS,
NAIROBI.

*Drgs collected
on 8.12.95*

RE: NYERI WATER SUPPLY - FEASIBILITY STUDY

Further to your letter KW/bn/K1083/208 of 2nd March, 1995,
and your subsequent letters of 23rd November, 1995 and
28th November, 1995, please receive herewith the drawings requested
for in transparencies as per attached schedule.

Yours faithfully,

S. M. Njau

FOR: DIRECTOR OF WATER DEVELOPMENT

Gauff Ingenieure

15th December, 1995
MK/bn/K1083/1124

H P GAUFF KG — CONSULTING ENGINEERS — P.O. BOX 49817 NAIROBI/KENYA.

M/s. Sir Alexander Gibb & Partners
P.O. Box 30020
NAIROBI

Attn: Mr. Bati

Beratende
Ingenieure
Consulting
Engineers
Ingénieurs
Conseils

Branch Office

NAIROBI
EAST CHURCH ROAD
WESTLANDS
TEL: 445288
FAX: 446124



Dear Sir,

REF: NYERI WATER SUPPLY FEASIBILITY STUDY - DRAWINGS/PLANS

Reference is made to the discussion you had with our Mr. Kinya on 13th December, 1995 on the above subject.

Attached herewith is a list of the drawings that we may need in the course of our study. We therefore request you to make a print of the drawings listed and advise us of the cost of printing.

In anticipation of your kind cooperation, we remain,

Yours faithfully,
H.P. GAUFF KG
Consulting Engineers

L. Laubert
GENERAL MANAGER

D. Baker
HEAD, WATER & SANITATION

Encl

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Stadtsparkasse Nuernberg 1 188 442
Commerzbank AG Nuernberg 5 111 141
Postsparkasse Nuernberg 93318 859

Commercial Bank of Africa
Nairobi/Kenya No. 10020
Stanbic Bank Kenya
Nairobi/Kenya No. 151010 880 4001

Gauff Ingenieure

File

Beratende
Ingenieure
Consulting
Engineers
Ingénieurs
Conseils

25th January, 1996
KW/bn/K1083/086

H P GAUFF KG — CONSULTING ENGINEERS — P.O. BOX 49817 NAIROBI/KENYA.

Branch Office

NAIROBI
EAST CHURCH ROAD
WESTLANDS
TEL: 445288
FAX: 446124

The Town Clerk
Nyeri Municipal Council
P.O. Box 180
NYERI



Dear Sir,

RE: NYERI WATER SUPPLY - FEASIBILITY STUDY

Record of Discussions

Enclosed please find notes on the principal aspects of the discussions held in our offices on 19th January, 1996.

Yours faithfully,
H.P. GAUFF KG
Consulting Engineers

Handwritten signature of L. Laubert in dark ink.
L. Laubert
GENERAL MANAGER

Handwritten signature of D. Baker in dark ink.
D. Baker
HEAD, WATER & SANITATION

cc: Eng. Mwaura
Engineer
Gauff

- MOLG
- Nyeri Municipal Council
- Frankfurt

Encl

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Stanbic Bank Kenya
Nairobi Kenya No. 151010 880 4001

NYERI WATER SUPPLY - FEASIBILITY STUDY

RECORD OF DISCUSSIONS

The discussions were held when the Nyeri Municipal Council officials called in at the H.P. Gauff Nairobi offices on 19th January, 1996.

Present

Mr. Gikuhi	- Town Clerk	Nyeri Municipal Council
Mr. Nguiguti	- Engineer	Nyeri Municipal Council
Mr. Baker	- Head, Water & Sanitation	H.P. Gauff
Mr. Wangombe	- Project Engineer	H.P. Gauff

1. Mr. Gikuhi asked for an update on the on-going study. Mr. Baker explained that the report for the Pre-feasibility stage was being finalised and would be submitted very soon. There had been delay whilst awaiting the Gibb drawings for the earlier study, and this had already been explained to KfW. Some moderate delay was found better than possible cost implications if the Gibb drawings were not awaited, and then were found to necessitate review of the pre-feasibility recommendations.
2. It was noted that the old "as built" drawings which were in Maji House had been obtained by Gauff in December 1995. Mr. Wangombe would expedite provision of copies to the Council.
3. Mr. Gikuhi noted that the present water supply situation in Nyeri was very critical. From the discussions with the recent KfW mission, it was apparent they could not expect donor financing of short term improvements. Mr. Gikuhi informed that the Council had therefore decided to implement the measures that were found possible within their own resources. The Gauff Situation Assessment Report had recommended augmentation from the pumped Chania Intake as the lower capital cost alternative, and this was the option the Council was investigating.
4. Mr. Nguiguti informed that he had surveyed the rising main from the Chania Intake to the Kamakwa Treatment Works. The required new raw water pumps had been sized, and the Council had invited quotations from a number of firms. Mr. Baker offered assistance in reviewing the Council design and pump selection if Gauff were provided with the details. The Council were to provide the pump technical literature and quotations, and the profile of the rising main.
5. It was recalled that the Situation Assessment had recommended that the Kamakwa Treatment Works could be uprated to 9,000 m³/day by modifying the existing facilities. It was agreed H.P. Gauff would provide details of these proposals and cost estimates, so that the Council could arrive at a decision regarding their implementation. Gauff would also pursue details of the availability and rental cost of the sieving machine recently used in Kericho, so that the Council could do their own regrading of filter sand.

