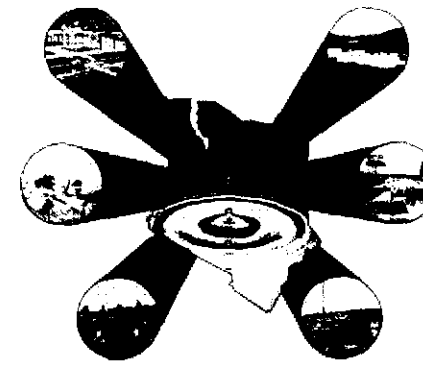
KENYA
LAKE VICTORIA SOUTH WATER AND WASTEWATER FEASIBILITY STUDY



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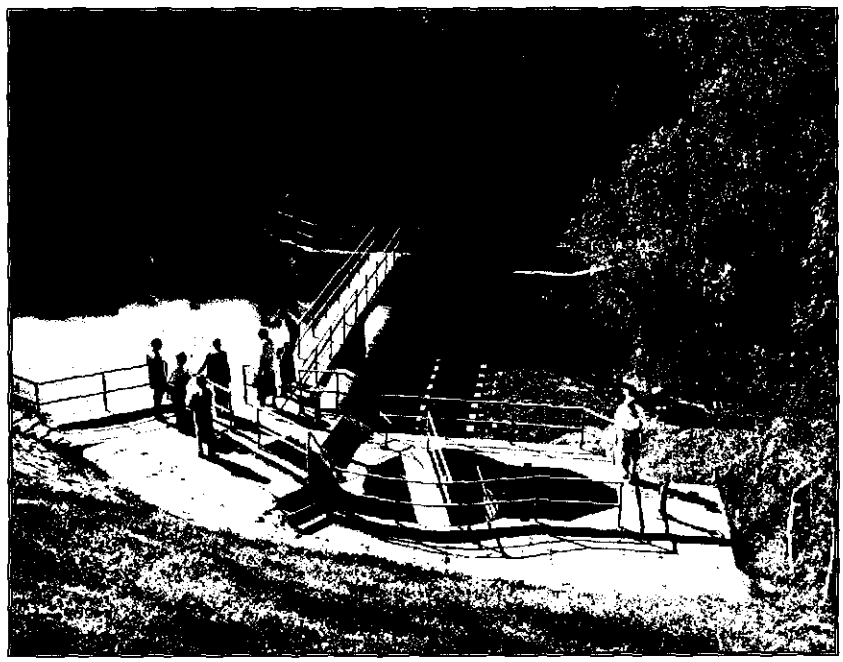

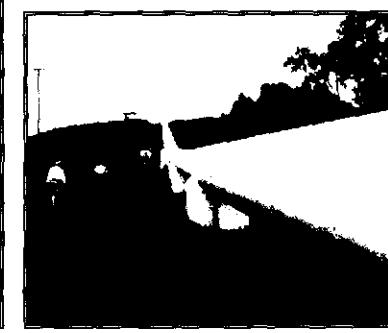

Prepared For:

THE REPUBLIC OF KENYA MINISTRY OF WATER AND IRRIGATION

&

THE LAKE VICTORIA SOUTH WATER SERVICES BOARD

PREPARED BY:

COLER & COLANTONIO, INC. PROJECT TEAM

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TABLE OF CONTENTS

CONTENTS SUMMARY

Executive Summary
Section 1 Introduction
Section 2 Framework For Analysis
Section 3 Institutional Arrangements
Section 4 Lake Victoria South Water Services Board
Section 5 Kericho
Section 6 Kisii
Section 7 Migori
Section 8 Preliminary Environmental Impact Analysis
Section 9 Financing and Implementation Plan
Section 10 Development Impact

DETAILED CONTENTS

EXECUTIVE SUMMARY **Ex-1**

1. INTRODUCTION **1-1**

1.1 Background and Purpose 1-1
1.2 Project Scope 1-5
1.3 Project Approach 1-5
1.4 Project Team 1-6
1.5 Community Selection Process 1-6

2. FRAMEWORK FOR ANALYSIS **2-1**

2.1 Overall Design Criteria and Projections Methodology **2-1**
2.1.1 Overall Design Criteria 2-1
2.1.2 Population and Water Demand Projections Methodology 2-2
2.1.3 Wastewater Flow Projections Methodology 2-3
2.2 Treatment Standards and Design Criteria **2-4**
2.2.1 Drinking Water Treatment Water Quality Requirements 2-4
2.2.1 (a) Bacteriological Water Quality Requirements 2-4
2.2.1 (b) Chemical Water Quality Requirements 2-5
2.2.2 Wastewater Treatment Effluent Requirements 2-7
2.2.3 Wastewater Sludge Disposal Requirements 2-10

3. INSTITUTIONAL ARRANGEMENTS 3-1

3.1 Overview of Existing Institutional Arrangements 3-1
3.1.1 The Water Act and National and Regional Institutions 3-1
3.1.2 Lake Victoria South Water Services Board 3-3
3.2 Theoretical Management Structure Options 3-6
3.3 Review of Actual Management Structures in Place 3-10
3.3.1 National Water and Sewerage Corporation (NWSC), Uganda 3-10
3.3.2 Massachusetts Water Resources Authority (MWRA), United States 3-10
3.4 Comparison of LVSWSB to Theoretical and Actual Structures in Place 3-11
3.5 Lake Victoria South Water Services Board Recommendations 3-12

4. LAKE VICTORIA SOUTH WATER SERVICES BOARD 4-1

4.1 Overview 4-1
4.2 Needs Evaluation 4-1
4.3 Recommendations 4-4
4.3.1 Toolkits and Standardization / Certification Programs 4-4
4.3.2 Regionalization 4-7

5. KERICHO 5-1

5.1 General Information and Projections 5-1
5.1.1 Location 5-1
5.1.1 Topography, Geology, and Climate 5-1
5.1.2 Land Use and Roadway Infrastructure 5-1
5.1.3 Power Supplies 5-3
5.1.4 Population 5-4
5.1.5 Water Demand and Service Goals 5-6
5.1.6 Wastewater Flow and Service Goals 5-8
5.2 Water 5-10
5.2.1 Water System Overview 5-10
5.2.2 Water Sources and Intakes 5-11
5.2.2 (a) Water Sources and Intakes Description 5-11
5.2.2 (b) Water Sources and Intakes Needs 5-14
5.2.2 (c) Water Sources and Intakes Improvement Options 5-15
5.2.2 (d) Water Sources and Intakes Recommendations 5-17
5.2.3 Water Treatment 5-18
5.2.3 (a) Timbilil Water Treatment Works Description 5-18
5.2.3 (b) Timbilil Water Treatment Works Needs 5-20
5.2.3 (c) Timbilil Water Treatment Works Recommendations 5-21
5.2.3 (d) Kimugu Water Treatment Works Description 5-21
5.2.3 (e) Kimugu Water Treatment Works Needs 5-22
5.2.3 (f) Kimugu Water Treatment Works Recommendations 5-23
5.2.4 Water Distribution 5-23
5.2.4 (a) Water Distribution Description 5-23
5.2.4 (b) Water Distribution Needs 5-28
5.2.4 (c) Water Distribution Recommendations 5-30

5.3 Wastewater **5-30**
5.3.1 Wastewater Overview 5-30
5.3.2 Wastewater Collection 5-31
5.3.2 (a) Wastewater Collection Description 5-31
5.3.2 (b) Wastewater Collection Needs 5-36
5.3.2 (c) Wastewater Collection Recommendations 5-38
5.3.3 Wastewater Treatment, Disposal, and Residuals Management 5-38
5.3.3 (a) Wastewater Treatment, Disposal, and Residuals Management Description 5-38
5.3.3 (b) Wastewater Treatment, Disposal, and Residuals Management Needs 5-42
5.3.3 (c) Wastewater Treatment, Disposal, and Residuals Management Recommendations 5-43
5.4 Management and Operation and Maintenance (O&M) **5-44**
5.4.1 Management and O&M Description 5-44
5.4.2 Management and O&M Needs 5-51
5.4.3 Management and O&M Recommendations 5-54

6. KISII **6-1**

6.1 General Information and Projections **6-1**
6.1.1 Location 6-1
6.1.2 Topography, Geology, and Climate 6-1
6.1.3 Land Use and Roadway Infrastructure 6-1
6.1.4 Power Supplies 6-4
6.1.5 Population 6-6
6.1.6 Water Demand and Service Goals 6-8
6.1.7 Wastewater Flow and Service Goals 6-11
6.2 Water **6-13**
6.2.1 Water System Overview 6-13
6.2.2 Water Sources and Intakes 6-15
6.2.2 (a) Water Sources and Intakes Description 6-15
6.2.2 (b) Water Sources and Intakes Needs 6-17
6.2.2 (c) Water Sources and Intakes Improvement Options 6-18
6.2.2 (d) Water Sources and Intakes Recommendations 6-20
6.2.3 Water Treatment 6-21
6.2.3 (a) Kegati Water Treatment Works Description 6-21
6.2.3 (b) Kegati Water Treatment Works Needs 6-25
6.2.3 (c) Kegati Water Treatment Works Recommendations 6-25
6.2.3 (d) Nyakomisaro Water Treatment Works Description 6-26
6.2.3 (e) Nyakomisaro Water Treatment Works Needs 6-28
6.2.3 (f) Nyakomisaro Water Works Recommendations 6-29
6.2.4 Water Distribution 6-29
6.2.4 (a) Water Distribution Description 6-29
6.2.4 (b) Water Distribution Needs 6-36
6.2.4 (c) Water Distribution Recommendations 6-38
6.3 Wastewater **6-39**
6.3.1 Wastewater Overview 6-39
6.3.2 Wastewater Collection 6-39
6.3.2 (a) Wastewater Collection Description 6-39
6.3.2 (b) Wastewater Collection Needs 6-42
6.3.2 (c) Wastewater Collection Recommendations 6-43
6.3.3 Wastewater Treatment, Effluent Disposal, and Residuals Management 6-44

6.3.3 (a) Wastewater Treatment, Disposal, and Residuals Management Description 6-44
6.3.3 (b) Wastewater Treatment, Disposal, and Residuals Management Needs 6-47
6.3.3 (c) Wastewater Treatment, Disposal, and Residuals Management Recommendations 6-48
6.4 Management and Operation and Maintenance (O&M) 6-49
6.4.1 Management and O&M Description 6-49
6.4.2 Management and O&M Needs 6-56
6.4.3 Management and O&M Recommendations 6-58

7. MIGORI 7-1

7.1 General Information and Projections 7-1
7.1.1 Location 7-1
7.1.2 Topography, Geology, and Climate 7-1
7.1.3 Land Use and Roadway Infrastructure 7-2
7.1.4 Power Supplies 7-5
7.1.5 Population 7-7
7.1.6 Water Demand and Service Goals 7-10
7.1.7 Wastewater Flows and Service Goals 7-13
7.2 Water 7-15
7.2.1 Water System Overview 7-15
7.2.2 Water Sources and Intakes 7-17
7.2.2 (a) Water Sources and Intakes Description 7-17
7.2.2 (b) Water Sources and Intakes Needs 7-22
7.2.2 (c) Water Sources and Intakes Improvement Options 7-23
7.2.2 (d) Water Sources and Intakes Recommendations 7-27
7.2.3 Water Treatment 7-28
7.2.3 (a) Water Treatment Description 7-28
7.2.3 (b) Water Treatment Needs 7-28
7.2.3 (c) Water Treatment Recommendations 7-29
7.2.4 Water Distribution 7-29
7.2.4 (a) Water Distribution Description 7-29
7.2.4 (b) Water Distribution Needs 7-34
7.2.4 (c) Water Distribution Recommendations 7-36
7.3 Wastewater 7-37
7.3.1 Wastewater Overview 7-37
7.3.2 On-Site and Small Treatment Systems 7-37
7.3.2 (a) On-Site and Small Treatment Systems Description 7-37
7.3.2 (b) On-Site and Small Treatment Systems Needs 7-42
7.3.2 (c) On-Site and Small Treatment Systems Recommendations 7-42
7.3.3 Centralized Collection, Treatment, Disposal, and Residuals Management 7-43
7.3.3 (a) Centralized Collection, Treatment, Disposal, and Residuals Management Needs 7-43
7.3.3 (b) Centralized Collection, Treatment, Disposal, and Residuals Management Recs. 7-48
7.4 Management and Operation and Maintenance (O&M) 7-48
7.4.1 Management and O&M Description 7-48
7.1.1 Management and O&M Needs 7-55
7.4.2 Management and O&M Recommendations 7-57

8. PRELIMINARY ENVIRONMENTAL IMPACT ANALYSIS 8-1

8.1 Environmental Analysis Overview 8-1
8.2 Environmental Legislation 8-2
8.2.1 The Environmental Management and Coordination Act 8-2
8.2.2 The Environmental (Impact and Assessment Audit) Regulations, 2003 8-2
8.2.3 Draft Environmental Quality Standards 8-3
8.3 Evaluation Elements 3
8.4 Evaluation of Water Projects 8-4
8.5 Evaluation of Wastewater Projects 8-7

9. FINANCING AND IMPLEMENTATION PLAN 9-1

9.1 Overview 9-1
9.2 Summary of Project Costs and Needs 9-1
9.3 Financing 9-8
9.3.1 Work Plan 9-8
9.3.2 Project Structure 9-9
9.3.3 Financing Sources 9-11
9.3.4 Financing Plan 9-13
9.3.5 Security Package 9-14
9.3.6 Financial Analysis 9-15
9.3.7 MIKUTRA (Migori) 9-18
9.3.7 (a) MIKUTRA Financial Modeling 9-18
9.3.7 (b) MIKUTRA CapEx Plan 9-19
9.3.7 (c) MIKUTRA Sensitivities 9-19
9.3.8 KEWASCO (Kericho) 9-21
9.3.8 (a) KEWASCO Financial Modeling 9-21
9.3.8 (b) KEWASCO CapEx Plan 9-22
9.3.8 (c) KEWASCO Sensitivities 9-22
9.3.9 Gusii (Kisii) 9-24
9.3.9 (a) Gusii Financial Modeling 9-24
9.3.9 (b) Gusii CapEx Plan 9-25
9.3.9 (c) Gusii Sensitivities 9-25
9.3.10LVSWSB 9-26
9.3.10 (a) LVSWSB Financial Model 9-26
9.3.10 (b) LVSWSB CapEx Plan 9-28
9.3.10 (c) LVSWSB Sensitivities 9-31
9.4 Implementation Plan 9-33

10. DEVELOPMENT IMPACT 10-1

LIST OF APPENDICES

1-1 Project Team Letter to Grantee containing Draft Work Plan and Draft Community Selection Criteria (1/10/2006)
1-2 Project Team Contact Information
1-3 Community Pre-Visit Survey and Data Request Results
1-4 LVSWSB Letter to Ministry of Water and Irrigation stating community selections and including completed Community Selection Criteria Forms (1/31/2006)
1-5 Project Team Letter to Grantee containing Final Work Plan (2/26/2006)
1-6 Catalog of Data Collected (3/9/2006)

2-1 World Health Organization Report #9, Table 5.1 "Anticipated Contribution of Domestic Sewage from Various Types of Establishments"

4-1 Automatic Meter Reading (AMR) Informational Brochure (City of Cambridge, Massachusetts)
4-2 Sample Consumer Confidence Reports for 2004 and 2005 (City of Cambridge, Massachusetts)
4-3 LVSWSB Detailed Projects and Cost Estimation Matrix

5-1 Kericho Detailed Water Demand and Wastewater Flow Estimates
5-2 Kericho Detailed Projects, Phasing, and Cost Estimation Matrix
5-3 Kericho Immediate Action Items

6-1 Kisii Detailed Water Demand and Wastewater Flow Estimates
6-2 Kisii Detailed Projects, Phasing, and Cost Estimation Matrix
6-3 Kisii Immediate Action Items
6-4 Letter to UN-Habitat containing comments on UN-Habitat's immediate intervention recommendations in Kisii (5/15/2006)

7-1 Migori Detailed Water Demand and Wastewater Flow Estimates
7-2 Migori Detailed Projects, Phasing, and Cost Estimation Matrix
7-3 Migori Immediate Action Items

9-1 LVSWSB Financial Modeling
9-2 Kisii Financial Modeling
9-3 Migori Financial Modeling
9-4 Kericho Financial Modeling

10-1 List of Suppliers

ABBREVIATIONS

AC	Asbestos Cement
ac	acre
ADB	African Development Bank
alum	aluminum sulfate
As	Arsenic
Ba	Barium
BAT	British American Tobacco
BMP	Best Management Practice
BOD_5, BOD	5-Day Biological Oxygen Demand
BPD	Building Partnerships for Development in Water and Sanitation
C	Celsius
Ca	Calcium
CAC	Catchment Advisory Committee
$CaCO_3$	Calcium Carbonate
CapEx	Capital Expenditure
CBD	Central Business District
CCA	Corporate Council on Africa (USA)
Cd	Cadmium
Cl	Chloride
CN	Cyanide
CO_2	Carbon Dioxide
COD	Chemical Oxygen Demand
Cr	Chromium
Cu	Copper
d	day
DBSA	Development Bank of South Africa
DDT	Dichloro Diphenyl Trichloroethane
DEG	Deutsche Investitions und Entwicklungsgesellschaft (Germany)
Design Manual	2005 Practice Manual for Water Supply Services in Kenya
DI	Ductile Iron
DO	Dissolved Oxygen
DWO	District Water Office
EBRD	European Bank for Reconstruction and Development
ECA	Export Credit Agency
EIA	Environmental Impact Assessment
ENEP	El Nino Environmental Programme
EPA, USEPA	United States Environmental Protection Agency
F	Fluoride
Fe	Iron
Fe	Iron
ft	foot
g	gram
GI	Galvanized Iron
GIS	Geographic Information System
GOK	Government of Kenya
GPS	Geographic Positioning System
GWASCO, Gusii	Gusii Water & Sanitation Company Limited
ha	hectare
Hg	Mercury

hr	hour
hrs	hours
I/I	Infiltration and Inflow
IFC	International Finance Corporation (World Bank)
in	inch
ISC	Individual Sewer Connection
IWC	Individual Water Connection
JICA	Japan International Cooperation Agency
K	Potassium
KCC	Kenya Cooperative Creameries
KEBS	Kenya Bureau of Standards
KenGen	Kenya Electricity Generating Company Limited
KEWASCO	Kericho Water and Sanitation Company Limited
KfW	Reconstruction Credit Institute (Kreditanstalt für Wiederaufbau) (Germany)
kg	kilogram
km	kilometers
km^2	square kilometers
KMC	Kisii Municipal Council
KPLC	Kenya Power and Lighting Company
KShs	Kenyan Shillings
kV	kilovolts
kVA	kilovolt amps
kW	kilowatt
kW-hr	kilowatt hour
l	liters
lpcd	liters per capita per day
lpd	liters per day
lps	liters per second
LVSWSB	Lake Victoria South Water Services Board
m	meters
M/E	Mechanical/Electrical
m^2	square meter
m^3	cubic meter
MCC	Millennium Challenge Corporation
MDC	Metropolitan District Commission (USA)
MDG	Millennium Development Goal
Mg	Magnesium
mg	milligrams
MIKUTRA	MIKUTRA Water and Sanitation Company Limited (Migori, Kuria, Transmara)
MIWASCO	Migori Water and Sewer Company Limited (Previous name, superseded by MIKUTRA)
ml	milliliters
mm	millimeters
Mn	Manganese
mo	month
MoF	Ministry of Finance (Kenya)
MPN	Maximum Probably Number
MWI	Ministry of Water and Irrigation (Kenya)
MWRA	Massachusetts Water Resources Authority (USA)
N	Nitrogen
Na	Sodium

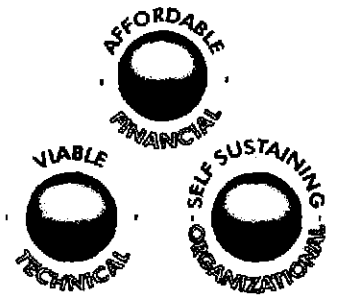
NEAP	National Environment Action Plan
NEMA	National Environmental Management Authority
NEWEA	New England Water Environment Association (USA)
NGO	Non-Governmental Organization
NH_3	Ammonia
NISA	Not In Service Area
NO_2	Nitrite
NO_3	Nitrate
NSC	No Sewer Connection
NTU	Nephelometric Turbidity Units
NWC	No Water Connection
NWCPC	National Water Conservation and Pipeline Corporation (Kenya)
NWMP	National Water Master Plan (Kenya)
NWSA	Nyasare Water Supply Association
NWSC	National Water and Sewerage Corporation (Uganda)
O&M	Operation and Maintenance
OPIC	Overseas Private Investment Corporation
P	Phosphorus
Pb	Lead
pH	negative log of hydrogen ion concentration (measure of acidity)
PO_4	Phosphate
PPF	Project Preparatory Facility
PVC	Polyvinyl Chloride
QA/QC	Quality Assurance and Quality Control
RCMRD	Regional Center for Mapping of Resources for Development
s	second
Se	Selenium
SO_4	Sulfate
SONY	South Nyanza Sugar Company
SPA	Service Provider Agreement
SS	Suspended Solids
TCU	True color unit
TDS	Total dissolved solids
TDS	Total dissolved solids
TEAMS	Total Electronic Asset Management System (USEPA)
TSS	Total Suspended Solids
TWIST	The Wastewater Information System Tool (USEPA)
UfW	Unaccounted–for-Water
UN	United Nations
UN-Habitat	United Nations Human Settlements Programme
uPVC	Unplasticized polyvinyl chloride
USAID	United States Agency for International Development
USEPA	United States Environmental Protection Agency
USD	United States Dollar
USTDA, TDA	United States Trade and Development Agency
V	Volt
WAB	Water Appeals Board (Kenya)
WB	World Bank
WC	Water Closet
WEF	Water Environment Federation (USA)
WHO	World Health Organization

wk	week
WRMA	Water Resources Management Authority (Kenya)
WSB	Water Services Board (Kenya)
WSP	Waste Stabilization Pond
WSP	Water Service Provider (Kenya)
WSRB	Water Services Regulatory Board (Kenya)
WSTF	Water Services Trust Fund (Kenya)
WTF	Wastewater Treatment Facility
yr	year
Zn	Zinc

EXECUTIVE SUMMARY

Background and Purpose

The Kenya Ministry of Water and Irrigation (MWI) obtained a grant from the United States Trade and Development Agency (USTDA) for a water and wastewater feasibility study in the Lake Victoria South Water Services Board (LVSWSB) Region. A Project Team lead by Coler & Colantonio, Inc. has served as the project contractor.



The goal of the study was to determine the feasibility of establishing viable, affordable, and self-sustaining water and wastewater utilities in three representative towns in the region. The project premise was that such utilities could be financed, constructed, operated and maintained principally via user tariffs set near the Kenyan average. In order to determine the feasibility of establishing the three key pillars of viability, affordability, and sustainability, the Project Team included technical experts (Coler & Colantonio, Inc. and CAPEconsult), finance experts (Tusk Financial and Babford & Company), and organizational and management experts (The Bhatti Group). Other experts were consulted on an ad hoc basis.

The recommendations of the study are formulated to meet or exceed the 2015 Millennium Development Goal (MDG) target for water and wastewater. Millennium Development Goal Target 10 is to "halve, by 2015, the proportion of people without sustainable access to safe drinking water and basic sanitation".[1]

After an initial screening process, the towns of Kericho, Kisii, and Migori were selected for detailed study (Map Ex-1). These towns fall under the jurisdiction of the newly-established Lake Victoria South Water Services Board (launched December 2004). The towns each range in population from about 100,000 to 200,000 and are growing at rates sufficient to double their populations within twenty years.

In addition to dramatic public health benefits, the provision of reliable and affordable clean water and sanitation will enable the region to develop economically. Local businesses will be provided with the reliable water supplies they need for successful operation and growth. The amount of time spent by women and children searching for water will be drastically reduced, thereby freeing up more time for productive work and education.

Water and Wastewater Utilities Background

It is estimated that 75% of the urban population of Kenya would have access to safe drinking water if all existing water infrastructure were operational. However, only about 49% of urban dwellers have access to these services.[2] Rates of access to improved sanitation are lower.

Less than 20% of the existing population in Kisii and Migori has access to a piped water source and less than 5% has access to a piped wastewater system. In Kericho, more than half of the existing population has access to a piped water source, but less than 10% is connected to the existing sewer system.

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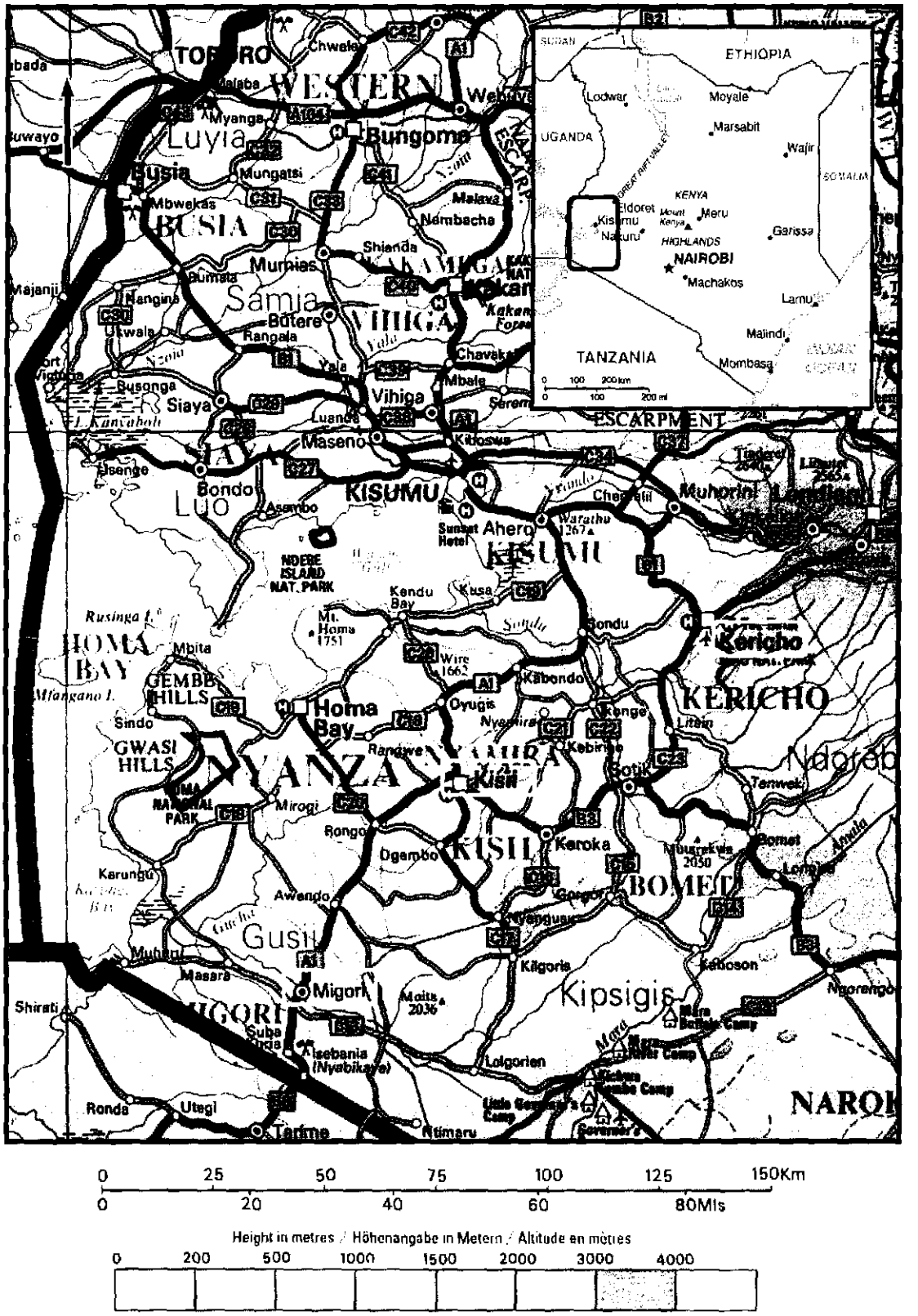
[1] Established at the UN Millennium Summit, September 2000.

[2] *Proceedings of Nyanza Professional Caucus Symposium on Water Resources and Sanitation Management in Kenya.* Foreword. 11-12 May 2000, Tom Mboya Labour College, Kisumu.



Map Ex-1. Study Area

Source Macmillan Education, Ltd. Kenya Traveller's Map, Third Ed. 1993. London.

Deficiencies in water and wastewater infrastructure, management, operation, and maintenance have resulted in many households and businesses being without access to piped water and sanitation, or being provided with only intermittent supplies of water. Record-keeping associated with water and wastewater infrastructure, including revenue collection, is generally inadequate or non-existent. Existing facilities do not produce at their rated capacities due to inadequate maintenance, unreliable electrical power sources, and insufficient funds for replacement of failed systems. Water distribution systems are estimated to lose more than half of their water via leaks and unmetered usage. This situation gives rise to decreasing rates of access to water and wastewater services, an increased incidence of waterborne disease, and decreased economic productivity.

A 2002 report prepared by the Kenyan Ministry of Environment and Natural Resources noted that access to water and sanitation in Kenya has declined over the past two decades. Several reasons for the failure of existing systems were cited:[3]

- "Poor operational and maintenance services which is compounded by limited resources allocations.
- Most of them [water and wastewater infrastructure facilities] have outlived their economic lives and therefore require major rehabilitation works to revive them.
- Majority of them [water and wastewater infrastructure facilities] cannot sustain the current demand, because of population increase and increased economic activities, and may therefore require major reconstruction or augmentation."

Inadequate service provision cannot be adequately explained by an inability to pay for services. In fact, the rates that many Kenyans pay for water approaches or exceeds rates paid in the United States. Average piped water rates in the United States are around 46 Kshs/m^3.[4] Average Kenyan piped water rates are currently approaching 40 Kshs/m^3. However, rates paid by the poorest Kenyans at kiosks and water vendors exceed 100 Kshs/m^3 and approach 1,000 Kshs/m^3 during times of water crises (Figure Ex-1).