6. Mr. Nguiguti informed that the Council had continued to follow up on the level of water losses, including tracking down illegal consumption and cutting off out of use connections. Mr. Nguiguti was however becoming more and more convinced that there was a problem with the bulk metering at Kamakwa. He had noted that the main supply pipe was often only partially filled. Removal of some pipe pieces in the meter's vicinity had shown clear signs of the normal water level in the pipe. Air was drawn in when the water levels in the tank fell, and the air was released downstream of the meter. Mr. Nguiguti was not even sure that the meters were accurate when the pipework was running full.
7. Mr. Baker checked and confirmed that Gauff's ultrasonic flow measurement equipment was available. It was agreed Gauff would send an engineer to Nyeri in the coming week with the equipment to take flow measurements as a check against the accuracy of the bulk meters. Measurements would also be taken on the raw water mains to see if there were significant losses along them, and possibly also at selected points in the distribution system, to help narrow down areas of high leakage losses. The Council would provide labour in uncovering the pipework, and other assistance.

Notes by:

K.B. WANGOMBE

POSITION	STAFF NUMBERS							ANNUAL COST [KShs]	
	Head Office and General	Ihwa Intake and Kirti TW	Kamakwa TW	Nyeri Reticulation	Amboni Intake and TW	Kiganjo Reticulation	Total	Each	Total

[illegible]

Superintendent	-	3	1		1	5	202,020	1,010,100
Senior Operator	-	6	3		2	11	140,850	1,549,350
Technician	-	3	2		1	6	140,850	845,100
Operator	2	18	-		-	20	76,980	1,539,600
Foreman	-	6	5		3	14	112,140	1,569,960
Laboratory Assistant	-	2	-		-	2	76,980	153,960
Chemical Attendant	-	12	-		-	12	62,880	754,560
Pump Attendant	-	8	-		-	8	62,880	503,040
Line Patroller	2	-	12		6	20	58,140	1,162,800
Plumbers	-	4	15		8	27	85,860	2,318,220
Meter Readers	-	-	12		6	18	62,880	1,131,840
Subordinate Staff / Watchmen	3	15	15		8	41	62,880	2,578,080
Sub-Total							15,116,610	

POSITION	STAFF NUMBERS							ANNUAL COST [KShs]	
	Head Office and General	Ihwa Intake and Kirti TW	Kamakwa TW	Nyeri Reticulation	Amboni Intake and TW	Kiganjo Reticulation	Total	Each	Total

General Manager	1					1	308,760	308,760
Deputy General Manager	2					2	256,200	512,400
Ast. General Manager	3					3	238,830	716,490
Senior Superintendent	-					-	202,020	-
Revenue Officer	2					2	140,850	281,700
Public Relations Officer	2					2	140,850	281,700
Accountant	2					2	202,020	404,040
PC Operators & Clerks	10					10	102,000	1,020,000
Secretary	1					1	172,260	172,260
Copy Typist	3					3	76,980	230,940
E&M Technicians	3					3	140,850	422,550
Maintenance Artisans	18					18	102,000	1,836,000
Draughtsmen	4					4	129,450	517,800
Storemen	4					4	76,980	307,920
Drivers	6					6	76,980	461,880
Subordinate Staff	4					4	58,140	232,560
Sub-Total							7,707,000	

Superintendent	-	3	1	1	1	6	202,020	1,212,120
Senior Operator	-	6	3	3	2	14	140,850	1,971,900
Technician	-	3	2	2	1	8	140,850	1,126,800
Operator	2	18	-	9	-	29	76,980	2,232,420
Foreman	-	6	5	3	3	17	112,140	1,906,380
Laboratory Assistant	-	2	-	2	-	4	76,980	307,920
Chemical Attendant	-	12	-	6	-	18	62,880	1,131,840
Pump Attendant	-	8	-	6	-	14	62,880	880,320
Line Patroller	2	-	12	-	6	20	58,140	1,162,800
Plumbers	-	4	15	3	8	30	85,860	2,575,800
Meter Readers	-	-	12	-	6	18	62,880	1,131,840
Subordinate Staff / Watchmen	3	15	15	12	8	53	62,880	3,332,640
Sub-Total							18,972,780	