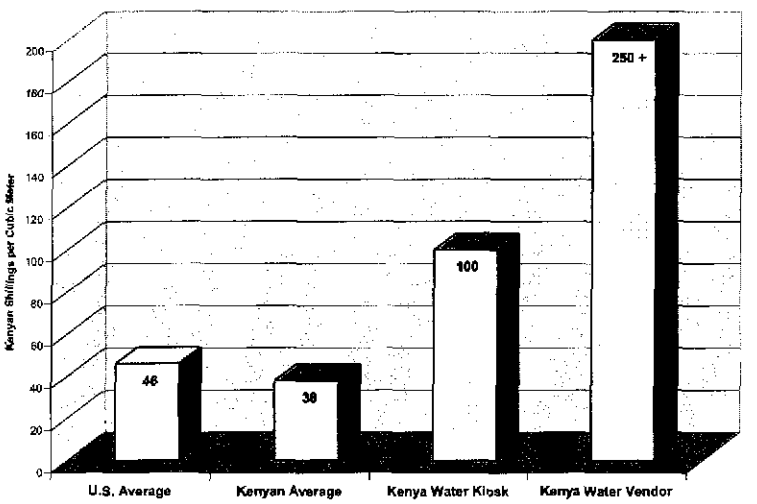


Figure Ex-1. Kenya and U.S. Water Tariff Rates

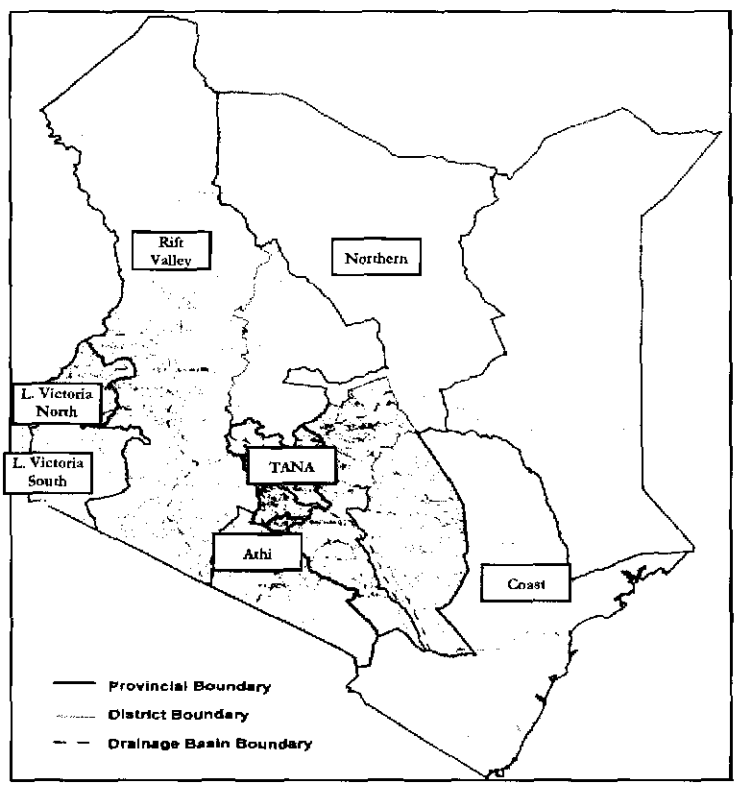
[3] Ministry of Environment and Natural Resources, Republic of Kenya, comp. *Abonyai Kiogora under supervision of D. N. Stower.* Review of the Water and Sanitation Component in the Poverty Reduction Strategy Paper, 2002. p 8.
[4] 2006 U.S. Water Rate Survey by NUS Consulting Group

Legislative and Institutional Background

A major step toward creating an environment where viable utilities can take hold came with the passage of the 2002 Kenya Water Act. This comprehensive piece of legislation created a regulatory framework that includes decentralizing control of water and wastewater service provision and encouraging more active involvement of the private sector.

Until the 2002 Water Act was passed, local towns had little control over their own water and wastewater systems. Tariffs were not set at cost-recovery levels despite a relatively high willingness to pay, revenue collection was poor, and collected revenues were not re-invested into the utilities. As a result, inadequate funding was available for system maintenance and existing infrastructure was allowed to fall into disrepair. With control now shifted from national to regional and local levels, Kenyan utilities can begin to steer themselves down a path toward efficient operation and management for full cost recovery and sustainability. Although conditions in some towns have not yet changed, others have already made significant progress in increasing efficiency and striving toward full cost recovery.

The decentralization of water and wastewater service provision is being accomplished by contracting with local water and wastewater service provider companies (WSP). The WSPs are autonomous companies under ownership of local town governments. They are contracted by one of seven regional Water Services Boards (WSB) to perform operation, maintenance, billings and collections (Map Ex-2). The infrastructure itself is owned by the WSBs and the WSPs pay a lease fee to the WSBs. The Lake Victoria South Water Services Board (LVSWSB) was established on 12th March 2004. By July of 2006, WSPs had been established in all three of the selected study towns in the LVSWSB area (Kericho, Kisii, and Migori).



Map Ex-2. Kenya Water Services Board (WSB) Regions

Key Findings

Existing levels of water and wastewater service provision vary throughout the LVSWSB area. However, the following findings generally apply throughout the region:

1. **New legislative framework has created favorable conditions**
   - The Kenya Water Act represents a major positive legislative shift
   - Many previous barriers to establishing viable utilities have been removed
   - The Water Act enables local decision-making, locally appropriate solutions, and clear accountability
   - The WSB / WSP structure is favorable from a financing petspective

2. **Tariffs often high, yet service often poor**
   - Service tariffs paid by many customers (especially those obtaining water from vendors) approach or exceed rates paid in the U.S. and Europe
   - Despite high tariffs, service is often unreliable or unavailable
   - Willingness and ability to pay for *good* service is relatively high; lower payment ratios in some communities likely stem from poor service provision
   - An apparent correlation exists between payment ratio and quality of service

3. **Tariffs need refinement**
   - National standard tariffs do not ensure cost-recovery; WSPs operate at a loss
   - WSP-specific tariffs should be developed to ensure full cost recovery
   - Need standardized approach to tariff-setting based on real data and expected future expenditures
   - Need improved accounting and record-keeping to understand actual costs and estimate future needs

4. **Need business-minded approach to management**
   - WSPs must understand customer base, service and revenue goals, and staffing needs
     - Reliable data is crucial for decision-making and must be acquired
     - Accurate accounting, metering, and billing are required
   - Revenue collection systems need a "jump-start"
     - Reducing lost water will decrease costs and increase revenue
       - Leak detection and repair needed
       - Old, under-recording meters should be replaced
       - All customers (including flat-rate customers) should be registered and metered
       - Illegal connections should be eliminated
       - A change in consumer mindset regarding illegal connections is needed
     - Connections should be added where capacity exists, especially wastewater connections
   - Trust must be established with customer base to ensure public "buy-in" for future projects
     - Responsiveness and communication improvements needed
   - Training programs should be developed for managers
   - Local entrepreneurship should be encouraged
     - Entrepreneurship will reduce burdens on WSPs, develop local income-generating opportunities
     - Opportunities include management of water kiosks, public toilets, septage hauling, etc.
   - Some systems should be regionalized for cost effectiveness
     - Regionalization may be appropriate for leak detection, chemical procurement, lab sampling, etc.

5. **Operation & Maintenance improvements required**
   - WSP need to understand existing assets
     - Improved data acquisition and analysis required
     - System inventories and mapping should be developed
     - Laboratory sampling improvements needed
   - WSP need to develop systems to maintain assets
     - Asset Management Programs should be instituted
     - Preventative Maintenance Programs should be instituted
   - LVSWSB should develop training and certification programs
     - Training and certification programs should include water and wastewater facility operators, operators of water kiosks and public toilets, water vendors, and pipe fitters.
     - Laboratory certification should be instituted to improve reliability of sampling results

6. **Effective watershed protection needed**
   - Watershed encroachment, erosion, and pollution must be reduced to prevent further water quality deterioration and increased water treatment costs
     - Watersheds should be delineated
     - Local enforceable by-laws should be established
     - Drainage and farming Best Management Practices (BMP) should be implemented
     - Riparian conservation land should be purchased
     - Squatters should be relocated

7. **Public Education & Public Relations programs needed**
   - Few WSPs have structured programs
     - Poor sanitation, limited water conservation, and illegal water connections in many areas may be partially attributed to a lack of public education and public relations
     - A sense of understanding and respect for shared resources should be cultivated
   - Development of public education and public relations programs will ensure that customers understand the benefits of investments
     - Customer "buy-in" will be crucial for successful project implementation

8. **Existing infrastructure requires upgrade and replacement**
   - Many facilities operate far below design capacity
   - Immediate repairs and upgrades should be performed to quickly boost capacity, service population and revenue

9. **Communal and on-site systems**
   - Water Kiosks, Public Toilets
     - Few exist, poorly managed
     - Cost-effective way to serve many areas including informal settlements
   - On-Site wastewater
     - Most residents utilize on-site wastewater (sanitation) systems
     - Should be viewed as an important piece of wastewater infrastructure
     - Able to protect public health if managed properly
     - Extending sewers cost prohibitive and unnecessary for many areas

10. **Major new infrastructure required**
    - Existing systems often undersized, malfunctioning
    - Electrical power often unavailable or unreliable; gravity systems and renewable energy sources should be developed
    - Major surface water supply development needed to meet existing demand and expected growth
    - Increasingly favorable economies of scale will enable financing of required large investments

Recommendations and Cost Estimates

Recommendations were developed for LVSWSB and the WSPs serving Kericho, Kisii, and Migori. The recommendations describe required improvements in water and wastewater infrastructure, management, operation, and maintenance throughout the study period. Multiple field visits were made to each town and LVSWSB headquarters in Kisumu to gather information required to assess needs and develop recommendations. Numerous discussions were held LVSWSB and each WSP to review and refine the recommendations reflecting local input. Recommendations were formulated into detailed Project Matrices including estimated phasing, costs, and detailed descriptions of observed problems and recommended solutions. Cost estimates were based on information gathered during site visits, interviews with local staff, information provided by LVSWSB and the WSPs, previous studies, costs from previous similar projects, available Kenyan guidelines, and engineering estimates. Recommendations and cost estimates are as follows.

Lake Victoria South Water Services Board Recommendations

The activities recommended to be undertaken by the LVSWSB may be categorized into two principal groups. The first group includes the development of ***toolkits and standardization programs*** to assist WSPs as they work to improve service provision. By developing these toolkits and standardization programs and assisting WSPs in their use, LVSWSB will be encouraging WSPs to put in place the systems that are vital for the establishment of sustainable utilities. The toolkits and standardization programs will also simplify LVSWSB's task of monitoring and promoting progress of the WSPs. The second category includes ***regionalization*** of some services as appropriate to take advantage of economies of scale to reduce costs and improve efficiency.

Toolkits and Standardization Programs

Toolkits
- System Inventory and Asset Management Planning
- Tariff Analysis
- Preventative Maintenance
- Illegal Connections
- Watershed (Catchment) Protection
- On-Site Wastewater Management
- Water Kiosks, Water Vendors, and Public Toilet Management
- Public Education
- Local Revenue (arrears collection, transitioning to metered connections)

Programs
- Laboratory Certification
- Operator Training and Certification
- Management Training

Regionalization
- Community Public Relations and Communications Program
- Bulk Procurement Evaluation
- Upgrade LVSWSB Garage for Regional Activities
- LVSWSB Headquarters Centralized Laboratory Testing and QA/QC
- Leak Detection and Repair Equipment and Operators
- Septage Exhauster, Sewer and Drain Cleaning Equipment
- Water Bowser

The cost of the above LVSWSB activities is estimated at $700,000 as detailed in Section 4 and Appendix 4-3.

Water Service Provider Recommendations

Population projections and service goals were defined for the towns and utility service areas in collaboration with LVSWSB and each WSP, taking into account the 2015 MDG targets. Individual WSP needs, options, preferred alternatives, costs, and phasing were developed iteratively to cost-effectively meet the service goals through the end of the study period (2025). The final project recommendations incorporate comments received on multiple draft reviews with LVSWSB and each WSP.

The WSP recommendations have been categorized into **four principal groups for water-related activities** and **three principal groups for wastewater-related activities**:

WSP Recommendation Categories

Water	**Wastewater**
Management	Management
Source	Collection
Treatment	Treatment
Distribution	

Project phasing has been summarized into the following three categories:
- Immediate (within ~1 year)
- Short Term (by 2015)
- Long Term (by 2025)

The detailed project matrices and financial analysis include a further breakdown of project phasing by year.

The Immediate Projects include a variety of tasks intended to:
1. Quickly boost capacity and service populations, reduce water losses, and increase revenue
2. Improve management, data acquisition and analysis, and operation and maintenance (O&M)
3. Begin detailed planning and preliminary design required for major infrastructure projects
4. Demonstrating the viability of the service entities (WSPs) as business units.

In addition to Immediate Projects, lists of local action items were prepared and distributed to each WSP. These include data gathering, O&M, management, and planning activities that require minimal financial investment and can be accomplished immediately with existing WSP staff. Accomplishing the local action items will begin to prepare the WSPs for full implementation of the project recommendations.

The Short Term and Long Term Projects include additional planning and design activities, but focus on constructing new, upgraded, and expanded infrastructure. Key projects in the three communities include, but are not limited to, the following:
- ⇒ Construction of water supply dams and intakes
- ⇒ Upgrade, expansion, and construction of new water treatment, storage, and distribution systems
- ⇒ Upgrade, expansion, and construction of new wastewater collection systems and treatment facilities
- ⇒ Expansion of water metering and leak detection and repair programs
- ⇒ Purchase of new laboratory and maintenance equipment
- ⇒ Additional training programs for WSP staff and managers
- ⇒ Continued refinement and implementation of asset management systems including mapping, computer hardware and software, master meters, preventative maintenance programs, etc.
- ⇒ Watershed protection and public education programs
- ⇒ Regionalization and local entrepreneurship programs

A brief narrative highlighting the major infrastructure needs in each town is provided below along with tables detailing existing service populations, service goals, and required major projects and cost estimates to meet the stated goals. A cost summary for all three WSPs and LVSWSB is also provided. Detailed descriptions of recommended projects and cost estimation are included in Sections 5, 6, and 7 and the associated Appendices.

Kisii

Gusii Water and Sanitation Company Limited (GWASCO) is the WSP for Kisii. With approximately 200,000 inhabitants, Kisii has the largest population of the three towns studied. Two existing water treatment facilities currently serve less than 30,000 residents, but recommended immediate upgrades including auxiliary power and pump replacements would approximately double present production and approach design capacity. To expand the service area and keep pace with population growth, a new intake and dam on the Gucha River will be required in the short and long term, respectively.

Water service goals and associated costs to achieve the service goals are presented in Figures Ex-2 and Ex-3. In order to meet the Millennium Development Goals and keep costs to a minimum, it was determined that a relatively large percentage of the service population (greater than one-third) would be served by public water kiosks by 2015.

Figure Ex-2. Kisii Existing Water Service Population and Future Service Goals

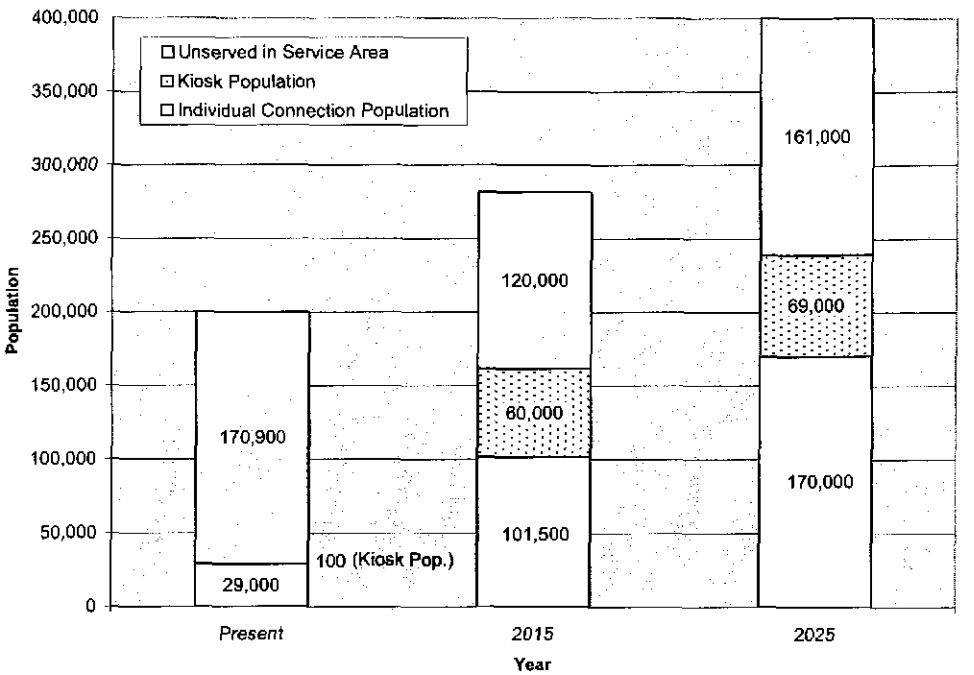


Figure Ex-3. Kisii Required Projects and Cost Estimates to Meet Water Service Goals

	Immediate *Within ~1 Year*	Short Term *By 2015*	Long Term *2016 - 2025*
Management	$ 870,000	$ 950,000	$ -
	Mapping, Bulk Metering, System Inventory, Asset Management Plan, Preventative Maintenance Plan, Water Audit, Watershed Protection, Illegal Connections, Training, Computers, Tariff Analysis, Staffing Study, Public Education, Equipment, Vehicles / New Offices, Consumer Meter Replacement, Land Purchase for Watershed Protection		
Source	$ 80,000	$ 2,680,000	$ 8,800,000
	Source Augmentation, Power Studies	*New Intake, Raw Water Main*	*Dam & Reservoir, Raw Water Main*
Treatment	$ 320,000	$ 4,440,000	$ 3,000,000
	WTP Upgrade Study, Sampling, Besic Lab and WTP Improvements	*New WTP, Existing WTP Upgrades*	*WTP Expansion*
Distribution	$ 660,000	$ 5,460,000	$ 8,760,000
	System Improvement Plans, Leak Detection & Repair, Kiosk Planning, Distribution System Upgrades	*System Expansion Plan, Distribution System Expansion, Water Kiosks, New Service Connections, Storage*	*Water Kiosks, New Service Connections, Storage*
TOTAL	**$ 1,930,000**	**$ 13,530,000**	**$ 20,560,000**
TOTAL WATER (ROUNDED)			**$ 36,000,000**

The existing wastewater treatment facility in Kisii was constructed in 1997 and has the capacity to serve more than half of the existing Town population, but currently serves less than five percent. Large increases in the wastewater service population are recommended via "infill" utilizing existing trunk sewer mains. Capacity increases required in the long term can be achieved using the existing wastewater treatment facility site.

Wastewater service goals and estimated costs to achieve the service goals are presented in Figures Ex-4 and Ex-5. Due to relatively low population density in many areas and the high cost of sewers, it was determined that on-site wastewater systems would be the most cost-effective means of providing adequate sanitation in many areas. It is recommended that the on-site systems be monitored and regulated by the town. In addition, major increases in the number of public toilets are proposed to quickly increase the served population at a relatively low cost.

Figure Ex-4. Kisii Existing Wastewater Service Population and Future Service Goals

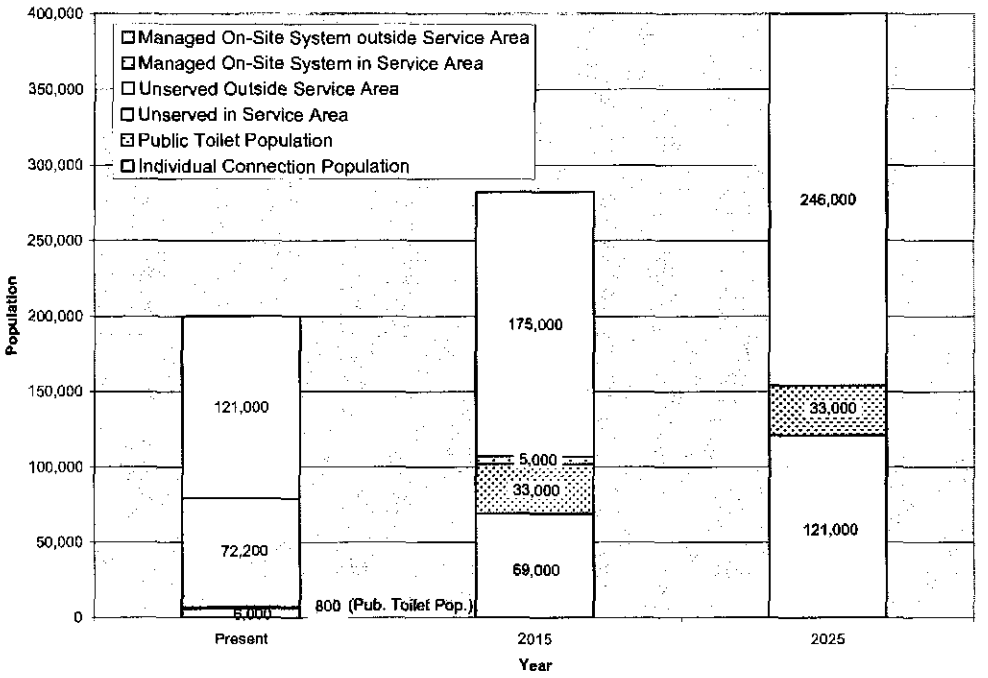


Figure Ex-5. Kisii Required Projects and Cost Estimates to Meet Wastewater Service Goals

	Immediate *Within ~1 Year*	Short Term *By 2015*	Long Term *2016-2025*
Management	$ 60,000	$ -	$ -
	On-Site Wastewater Management Plan, Public Toilet/Latrine Plan, Infill Incentive Program		
Collection	$ 350,000	$ 3,640,000	$ 4,500,000
	Wastewater collection study, Infill Connections, Replace Manhole Covers, Buy Exhausters and Sewer Cleaning Equipment, Rehab & New Public Toilets	*Infill Connections, Public Toilets*	*Sewer Expansion, New and Infill Connections, Public Toilets*
Treatment	$ 30,000	$ 160,000	$ 220,000
	WWTF Upgrade & Expansion Planning, O&M / Sampling Improvements, Screening	*Laboratory equipment; Ugrades including Algae Baffles, Sludge Valves, Sludge Removal, Lagoon Covers, Composting; Reuse Study*	*Supplemental Aeration, Recirculation System, Constructed Wetland*
TOTAL	**$ 440,000**	**$ 3,800,000**	**$ 4,720,000**
TOTAL WASTEWATER (ROUNDED)			**$ 9,000,000**

Kericho

The Kericho Water and Sanitation Company (KEWASCO) is the WSP for Kericho, which has the most developed water and wastewater infrastructure of the three towns studied. Two existing water treatment facilities currently serve more than half of the Town's 113,000 residents. Immediate capacity increases are required to keep pace with growing demand and expand the service area. A dam and reservoir on the Timbilil River will be required in the short term to augment the existing supply, especially during the dry season.

Water service goals along with associated costs to achieve the service goals are presented in Figures Ex-6 and Ex-7.

Figure Ex-6. Kericho Existing Water Service Population and Future Service Goals

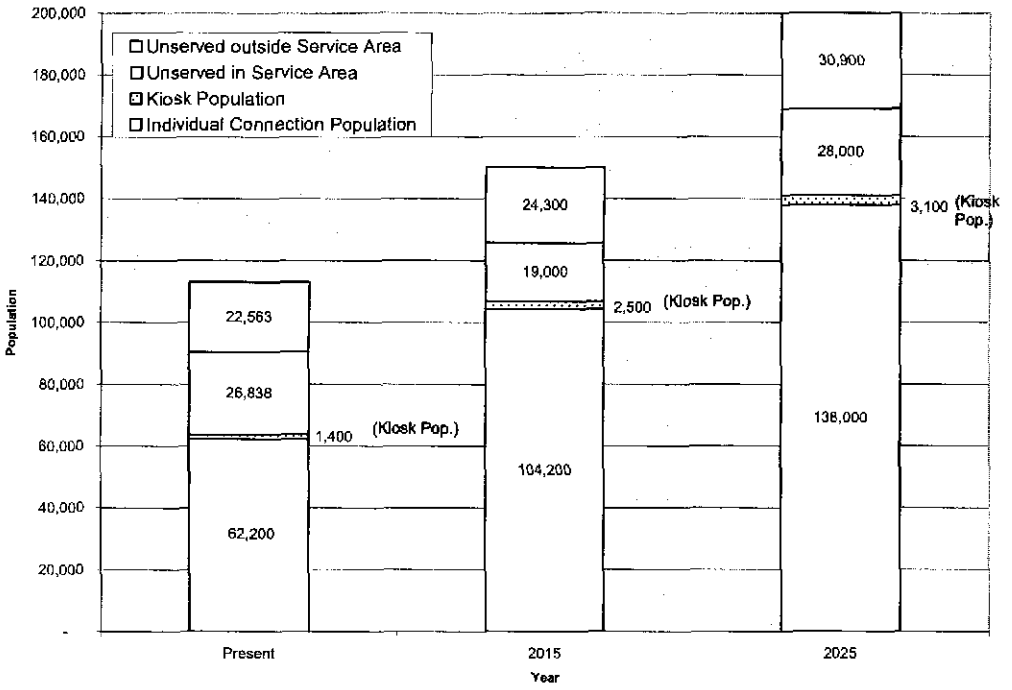


Figure Ex-7. Kericho Required Projects and Cost Estimates to Meet Water Service Goals

	Immediate *Within ~1 Year*	Short Term *By 2015*	Long Term *2016-2025*
Management	$ 800,000	$ 950,000	$ -
	Mapping, Bulk Metering, Consumer Meter Pilot, System Inventory, Asset Management Plan, Preventative Maintenance Plan, Water Audit, Watershed Protection, Illegal Connections, Training, Computers, Tariff Analysis, Staffing Study, Public Education, Equipment, Vehicles / New Offices, Consumer Meter Replacement, Land Purchase for Watershed Protection		
Source	$ 50,000	$ 8,260,000	$ -
	Source Augmentation Planning, Bulk Metering	*Dam & Reservoir, Raw Water Main*	
Treatment	$ 70,000	$ 1,960,000	$ 1,900,000
	WTP Upgrade / Expansion Planning; Laboratory Equipment	*Upgrade & Expand Timbilil WTP; Ugrade Kimugu WTP; New WTP and Raw Water Main Planning*	*New WTP*
Distribution	$ 180,000	$ 1,900,000	$ 3,400,000
	System Improvement Plans, Leak Detection & Repair, Kiosk Planning	*New Service Connections*	*System Expansion, New Service Connections*
TOTAL	**$ 1,100,000**	**$ 13,070,000**	**$ 5,300,000**
TOTAL WATER (ROUNDED)			**$ 19,500,000**

The existing wastewater treatment facility is situated on a relatively small parcel in the center of Town and serves approximately 10,000 residents, but has the capacity to serve almost twice that number. Infill sewer connections are recommended to take advantage of available excess capacity. The small site will necessitate that short term capacity increases be realized through innovative means such as solar pond aeration. An additional centralized wastewater treatment facility and satellite facility will be required in the long term.

Wastewater service goals along with associated costs to achieve the service goals are presented in Figures Ex-8 and Ex-9.

Figure Ex-8. Kericho Existing Wastewater Service and Future Service Goals

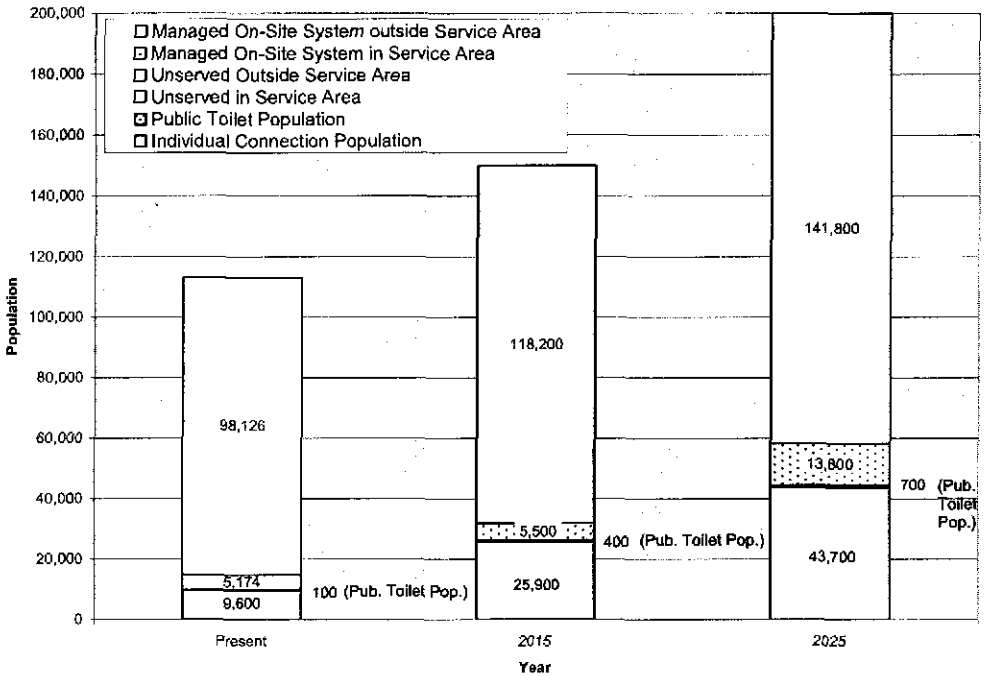


Figure Ex-9. Kericho Required Projects and Cost Estimates Required to Meet Wastewater Service

	Immediate *Within ~1 Year*	Short Term *By 2015*	Long Term *2016-2025*
Management	$ 20,000	$ -	$ -
	On-Site Wastewater Management Plan, Large User Discussions		
Collection	$ 160,000	$ 1,440,000	$ 3,400,000
	Wastewater collection planning, Infill Connections, Buy Exhauster and Sewer Cleaning Equipment, Rehab & New Public Toilets, I/I Evaluation	*New Pumping Station, Infill Connections, Public Toilets, Exhausters*	*Sewer Expansion, New and Infill Connections*
Treatment	$ 220,000	$ 600,000	$ 1,100,000
	WWTF Upgrade & Expansion Planning, WWTF Improvements i.e. Lab Upgrade, Pilot Aeration, etc.; Sludge Reuse / Septage Mgmt. Planning	*Digester Mixing, WWTF Expansion, Septage Receiving Improvements*	*New Central and Satellite WWTF*
TOTAL	**$ 400,000**	**$ 2,040,000**	**$ 4,500,000**
TOTAL WASTEWATER (ROUNDED)			**$ 7,000,000**

Migori

The MIKUTRA Water and Sanitation Company Limited is the WSP for Migori. Approximately 10,000 of the Town's 124,000 residents are presently served with a piped water supply from three boreholes. Development of the Oyani River as a new surface water supply is recommended in the short term to drastically increase the existing service population.

Water service goals along with associated costs to achieve the service goals are presented in Figures Ex-10 and Ex-11. In order to meet the Millennium Development Goals and keep costs to a minimum, it was determined that a relatively large percentage of the service population (approximately one-third) would be served by public water kiosks in 2015.