Table 3.7
STAFFING LEVELS: OPTION B1 YEAR 2020

POSITION	STAFF NUMBERS						ANNUAL COST [KShs]	
	Head Office and General	Ihwa Intake and Kiriti TW	Kamakwa TW	Nyeri Reticulation	Amboni Intake and TW	Kiganjo Reticulation	Total	
								Each Total

BOTH WATER AND SANITATION DUTIES

General Manager	1						1	308,760	308,760
Deputy General Manager	2						2	256,200	512,400
Ast. General Manager	3						3	238,830	716,490
Senior Superintendent	-						-	202,020	-
Revenue Officer	2						2	140,850	281,700
Public Relations Officer	2						2	140,850	281,700
Accountant	2						2	202,020	404,040
PC Operators & Clerks	10						10	102,000	1,020,000
Secretary	1						1	172,260	172,260
Copy Typist	3						3	76,980	230,940
E&M Technicians	3						3	140,850	422,550
Maintenance Artisans	18						18	102,000	1,836,000
Draughtsmen	4						4	129,450	517,800
Storemen	4						4	76,980	307,920
Drivers	6						6	76,980	461,880
Subordinate Staff	4						4	58,140	232,560
Sub-Total								7,707,000	

WATER SPECIFIC DUTIES

Superintendent		3	1	1		1	6	202,020	1,212,120
Senior Operator		6	2	3		2	13	140,850	1,831,050
Technician		3	1	2		1	7	140,850	985,950
Operator		18	6	-		-	24	76,980	1,847,520
Foreman		6	2	5		3	16	112,140	1,794,240
Laboratory Assistant		2	2	-		-	4	76,980	307,920
Chemical Attendant		12	6	-		-	18	62,880	1,131,840
Pump Attendant		-	6	-		-	6	62,880	377,280
Line Patroller		2	-	12		6	20	58,140	1,162,800
Plumbers		4	2	15		8	29	85,860	2,489,940
Meter Readers		-	-	12		6	18	62,880	1,131,840
Subordinate Staff / Watchmen		15	10	15		8	48	62,880	3,018,240
Sub-Total								17,290,740	

Table 3.8
STAFFING LEVELS: OPTION B2 YEAR 2020

POSITION	STAFF NUMBERS						ANNUAL COST [KShs]	
	Head Office and General	Ihwa Intake and Kiriti TW	Kanakwa TW	Nyeri Reticulation	Amboni Intake and TW	Kiganjo Reticulation	Total	
							Each	Total

BOTH WATER AND SANITATION DUTIES

General Manager	1						1	308,760	308,760
Deputy General Manager	2						2	256,200	512,400
Ast. General Manager	3						3	238,830	716,490
Senior Superintendent	-						-	202,020	-
Revenue Officer	2						2	140,850	281,700
Public Relations Officer	2						2	140,850	281,700
Accountant	2						2	202,020	404,040
PC Operators & Clerks	10						10	102,000	1,020,000
Secretary	1						1	172,260	172,260
Copy Typist	3						3	76,980	230,940
E&M Technicians	3						3	140,850	422,550
Maintenance Artisans	18						18	102,000	1,836,000
Draughtsmen	4						4	129,450	517,800
Storemen	4						4	76,980	307,920
Drivers	6						6	76,980	461,880
Subordinate Staff	4						4	58,140	232,560
Sub-Total								7,707,000	

WATER SPECIFIC DUTIES

Superintendent		3	1	1	1	1	7	202,020	1,414,140
Senior Operator		6	2	3	3	2	16	140,850	2,253,600
Technician		3	1	2	2	1	9	140,850	1,267,650
Operator		18	6	-	9	-	33	76,980	2,540,340
Foreman		6	2	5	3	3	19	112,140	2,130,660
Laboratory Assistant		2	2	-	2	-	6	76,980	461,880
Chemical Attendant		12	6	-	6	-	24	62,880	1,509,120
Pump Attendant		-	6	-	6	-	12	62,880	754,560
Line Patroller		2	-	12	-	6	20	58,140	1,162,800
Plumbers		4	2	15	3	8	32	85,860	2,747,520
Meter Readers		-	-	12	-	6	18	62,880	1,131,840
Subordinate Staff / Watchmen		15	10	15	12	8	60	62,880	3,772,800
Sub-Total								21,146,910	