Figure Ex-10. Migori Town Existing Water Service and Future Service Goals

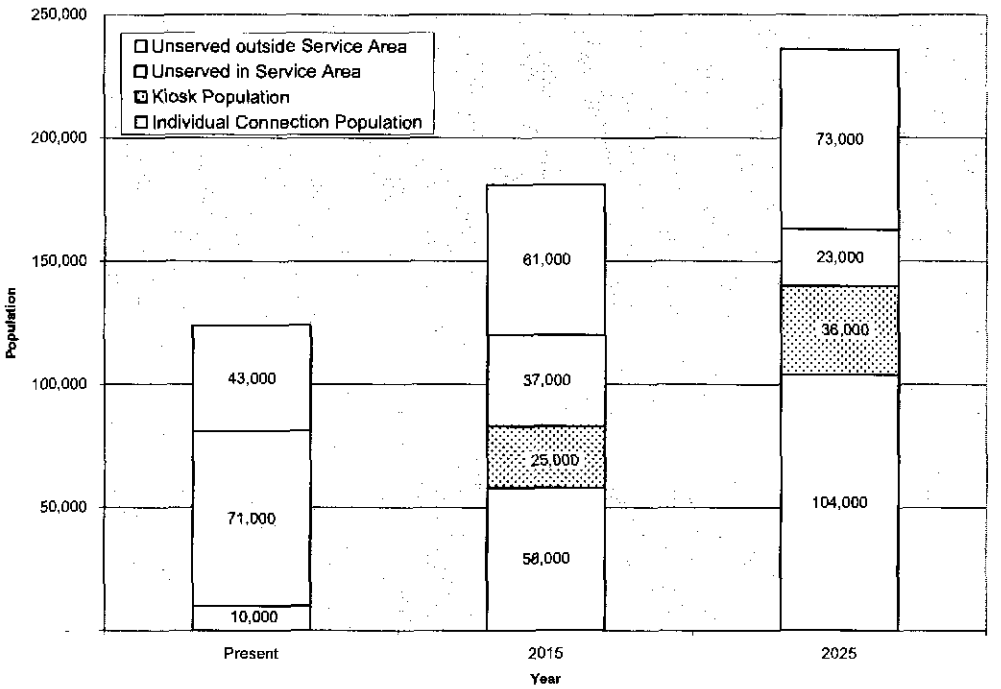


Figure Ex-11. Migori Projects and Cost Estimates Required to Meet Water Service Goals

	Immediate *Within ~1 Year*	Short Term *By 2015*	Long Term *2016-2025*
Management	$ 670,000	$ 240,000	$ -
	Mapping, Bulk Metering, Consumer Meter Pilot, System Inventory, Asset Management Plan, Preventative Maintenance Plan, Water Audit, Watershed Protection, Illegal Connections, Training, Computers, Tariff Analysis, Staffing Study, Public Education, Equipment, Vehicles / Offices Expansion, Land Purchase for Watershed Protection		
Source	$ 610,000	$ 3,330,000	$ 2,230,000
	Source Augmentation Planning, Boreholes testing / rehab / aux. power	*Oyani R. Intake, pumping, pipeline, aux. power*	*Additional intake, pumping & raw water pipeline capacity*
Treatment	$ 300,000	$ 2,130,000	$ 1,470,000
	Add disinfection, pH control	*Treatment Study, New WTP*	*WTP Expansion*
Distribution	$ 140,000	$ 6,400,000	$ 3,470,000
	System Improvement & Expansion Plans, Leak Detection & Repair, Kiosk Planning & Pilot	*Kiosks, Distribution upgrade & expansion, new service connections, storage / pumping*	*Kiosks, Distribution expansion, new service connections, storage / pumping*
TOTAL	**$ 1,720,000**	**$ 12,100,000**	**$ 7,170,000**
TOTAL WATER (ROUNDED)			**$ 21,000,000**

No centralized wastewater system exists in Migori, although a small lagoon system treats wastewater from a local hospital. Expansion of the hospital system and construction of a new centralized collection and treatment facility are recommended in the short term. Wastewater service goals along with associated costs to achieve the service goals are presented in Figures Ex-12 and Ex-13.

Figure Ex-12. Migori Town Existing Wastewater Service and Future Service Goals

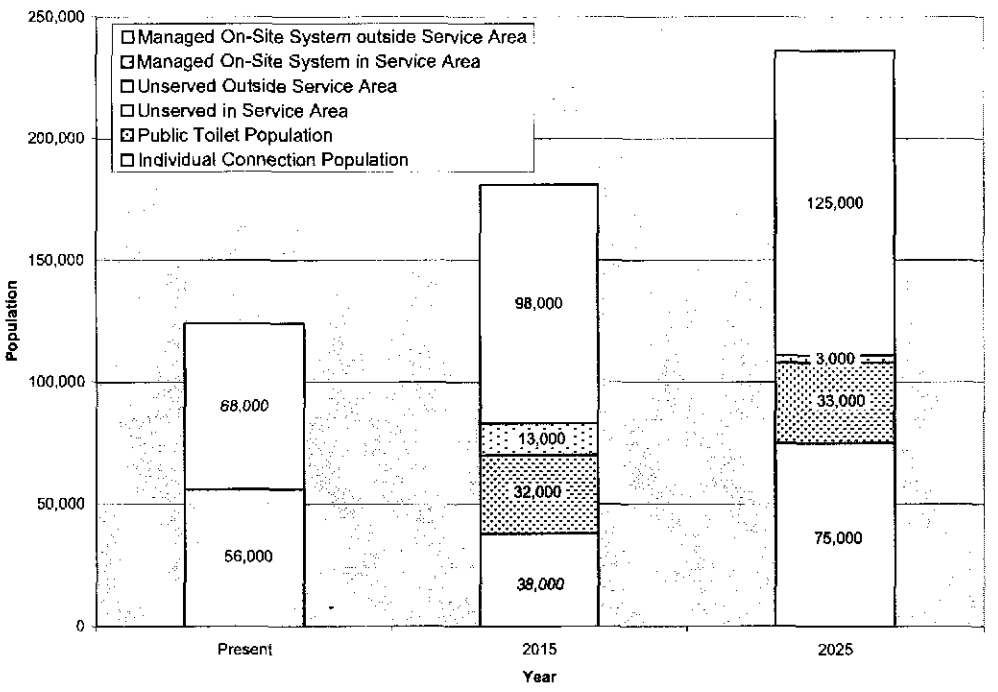


Figure Ex-13. Migori Projects and Cost Estimates Required to Meet Wastewater Service Goals

	Immediate *Within ~1 Year*	Short Term *By 2015*	Long Term *2016-2025*
Management	$ 30,000	$ -	$ -
	On-Site Wastewater Management Plan, Public Toilet Planning, Large User Discussions, St. Joseph's Lagoon discussions		
Collection	$ 80,000	$ 3,930,000	$ 2,590,000
	Wastewater collection planning, Public latrine rehab / commercialization plan & pilot program	*Public Latrines/Toilets; Exhauster purchase; Collection system & service connections*	*Sewer Expansion, New Connections*
Treatment	$ 70,000	$ 2,700,000	$ 500,000
	Municipal wastewater treatment study; St. Joseph's Lagoon feas. study, upgrades; septage discharge site assessment; Migori TTC septic upgrade	*Expand St. Joseph's Lagoons; Upgrade septage disposal site; Construct municipal WWTF*	*WWTF Expansion*
TOTAL	**$ 180,000**	**$ 6,630,000**	**$ 3,090,000**
TOTAL WASTEWATER (ROUNDED)			**$ 10,000,000**

As in Kisii, it was determined that on-site wastewater systems would be the most cost-effective means of providing adequate sanitation in many areas of Migori. It is recommended that the on-site systems be monitored and regulated by the town. In addition, almost half of the 2015 service population is expected to be served by public toilets to quickly increase the served population at a relatively low cost.

Environmental Impacts

A limited environmental impact analysis was performed as part of this study. On the whole, the recommended program is expected to produce widespread environmental benefits for the region. Specific adverse environmental impacts are expected to be limited to temporary construction impacts and downstream impacts from decreased in-stream flows as a result of increased surface water abstraction. Positive impacts will include the improved environmental health of Lake Victoria and other surface water bodies, streams, and groundwater resources in the region. In particular, the proposed projects will help to alleviate Lake Victoria's current eutrophication problems, which are caused in part by inefficient and non-existent wastewater treatment. This eutrophication has caused major economic impacts primarily stemming from the recent explosive growth of water hyacinth which has dramatic adverse effects on navigation, fishing, and water abstraction.

Detailed environmental impact analyses will be required and carried out for individual projects at the design phase in accordance with Government of Kenya regulations. At that time, appropriate measures will be detailed for mitigating any expected adverse environmental impacts.

Total Costs

The total estimated costs for all study recommendations are presented in Table Ex-1. Costs associated with large infrastructure projects will require refinement after more detailed studies are carried out as part of the Immediate Projects.

Table Ex-1. Total Estimated Costs for Three Town WSPs and LVSWSB

	WATER	WASTEWATER	TOWN TOTAL
KERICHO	$ 19,470,000	$ 6,940,000	$ 26,410,000
KISII	$ 36,020,000	$ 8,960,000	$ 44,980,000
MIGORI	$ 20,990,000	$ 9,900,000	$ 30,890,000
TOATALS	$ 76,480,000	$ 25,800,000	$ 102,280,000

LAKE VICTORIA SOUTH WATER SERVICES BOARD	$ 700,000

GRAND TOTAL	**$ 103,000,000**

Note: Excludes soft costs associated with closing financing and interest capitalization

Financing

The Project Team analyzed the 2002 Kenya Water Act and the resulting framework within which the proposed infrastructure investments will occur, examined relevant precedents for funding Kenyan and neighboring country water sector projects, and developed an understanding of the available and more suitable financing sources for the LVSWSB projects. Throughout the study, the Project Team analyzed financing issues, the project structure and the security package that would be available for financiers, the source of revenue and contractual agreement generating the revenue, and the appetite of various multilateral and regional development funding institutions.

The Project Team developed financial modeling projections utilizing the findings of the study, inclusive of capital costs, timing of expenditures, projected water demand and wastewater flow, tariffs, and financing terms. In order to generate an economic analysis of the LVSWSB projects, the Project Team developed eight different financial models. Detailed assumptions models were created for each town incorporating data developed in the study including expected numbers of customers, water sold, etc. These models feed into distinct financial models for each community, which in turn yield results that are input into a LVSWSB financial model. The latter is the required financial model for the study scope of work and the one which would be presented to prospective financiers.

Finally, the Project Team introduced the prospective projects to various financial institutions and discussed a bridge financing concept with two regional banks. The latter expressed interest in exploring the concept further as a means to bridge the time it would take to secure the long term concessionary type financing which is available to such projects. Considering the need to maintain low tariffs coupled with the long lead times for capital recovery in such infrastructure investments, the only viable financing sources are those which can provide 20-year type funding at reduced interest rates. These sources include the African Development Bank, World Bank, German and French development agencies, and others. All indications from this donor community and their counterparts at the Kenya Ministry of Finance are that there will be support for the LVSWSB capital requirements identified in the Study, albeit with an evaluation and approval process which can take two to three years. The Project Team's work evaluates options to avoid undue delays to implementation.

Financing Structure

The burden of funding the larger infrastructure needs in each community is left to the Water Services Board. The Kenya Water Act mandates the Water Services Boards not only finance but also construct and provide major maintenance for the infrastructure within their region. Further, the Water Services Boards must contract with WSPs, monitor their performance, and assess their respective financial and infrastructure requirements, among other responsibilities. The Water Services Boards fall under the Ministry of Water and Irrigation, whereas the WSPs are primarily owned by local municipalities. The WSPs are responsible for operating the infrastructure provided/built by the Water Services Board, in exchange for lease payments and a royalty fee. The lease payments for new infrastructure will be agreed to but will at a minimum include total capital cost recovery and some level of maintenance reserve. Hence, the project financing structure, as depicted in Figure Ex-14, will have the Water Services Board as the "borrower" and owner of the infrastructure. The revenue stream will originate from the various WSPs *contracted* to provide the water and wastewater services to their respective communities. Additional towns in the region (Homa Bay and Bomet) are included in the figure to indicate this structure could apply to additional towns not included as part of the present study.

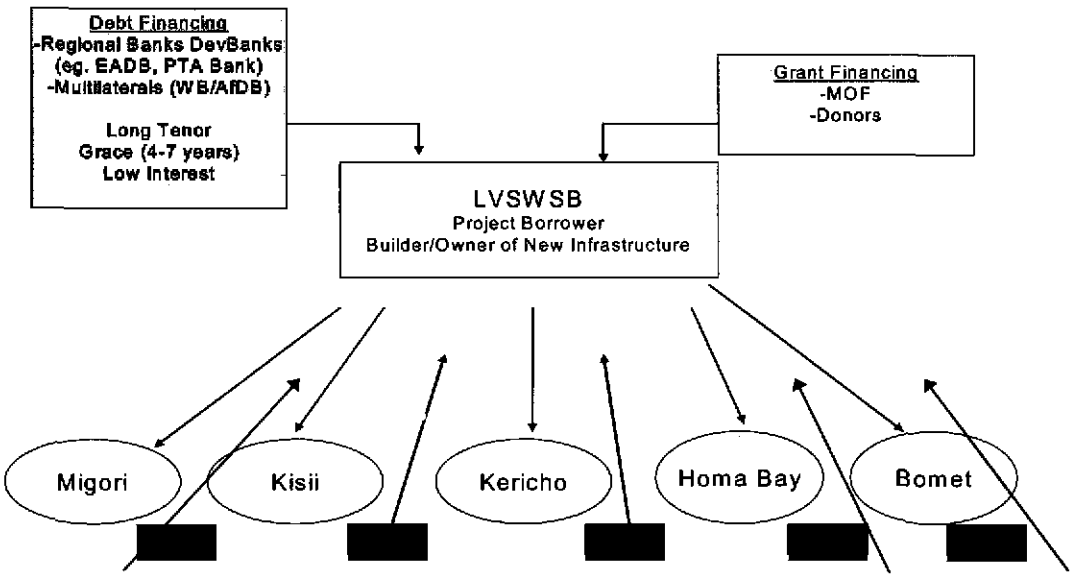


Figure Ex-14. Project Financing Structure

A signed Service Provider Agreement (SPA) defines the contractual relationship between the WSB and the WSP for each community. The revenue to the Water Services Board is determined by a royalty on revenues of the WSP (including water and sewer tariffs and other fees), pass-through through meter rental fees, and an annual lease cost for future capital investments which will cover the cost of capital and more.

As indicated in Figure Ex-14, the new infrastructure remains under ownership of the Water Services Board, allowing it to remove the WSP in the event of non-performance without requiring a transfer of infrastructure assets. This flexibility is viewed as a good structure from a financing perspective and the Water Services Board will have multiple sources of revenue arising from various WSP within their service region. In public-private partnership schemes in other countries, responsibilities similar to those of LVSWSB are issued by concession to a private sector company, typically foreign. In Kenya, the private sector component sits at the level of providing services and collecting fees (WSPs).

Financing Sources

As owner of the Water Services Board, the government can access extended tenor donor and government guaranteed financing which would not be available to private sector sponsors. The LVSWSB and other Kenyan Water Services Boards have demonstrated the ability to manage existing infrastructure and oversee the construction of new infrastructure. Other than a significant balance sheet and financial capacity which a private sector sponsor can provide, the Water Services Board has the requirements to act as owners, and given the desperate need for low tariffs, is uniquely positioned to obtain the lower cost financing as a parastatal entity. Thus the financing sources indicated in Figure Ex-14 consider sovereign lenders, long tenors (20-30 yrs), long grace periods (5-7 years), low interest rates (3-5%) and a grant component from both donors and the Government of Kenya. Traditionally these financings have a Government of Kenya underlying guarantee. The level of grant to the overall financing requirement is estimated at 15-20%.

Meetings held with regional development banks and multilateral lenders active in the Kenyan water sector have demonstrated continued appetite and capacity for such projects, and interest in the LVSWSB requirements. The level of investment sought is in line with expectations. The concern with securing the desired long term financing is the time required before a first disbursement could occur. Donors, the Ministry of Finance, the Ministry of Water and Irrigation, and LVSWSB all concurred that one should expect two to possibly three years.

The Project Team presented a concept of a bridge financing utilizing regional development banks and held preliminary discussions with potential lenders. The interest exists subject to certain conditions and reviewing information from the study and proposed terms. A bridge financing would be sized to the capital requirements over the next 3 years, ensuring that the LVSWSB projects can begin their implementation per the study recommendations without losing two plus years of time. Once the long term debt financing is secured from the donor community, the bridge financing would be repaid and additional capital would be secured for the ensuing capital investments. A bridge financing amount would range between $25 and $35 million.

Financing Plan

The recommended capital expenditures plan spans over 15 years. At certain points in time the plan requires a spike in investment (e.g. a treatment plant or dam) with respect to each community. Once aggregated at the level of the Water Services Board there still is a spike after tbe fifth year due to multiple converging projects expected in years nine and ten. Figure Ex-15 is a graph of annual capital requirements for LVSWSB and the study towns, including ancillary costs related to financing (labeled 'other'). The overall program, with the inclusion of soft costs related to interest and other finance fees, is $107.5 million.

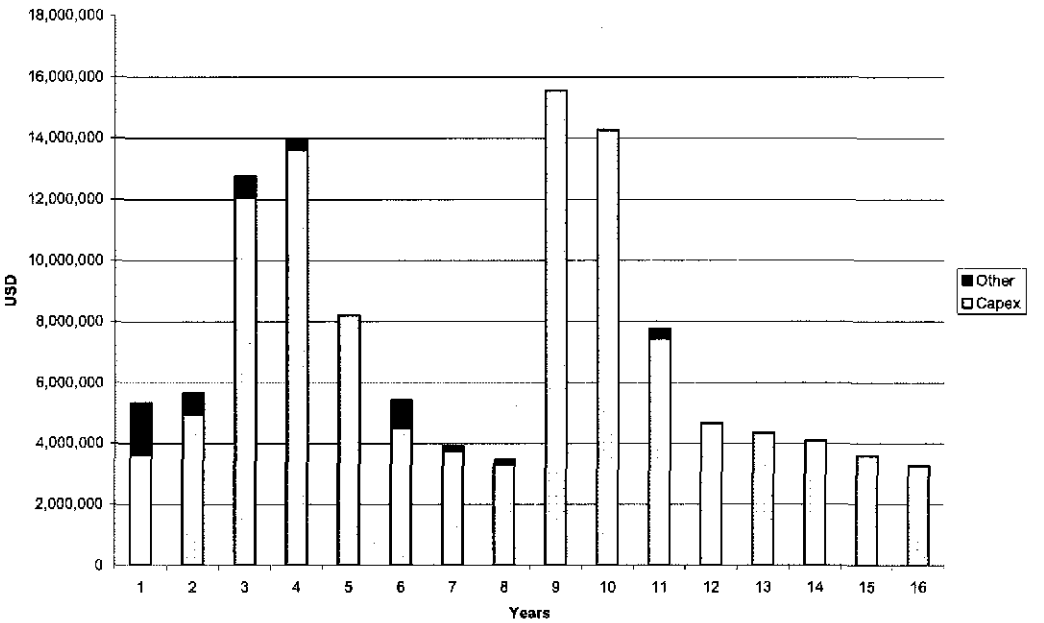


Figure Ex-15. Capital Expenditures

Despite new water treatment capacity, reduced water losses, and new wastewater treatment plants coming on-line quickly, the ramp up of customers still requires time before the LVSWSB (or WSPs) can be self-sufficient and generate cash flow for the ongoing/remaining investment plan (particularly with a goal of maintaining tariffs at or near the Kenyan average). On the other hand, financing sources are not interested in 10 to 12 year loan drawdown periods or grace periods extending beyond seven years (donors such as commercial and development banks typically stay at four years and under for grace).

Thus the recommended financing plan considers that the LVSWSB will require two to three separate financings in five year intervals, complemented with a Grant amount equivalent to approximately 15 - 20% of total project costs. The capital cost requirements assume some over-borrowing in order to satisfy the incremental interest until revenues can be ramped up.

As shown in Figure Ex-16, LVSWSB would require a first debt facility (excluding the Grant amount) of approximately $36 million to be drawn down over 5 years; a second facility starting in year six and reaching approximately $38 million; followed by a third in year 11 of about $17 million. A debt service reserve account (6 months) has been recommended and structured in the financial projections.

A grace period of 5 years and a first financing tenor of 25 years all-in, using an interest rate of 5%, produces bankable results. It is possible that the LVSWSB can extend its grace period beyond 5 years, while limiting the drawdown to 5 years, reducing the need to over-borrow, and placing less strain on the respective WSP's lease payments back to the LVSWSB.

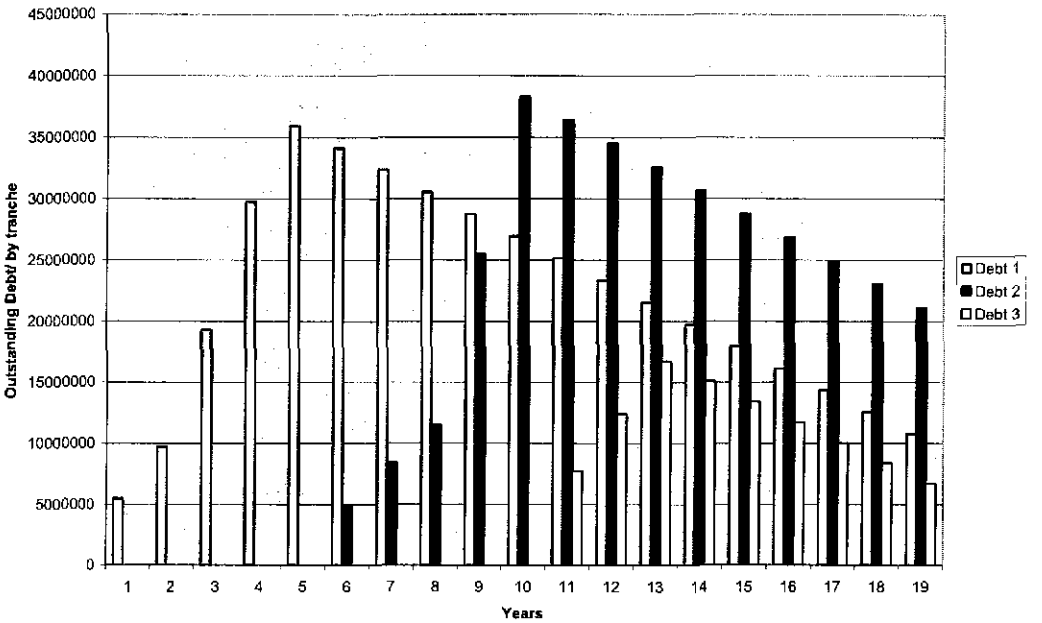


Figure Ex-16. Debt Tranches

Financing Summary Results

The Project Team initially evaluated each town as a stand-alone entity under reasonable tariff and demand assumptions to determine financial viability of the capital expenditure program and resulting new revenues. Next, LVSWSB financial projections were generated while treating the respective WSPs differently as they are not the recipients of financing and must just pay the LVSWSB fees for using their assets (old and new). The summary results are presented in Figure Ex–17.

LVSWSB USD	2008	2009	2010	2011	2012	2013
	June 30 yr end					
Revenues						
Kisii Licensee Fees	$ 21,159	$ 30,168	$ 39,288	$ 55,488	$ 76,512	$ 96,206
Migori Licensee Fees	$ 22,482	$ 45,489	$ 55,221	$ 84,708	$ 102,669	$ 116,586
Kericho Licensee Fees	$ 136,730	$ 149,230	$ 160,065	$ 169,920	$ 180,607	$ 192,207
Water Meter Rent Revenue	$ 26,616	$ 40,358	$ 50,563	$ 62,502	$ 76,513	$ 92,956
New Lease Fees (Cost of Capital for New WSP Investments)	$ 146,268	$ 321,404	$ 619,658	$ 859,529	$ 1,180,569	$ 3,775,625
Existing LVS Revenue (less License Fees year 1, grow @3%)	$ 4,622,209	$ 4,760,875	$ 4,903,701	$ 5,050,812	$ 5,202,337	$ 5,358,407
Maintenance Fund From WSPs (percentage of cost of capital)	$ 182,650	$ 247,820	$ 603,357	$ 681,760	$ 410,696	$ 226,362
TOTAL REVENUES	**5,158,115**	**5,595,345**	**6,431,863**	**6,964,719**	**7,229,902**	**9,860,349**
Expenses	(5,060,104)	(5,136,006)	(5,213,046)	(5,291,242)	(5,370,610)	(5,451,169)
EBITDA	(101,169)	238,626	990,565	1,427,653	1,611,879	4,160,156
NET INCOME	(378,552)	(402,429)	(437,682)	(753,023)	(1,246,758)	798,940
Cash	1,613,524	1,941,570	2,620,305	3,008,180	2,088,101	2,137,168
Debt Service Reserve Account (Cash)	201,918	399,057	561,227	781,346	1,796,275	1,924,793
ENDING CASH BALANCE	**1,815,442**	**2,340,628**	**3,181,532**	**3,789,526**	**3,884,376**	**4,061,961**
TOTAL ASSETS	**7,371,124**	**12,631,425**	**24,967,308**	**38,156,008**	**45,129,778**	**49,566,400**

Figure Ex-17. LVSWSB Summary Financial Projections Results

While the initial years have negative net income, the ending cash balance remains healthy and grows over the years creating reserve capacity for future expense requirements. Not shown in these results is a share of the surplus cash flow generated at the level of each WSP which according to the SPA will need to be distributed amongst the WSP and WSB, the latter's justification being major maintenance and new capital expenditures to expand and upgrade the system.

The Project Team's opinion of the project, using these assumptions and the recommendations made in the Study, is that it can successfully borrow these funds, deploy them, and generate income to repay the debt. What is also important is that it can be done maintaining the tariffs at or near their existing ones, with minimal escalation. Each WSP has a slightly different tariff regime but it remains within the Kenyan average.

Implementation

This study demonstrates that viable water and wastewater utilities can be developed and principally financed with user tariffs set near the Kenyan average. From its inception, a central focus of the project has been on ensuring that the study recommendations are implemented. The Lake Victoria South Water Services Board, still in its infancy, is at a pivotal juncture for this project and the development of the region. It is crucial that the current project momentum be maintained and immediately translated into project implementation.

The focus of initial implementation efforts should be on securing funds required for technical assistance to start immediate projects and on seeking bridge financing required for implementation of the Immediate and Short Term Projects. Securing limited funds for the first steps is crucial to maintaining the project momentum.

Figure Ex-18 summarizes the proposed implementation schedule, broken down into Technical and Financing tasks. As indicated, immediate financing will be required in the first nine months of the project to provide technical assistance and secure the bridge financing required to fully implement the Immediate Projects and begin the Short Term Projects. Securing the concessionary-type financing required for implementing larger projects may require more than two years.

If bridge financing is secured by the end of Year 1, then LVSWSB and the WSPs will be able to implement the Immediate Projects and some Short Term Projects extending though the first part of Year 3. During this period, work will continue to secure the long-term concessionary financing required for projects from Year 3 through the Short Term. As described previously, it is expected that a second and possibly third tranche of financing will be required by 2015 to fund the remaining projects throughout the study period.

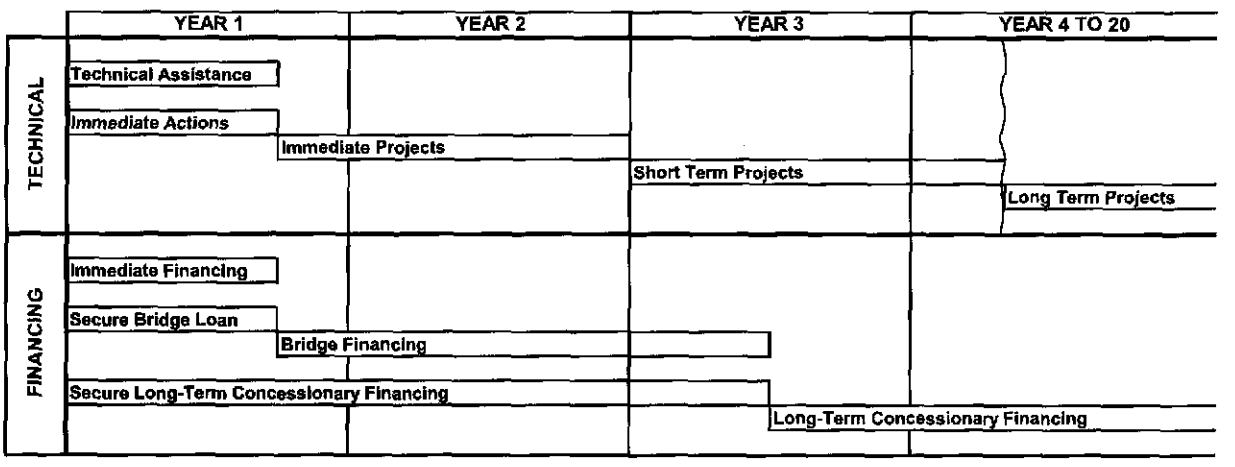


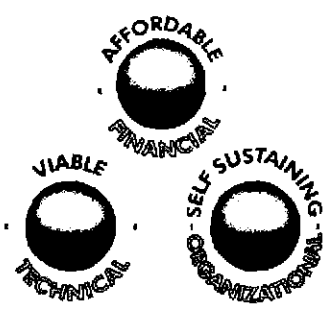
Figure Ex-18. Proposed Project Implementation Timeline

The recommended financing and technical assistance projects to be undertaken in the first nine months are outlined in Table Ex-2. Approximately $550,000 will be required in this period to provide technical assistance and move the bridge financing process forward to the level of a preliminary term sheet. The technical projects will demonstrate to potential donors and lenders that the WSPs have taken important steps toward becoming bankable utilities and that they are prepared to move immediately into full implementation once financing is made available.

Table Ex-2. Estimated Costs for Immediate Technical Assistance and Financing Needs

TASK	SUMMARY TITLE	LVSWSB	KISII	KERICHO	MIGORI	EST. COST
	FINANCING					
1	Seek Bridge Financing Preliminary Term Sheet	X				$ 100,000
	WATER & WASTEWATER ACTIVITIES					
2	Mapping (includes Satellite Imagery, GPS receivers, Software and Hardware)	X	X	X	X	$ 160,000
3	Asset Management Plans (includes Software)	X	X	X	X	$ 55,000
	WATER MANAGEMENT					
4	Bulk Water Meter Plans		X	X	X	$ 15,000
5	Consumer Water Meter Planning & Pilot (includes Meters)		X	X	X	$ 35,000
6	Illegal Connections Plan	X	X	X	X	$ 15,000
	WATER SOURCE & TREATMENT					
7	Auxillary Power Analysis and Design		X		X	$ 40,000
8	Well Rehabilitation Assistance				X	$ 25,000
	WATER DISTRIBUTION					
9	Leak Detection and Repair Program (includes Leak Detection Equipment)	X	X	X	X	$ 25,000
10	Distribution System Re-activation Plan		X			$ 15,000
	WASTEWATER COLLECTION					
11	Sewer Infill Connections Program		X	X		$ 20,000
12	I/I Sewer System Evaluation Program			X		$ 10,000
	WASTEWATER TREATMENT					
13	Pilot Aeration Analysis			X	X	$ 20,000
14	Hospital Lagoons Capacity Analysis				X	$ 15,000
	TOTAL					$ 550,000

Conclusion



The Lake Victoria South Water Services Board area is rich in human and natural resources. This vibrant region has the potential to become one of East Africa's most productive and prosperous areas. However, the region's economic development and public health are significantly weakened by inadequate and deteriorating water and wastewater infrastructure.

This study demonstrates that viable water and wastewater utilities can be developed and principally financed with user tariffs set near the Kenyan average. The 2002 Water Act reforms have been systematically implemented over the past five years to bring about a new era where self-sustaining water and wastewater utilities can take hold in Kenya. The Lake Victoria South Water Services Board is positioned to take advantage of the opportunities afforded by this new regulatory environment. This study lays out the technical, financial, and organizational requirements for moving forward and creating viable, affordable, and self-sustaining utilities. The resultant provision of affordable and high quality water and sanitation services to bundreds of thousands of Kenyans will have far-reaching public health benefits and unlock the region's economic potential.

1. INTRODUCTION 1-1

1.1 Background and Purpose 1-1

1.2 Project Scope 1-5

1.3 Project Approach 1-5

1.4 Project Team 1-6

1.5 Community Selection Process 1-6

1. INTRODUCTION

1.1 Background and Purpose

This study evaluates the feasibility of establishing viable, affordable, and self-sustaining water and wastewater utilities in three western Kenya towns: Kericho, Kisii, and Migori (Figure 1-1). The study also details a recommended capital improvements plan and outlines a strategy for financing implementation of the proposed projects. The study communities fall under the jurisdiction of the newly-established Lake Victoria South Water Services Board. The study was conducted by the Coler & Colantonio, Inc. Project Team.

It has been estimated that 75% of the urban population of Kenya would have access to safe drinking water if all existing water infrastructure were operational. However, only about 49% of urban dwellers have access to these services.[1] The situation concerning access to sanitation is similar. Deficiencies in water and wastewater infrastructure, operations, and management have resulted in many individuals and businesses being without access to piped clean water and sanitation, or being provided with only intermittent supplies of water. Existing facilities do not produce at their rated capacities due to inadequate equipment maintenance and a lack of reliable power supplies. Some water distribution systems lose more than half of their water via leaks and unmetered usage. This situation gives rise to an increased incidence of waterborne disease and decreased economic productivity. Record keeping associated with water and wastewater infrastructure, including revenue collection, is generally inadequate.

Despite inadequate service provision, the rates that many Kenyans pay for water is often comparable and sometimes higher than rates paid in the United States and Europe. In fact, it is often the poorest Kenyans who pay the most. The lack of a piped water supply in many areas forces residents to collect water from contaminated sources or purchase water from vendors who charge high rates for questionable quality water.

A 2002 report prepared by the Kenya Ministry of Environment and Natural Resources notes that access to sanitation in Kenya has declined over the past two decades and that about 41.7% of low-income households do not have access to adequate sanitation. It is estimated that 65.6% of rural Kenyan residents do not have access to safe water. Several reasons for the failure of existing water and wastewater systems are cited:[2]

- "Poor operational and maintenance services which is compounded by limited resources allocations.
- Most of them [water and wastewater infrastructure facilities] have outlived their economic lives and therefore require major rehabilitation works to revive them.
- Majority of them [water and wastewater infrastructure facilities] cannot sustain the current demand, because of population increase and increased economic activities, and may therefore require major reconstruction or augmentation."

After an initial data-gathering trip to Kenya and performing background research, the Project Team worked with the United States Trade and Development Agency (USTDA) and the Kenya Ministry of Water and Irrigation (MWI) to secure a grant to perform a feasibility study for three towns in western Kenya. The region was suggested by Professor George O. Krhoda, former Permanent Secretary for the Ministry of Water and Irrigation. The region is experiencing rapid population growth and has potential to become a vibrant center for economic activity due to an abundance of natural resources. A USTDA grant for the project was approved in 2005 with the Government of the Republic of Kenya as Grantee.

The larger towns in the area represent emerging so-called "secondary urban centers" and currently vary in population from ~100,000 to 200,000 each. These populations are expected to double over the next 20

years. Therefore, affected populations over the next 20 years in these three communities could exceed 700,000. Preliminary research by the Project Team indicated that viable water and wastewater systems could be financed, constructed, operated and maintained with user fees set near the Kenyan average.

The following general observations were made during the initial data-gathering Project Team visit to the proposed study communities:

- Current water demand outstrips supply, or will within the next five to ten years. Present water production is below stated treatment facility capacities due to equipment failure or decreased source capacity.

- Water treatment facilities are in need of expansion and rehabilitation to meet demand and reduce the incidence of waterborne illness.

- Unaccounted–for-Water (UfW) (i.e. lost water) is unacceptably high. UfW levels in excess of 50% are not uncommon.

- Where centralized wastewater systems exist, connections to the system are typically limited and treatment works are inefficient and poorly maintained. Effluent quality is poor and sludge products are not safely reused for beneficial purposes.

- Record keeping is inadequate. Basic information such as revenue collection and total customers is often uncertain or unknown.

- Water and wastewater services are not priced at cost-recovery levels despite a relatively high willingness and ability to pay. Revenue collection is low in many areas.

The passage of the Kenya Water Act in late 2002 created a regulatory framework conducive to establishing sustainable water and wastewater utilities. The ultimate goal of the Water Act is to create viable, self-sustaining water and wastewater service providers in Kenya. The Act is a comprehensive piece of legislation whose key provisions include decentralizing control of water and wastewater service provision and encouraging more active involvement of the private sector.

The decentralization of water and wastewater service provision is being accomplished by contracting with local water and wastewater service provider companies (WSP) for service provision. The WSP are autonomous companies under ownership of local town governments. The WSP are contracted by one of seven newly-established regional Water Services Boards (WSB) to perform operation, maintenance, and billings / collections. The WSP in turn pay a fee to the WSB. The infrastructure itself is owned by the WSB.

Until the 2002 Water Act was passed, local communities had little control over their own water and wastewater systems. As a result, system management and operation and maintenance were ineffective. Tariffs were not set at cost-recovery levels, despite a relatively high willingness to pay. Revenue collection was poor. Existing infrastructure was allowed to fall into disrepair. The passage of the Water Act represents a major step away from past inefficiencies and toward establishing viable water and wastewater systems. With control shifted from the national to the regional and local level, many Kenyan communities are now on the road to efficient operation and management of their utilities for full cost recovery and sustainability. By the summer of 2006, Water Service Provider (WSP) companies had been established in all three of the selected study communities in the Lake Victoria South Water Services Board (LVSWSB) area.

The burden of funding the larger infrastructure needs is left to the Water Services Boards (WSB). The fact that the new infrastructure remains under ownership of these Water Boards is viewed as a favorable structure from a financing perspective. The WSB have an immediate need for new infrastructure and will be seeking quick financing turnaround. Each WSB will have multiple sources of revenue arising from various WSP within their service region. Given the government ownership of the WSB, they can access donor and government guaranteed financing which would not be as easily available to private sector sponsors. Indications from donors and the Ministry of Finance are that they would be supportive of useful water and wastewater financing requests by the WSB. They highlight areas in which they seek comfort that the study will focus on: appropriate technical solutions, management at the level of the WSB and WSP, and viable economics.

One option considered in the feasibility study is various levels of commercialization. Successful commercialization of Kenya's water and wastewater schemes has been taking place since 1997. Commercialization of water and wastewater systems is currently underway in Nairobi, Nyeri, Eldoret, Meru, and Mombasa.[3] Funding and management for these initial commercialization efforts have come from British, French, German, and Japanese entities. Thus far, American entities have not been significantly involved with management or funding of water and wastewater commercialization projects in Kenya.

In addition to this feasibility study, USTDA provided funding for an African Water and Wastewater Orientation Visit to the United States in October 2006, which included 30 representatives from six African nations, including Kenya. To the Project Team's knowledge, no United States Orientation Visits or similar program for water and wastewater technology had previously been conducted for Kenyans. During the course of this study, it has become apparent to the Project Team that while many Kenyans have a favorable opinion of U.S. products in general, most are simply not familiar with the wide range of high-quality U.S. water and wastewater equipment and services available. U.S. water and wastewater technology has not been made available on the Kenyan market. There are a host of international players involved in the water and wastewater industry in Kenya. These include German, French, Swedish, Austrian, and Japanese consultants, funding entities, and equipment.

The ultimate goal of this study is to provide MOWI and LVSWSB with a report encompassing technical, operational, financial, and implementation recommendations which will enable them to move forward with projects to rehabilitate water and wastewater infrastructure and transform local utilities into self-sustaining entities.

In addition to dramatic public health benefits, the provision of adequate water and sanitation will enable the region to develop economically. The amount of time spent by women and children searching for water will be reduced or eliminated, thereby freeing up time for productive work and education. Local businesses will be provided with the reliable water supplies they require for successful operation and growth.

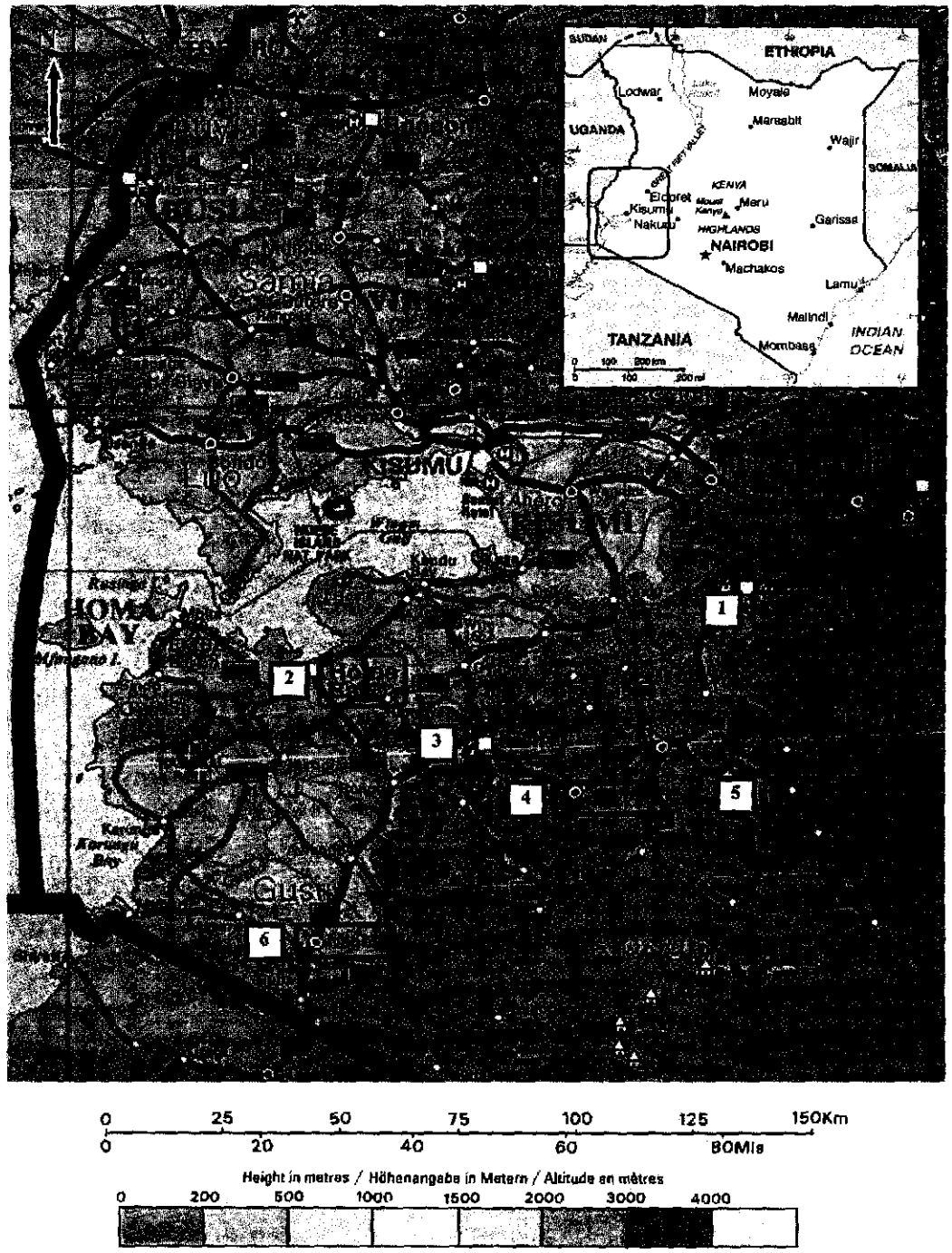


Figure 1-1 Project Area and Towns Initially Screened

Source: Macmillan Education, Ltd. Kenya Traveller's Map, Third Ed. 1993. Macmillan Education Ltd, London, United Kingdom.

1.1 Project Scope

The study communities are Kericho, Kisii, and Migori. For each community, this study examines water and sanitation infrastructure, management, and finance and recommends technical, managerial, and financial solutions to existing problems in the interest of creating self-sustaining systems that provide needed services at reasonable cost. The study also lays out a plan to assist the Government of Kenya in obtaining loans and grants to fund the recommended projects.

Key elements in the study include:

- Defining infrastructure improvements needed to accommodate a twenty-year study period.
- Determining operation and maintenance requirements.
- Defining a management structure appropriate for planning, organizing, staffing and controlling the program.
- Identifying expected capital, operation and maintenance, and management costs associated with the program through the study period.
- Estimating anticipated revenues from the program for the study period.
- Developing a financial model incorporating cost and revenue assumptions, including financing modules.
- Devising suitable financing structures for the entities, independently and combined, according to the economics derived from the study and with consideration to available financing sources.
- Identifying potential financing sources.
- Developing and documenting a plan for implementing the program.

1.2 Project Approach

From the start, the focus of the Project Team was on the economic viability of utilities. It is recognized that the condition and size of some existing infrastructure and institutions is such that they cannot currently serve as the basis for viable utilities. Therefore, considerable investment in infrastructure and capacity building will be required in order to achieve economic viability of the services. The goal is to establish these viable utilities with financing paid principally via user fees. This can only be achieved by establishing a program that provides for stable economics throughout the implementation petiod.

The proposed approach involves the following principal task categories, which were initiated in the order indicated, but were pursued simultaneously to a certain extent:

→ Initial Screening
→ Define Infrastructure Needs
→ Define Operation and Maintenance Needs
→ Outline Management Arrangements
→ Evaluate Economics and Develop Financing Structure
→ Develop and Document Implementation Plan

In order to clarify the project approach, a Work Plan was developed in late 2005 and finalized during meetings with the Grantee in Kenya in January 2006. The plan documents the organization, scope, responsibility, and schedule for the project. A copy of the Draft and Final Work Plans and accompanying letters to the Grantee are included in Appendix 1-1 and 1-5, respectively.

The project also included collaboration with the United Nations Human Settlements Programme (UN-Habitat). UN-Habitat is pursuing water and wastewater activities associated with its Lake Victoria Region Water and Sanitation Initiative, including a study and implementation of some immediate interventions in

Kisii and a preliminary study in Migori. UN-Habitat's efforts are focused on immediate interventions, whereas this study also includes consideration of long-term needs. The Project Team met with UN-Habitat representatives in Nairobi and/or Kisumu during three visits to Kenya (April 2006, July/August 2006, and February 2007). The Project Team provided UN-Habitat with written comments on their proposed immediate interventions in Kisii in a May 2006 letter (Appendix 6-7).

1.3 Project Team

To achieve the goals of the project, Coler & Colantonio, Inc. formed a project team that includes experts in water and wastewater engineering and construction management, public facilities operation and management, institutional capacity building, water and wastewater rates and charges, and infrastructure finance advisory in Africa. The Project Team also includes local representation.

The Coler & Colantonio Project Team includes the following entities:

Coler & Colantonio, Inc.	*Environmental Infrastructure, Operations, and Rate Specialists*
Wright-Pierce, Inc.	*Environmental Infrastructure Specialists*
The Bhatti Group, Inc.	*Public Works Management Experts*
Tusk Financial	*Financing Structure / Arrangement and Modeling Experts*
Babford & Company, Inc.	*Kenya Expert and Financial Analysis*
CAPEconsult	*Local Engineering Firm*

Contact information for Coler & Colantonio, Inc. (Contractor) and all subcontractors are included in Appendix 1-2.

1.4 Community Selection Process

Due to budgetary constraints, only three communities were to be examined in detail as part of the study. The Government of Kenya selected the following six communities for initial screening (Figure 1-1):

- Kericho
- Kisii
- Migori
- Homa Bay
- Keroka
- Bomet

The screening process began by developing and sending Pre-Visit Survey / Data Request Forms to contacts in each of the six communities and developing quantitative Draft Community Selection Criteria. The Draft Community Selection Criteria were provided to the Grantee for their review several weeks before the January 2006 Project Team visit (Appendix 1-1).

During the first meeting of the January 2006 Project Team visit, the Community Selection Criteria were reviewed in detail with the Grantee and finalized. The Selection Criteria were categorized into Technical Criteria, Management Criteria, and Financial Criteria. The goal of the project is to establish viable utilities in the selected communities. Therefore, preference was given to communities with characteristics conducive to this goal. Although many communities have a strong need for improvements, it was agreed that the project should focus on communities with likelihood for success so that these communities may serve as a model for others in the region. In addition, it was decided that the communities should represent a cross section of communities in the region if possible so the conclusions of the report might be applicable to a wide range of communities.

The Project Team spent most of the remainder of the initial trip visiting each of the six Towns with LVSWSB staff. Each Town visit consisted of meeting with local water and wastewater managers and staff, touring neighborhoods and facilities, and reviewing the results of the Pre-Visit Survey / Data Request Forms (Appendix 1-3) and other available information. After concluding the community visits, the Project Team worked with LVSWSB to complete the agreed-to Community Selection Criteria Fotms (Appendix 1-4). The results of the Community Selection Criteria forms indicated that Kericho and Kisii were the most promising towns for establishing viable water and wastewater systems, followed by Migori and Homa Bay, whicb received similar scores. Due to the fact that UN-Habitat was alteady performing work in Homa Bay, the Lake Victoria South Water Services Board recommended that Migori be chosen for further study. The three selected communities represent a reasonable cross section of communities in the region in terms of their socio-economic status, level of development, and technical challenges.

To finalize the selection process, LVSWSB dtafted a letter to the Ministry of Water and Irrigation stating which communities were selected and the rationale for the decision (Appendix 1-4).

A catalog of data collected during the data gathering phase of the project is included in Appendix 1-6.

A total of five trips to Kenya were made by the Project Team during the course of the study as listed below. Each trip varied from approximately one to two weeks in duration.

1. January-February 2006
2. April 2006
3. July-August 2006
4. November 2006
5. January-February 2007

ENDNOTES:

[1] Proceedings of Nyanza Professional Caucus Symposium on Water Resources and Sanitation Management in Kenya. Foreword. 11-12 May 2000, Tom Mboya Labour College, Kisumu.
[2] Ministry of Environment and Natural Resources, Republic of Kenya, comp. Abonyai Kiogora under supervision of D. N. Stower. Review of the Water and Sanitation Component in the Poverty Reduction Strategy Paper, 2002. p 8.
[3] Ministry of Environment and Natural Resources, Republic of Kenya, comp. Abonyai Kiogora under supervision of D. N. Stower. Review of the Water and Sanitation Component in the Poverty Reduction Strategy Paper. p 13.

2. FRAMEWORK FOR ANALYSIS **2-1**

2.1 Overall Design Criteria and Projections Methodology **2-1**
2.1.1 Overall Design Criteria 2-1
2.1.2 Population and Water Demand Projections Methodology 2-2
2.1.3 Wastewater Flow Projections Methodology 2-3

2.2 Treatment Standards and Design Criteria **2-4**
2.2.1 Drinking Water Treatment Water Quality Requirements 2-4
2.2.1 (a) Bacteriological Water Quality Requirements 2-4
2.2.1 (b) Chemical Water Quality Requirements 2-5
2.2.2 Wastewater Treatment Effluent Requirements 2-7
2.2.3 Wastewater Sludge Disposal Requirements 2-10

2. FRAMEWORK FOR ANALYSIS

2.1 Overall Design Criteria and Projections Methodology

2.1.1 Overall Design Criteria

The primary sources of guiding principles, design guidelines, and unit costs for water infrastructure recommendations will be based on information provided in the following documents:

- *Practice Manual for Water Supply Services in* Kenya, Republic of Kenya Ministry of Water and Irrigation, November 2005 (2005 Manual).
- *Aftercare Study on the National Water Master Plan in the Republic of Kenya*, JICA, November 1998 (1998 Aftercare Study)

The following principles will be utilized in the development of recommendations as outlined in the Section 1.4.2 of the 2005 Manual:

(i) Capacity to satisfy demand to target year – Horizon of 20-25 years
(ii) Provision of safe and sanitary water
(iii) Wise, effective and efficient use of the water resource
(iv) Safe and sound O&M of water facilities with no negative environmental impacts
(v) The system must be in conformity with Water Act 2002
(vi) Enhancement of quality of living standards
(vii) Appropriate technology relevant to beneficiaries

The intent of utilizing Kenya-specific guidelines is to ensure utilization of technologies and practices known to be successful in Kenya. Simple, reliable technology will be recommended whenever feasible. As stated in Section 1.6 of the 2005 Manual, "simplicity and reliability should always take preference over sophistication." and "No pumping, treatment or mechanical equipment should be proposed without convincing technical or economic justification."

There is no national standard for planning and design of sewerage systems. The primary sources of guiding principles, design guidelines, and unit costs for wastewater infrastructure recommendations will be based on information provided in the following documents:

- *Report No. 9, Selection and Design Criteria for Sewerage Projects.* World Health Organization, 1973.
- *Aftercare Study on the National Water Master Plan in the Republic of Kenya.* JICA, 1998.
- *Waste Stabilisation Ponds Design Manual for Eastern Africa.* Lagoon Technology International, 1992.

The three communities chosen for study (Kericho, Kisii, and Migori) are all classified as "Urban Centers" according to the Ministry of Lands and Settlement and as listed in Appendix A of the 2005 Manual. This classification alone is sufficient criteria for providing water supply services, which presently exist in all three communities. Principal questions to be answered in this report include where and how to expand services and how best to improve existing services. It is not recommended to simply plan to extend piped water supplies to all neighborhoods solely because they lie within an area classified as an urban center. System expansion should be prioritized including consideration of technical and economic feasibility. Where population density is low, cost of providing piped supplies is high, and alternative sources are available, some extension of municipal services may not be warranted.

2.1.2 Population and Water Demand Projections Methodology

Water demand projections are made for the following years as per Section 2.1 of the 2005 Design Manual:

Initial	2006
Future	2015
Ultimate	2025

Water supplies shall be planned for the ultimate year demand where feasible. Mechanical equipment may be designed for shorter periods.

Initial year population and expected growth rates are based on a review of local, regional and national estimates including the latest (1999) census. Reliance on census data alone is not sufficient for forecasting because changing sub-location classifications and town boundaries make census data difficult to interpret in some areas. Population estimates include the entire municipal population, but are further subdivided to differentiate those living within the existing or proposed future water service area from those outside the service area.

Per capita water demand rates from Table 2.2 of the 2005 Manual (reproduced in Table 2-1 below) were utilized except where more reliable local estimates were available. These per capita rates are the same as those provided in the Aftercare Study on the National Water Master Plan. The estimates include an allowance of approximately 20% for water losses through leakage or wastage.

The per capita estimates are based on housing class designations (high, medium, and low) and whether or not the user has an individual water connection (IWC), has no individual water connection (NWC), or has no individual water connection and is not located within the service area (NWC & NISA). It is assumed that persons living within the service area but without individual connections will obtain water from kiosks or communal water points. Individuals outside the service area are assumed to not exert a water demand, although they may be included in other demand categories such as market-day or municipal/industrial/commercial demands.

Housing classes were estimated and forecast based on available information provided to the Project Team and general observations made during Town visits. Due to a lack of sufficient data, high and medium classes were merged into one category.

The present population with IWC, NWC, or NWC & NISA was estimated based on records available in each Town. Forecasts of future changes to these populations are based on expected population growth, available reports, and discussions with Town officials regarding proposed service area expansion and infill. Forecasts of future service connections and per capita demand growth may require adjustments as additional real data becomes available.

Allowances for institutional, commercial, industrial, and other large user demands including market day demands were added based on local information and the guidelines in Section 2 of the 2005 Manual. These uses were combined into one 'large water uses' category for the purposes of this study. In most instances, insufficient data was available to estimate demands from individual facilities (i.e. based on number of beds in a hospital). Therefore, available data on the largest water users in each town was used as a basis for extrapolating future water demands and additions and modifications were made to account for market day demands and in instances where additional information was available.

All population and water demand calculations are made using a series of cascading electronic spreadsheets for each community, enabling simple adjustments to projections. The calculations are contained in the relevant

Appendices for each of the three town report sections. As recommended in the 2005 Manual, it is assumed that all water is drawn within the entire day (24-hours) and no additional peak factors are applied to demands.

Table 2-1. Water Demand Rates as Defined in 2005 Manual

CONSUMER	UNIT	RURAL AREAS			URBAN AREAS		
		High potential	Medium potential	Low potential	High Class Housing	Medium Class Housing	Low Class Housing
People with individual connections	l/head/day	60	50	40	250	150	75
People without connections	l/head/day	20	15	10	-	-	20
Livestock unit	l/head/day	50			-		
Boarding schools	l/head/day	50					
Day schools with WC without WC	l/head/day	25 5					
Hospitals Regional District other	l/bed/day	400 200 100 } + 20 l per outpatient and day (minimum 5000 l/day)					
Dispensary and Health Centre	l/day	5000					
Hotels High Class Medium Class Low Class	l/bed/day	600 300 50					
Administrative offices	l/head/day	25					
Bars	l/day	500					
Shops	l/day	100					
Unspecified industry	l/ha/day				20,000		
Coffee pulping factories	l/kg coffee	25 (when re-circulation of water is used)					

2.1.3 Wastewater Flow Projections Methodology

Wastewater flow projections were developed in the same manner as water demand projections, except it was assumed that 80% of water consumed is discharged as wastewater. This percentage is based on suggested values provided in Table 5.1 of WHO Report #9 (Appendix 2-1). Wastewater generation estimates are modified in some instances where more accurate local data or use-specific data (such as industrial uses) was available.

Population was subdivided into those with an individual sewer connection (ISC), no sewer connection (NSC), and those with no sewer connection who do not live within the sewer service area (NSC, NISA).

All wastewater flow calculations are also included in the series of cascading electronic spreadsheets described previously.

2.2 Treatment Standards and Design Criteria

2.2.1 Drinking Water Treatment Water Quality Requirements

The water quality requirements used for the purposes of this study are as defined in Part A, Section 3 of the *Practice Manual for Water Supply Services in Kenya*, Kenya Ministry of Water and Irrigation, November 2005 (2005 Design Manual). The document references the Kenya drinking water quality standards, which conform to World Health Organization (WHO) guidelines.

The 2005 Design Manual cites six basic water quality requirements for drinking water treatment[1]. Water should be:

- Free of pathogenic (disease causing) organisms
- Containing no compounds that have an adverse acute or long-term effect on human health
- Fairly clear (i.e. low turbidity, little color)
- Not saline (salty)
- Containing no compounds that cause an offensive taste or smell
- Not causing corrosion or encrustation of the water supply system and not staining clothes washed in it.

2.2.1 (a) Bacteriological Water Quality Requirements

The Kenya drinking water standards specify requirements in the areas of bacteriological quality and chemical quality. Quality requirements should control the selection of source water and treatment processes and sources should be fully protected from contamination.

The Kenyan government has separate bacteriological quality requirements for distributed, contained (i.e., bottled), and raw water. The requirements for distributed and contained water are covered under the Kenya drinking water quality standards (KS 150–1996). These standards conform to the WHO guideline limits and are presented in Table 2-2.[2]

Table 2-2. Microbiological Limits for Drinking Water and Containerized Water[3]

Type of microorganism	Drinking Water	Contained Water
Total viable counts at 37° C per ml, max.	100	20
Coliforms in 250 ml	Shall be absent	Shall be absent
E-coli in 250 ml	Shall be absent	Shall be absent
Staphylococcus aureus in 250 ml	Shall be absent	Shall be absent
Sulphite reducing anaerobes in 50 ml	Shall be absent	Shall be absent
Pseudomonas aeruginosa fluorescence in 250 ml	Shall be absent	Shall be absent
Streptococcus faecalis	Shall be absent	Shall be absent
Shigella in 250 ml	Shall be absent	Shall be absent
Salmonella in 250 ml	Shall be absent	Shall be absent

If these requirements are not met, remedial actions are required to correct or minimize health effects due to these bacteriological deficiencies. These remedial actions may be temporary (i.e., issuing a recommendation to boil water) or long term (i.e., localizing and eliminating the contamination source or enacting treatment improvements).[4]

The treatment method required for raw water is determined by the coliform count in the water. Table 2-3 presents the treatment requirements based on the number of coliform per 100 ml. If more than 40% of the coliform population is fecal coliform, the raw water should be treated according to the treatment requirements of the next higher category.[5]

Table 2-3. Guideline Values for Raw Water[6]

Number of Coliform Organisms/100 ml	Treatment Requirement
0-50	Bacterial quality requiring disinfection only.
50-5,000	Bacterial quality requiring full treatment (coagulation, sedimentation, filtration and disinfection).
5,000-50,000	Heavy pollution requiring extensive treatment.
Greater than 50,000	Very heavy pollution unacceptable as source unless no alternative exists. Special treatment needed.

2.2.1 (b) Chemical Water Quality Requirements

Chemical water quality requirements relate to constituents that could be present in the drinking water and have significant health impacts. The maximum limits are based upon the Kenya drinking water quality standard (KS 150–1996) and WHO guidelines.[7]

Table 2-4 presents the maximum allowable concentrations for inorganic contaminants. Table 2-5 presents the maximum allowable limits for organic contaminants. Table 2-6 presents the maximum allowable limits for radioactive materials. Table 2-7 and Table 2-8 present desirable and permissible aesthetic standards for water intended for human consumption and typical domestic purposes.

Table 2-4. Limits for Inorganic Contaminants in Drinking Water and Containerized Water[8]

Substance	Limit of Concentration Mg/l, max.
Arsenic as As	0.05
Cadmium as Cd	0.005
Lead as Pb	0.05
Mercury (total as Hg)	0.001
Selenium as Se	0.01
Chromium as Cr	0.05
Cyanide as CN	0.01
Phenolic substances	0.002
Barium as Ba	1.0
Nitrate as NO_3	10
Fluoride as F	1.5

Note:
Local and climatic conditions may necessitate > 1.5 mg/l fluoride. In some extreme cases, fluoride concentration of 3 mg/l may be acceptable.

Table 2-5. Limits for Organic Contaminants of Health Significance in Drinking Water and Containerized Water[9]

Substance	Limit of Concentration Mg/l, max.
Benzene	10
Chlorinated Alkanes and Alkenes	
Carbon tetrachloride	3
1,2-Dichloroethylene	10
1,1-Dichloroethylene	0.3
Tetrachloroethylene	10
Trichlorophenol	30
Chlorophenols	
Pentachloraphenol	10
2,4,6 trichlorophenol	10
Polynuclear aromatic hydrocarbon	
Benzo (a) pyrene	0.01
Trihalomethanes	
Chloroform	30
Pesticides	
Aldrin/Dieldrin	0.03
Chlorodane (total)	0.3
2,4 D	100
DDT (total)	1
Heptachlor and Heptachlor	0.1
Eposide	0.01
Hexachlorobenzene	3
Lindane BHC Mehtoxychlor	30

Table 2-6. Limits for Radioactive Materials in Drinking Water and Containerized Water[10]

Radioactive Substance	Limit of Concentration Bq/l, max.
Gross Alpha activity	0.1
Gross Beta activity	1

Table 2-7. Desirable Aesthetic Quality[11]

Substance or Characteristic	Drinking Water	Containerized Water
Color in True color unit (TCU), max.	15	15
Taste and Color	Shall not be offensive to customers	Shall not be offensive to customers
Suspended matter	Nil	Nil
Turbidity in Nephelometric Turbidity Units (NTU), max.	5	1
Total dissolved solids in mg/l, max.	1,500	1,500
Hardness as $CaCO_3$, mg/l, max.	500	500
Aluminum as Al, mg/l	0.1	0.1
Chloride as Cl, mg/l, max.	250	250
Copper as Cu, mg/l, max.	0.1	0.1
Iron as Fe, mg/l, max.	0.3	0.3
Manganese as Mn, mg/l, max.	0.1	0.1
Sodium as Na, mg/l, max.	200	200
Sulphate as SO_4^{-2}, mg/l, max.	400	400
Zinc as Zn, mg/l, max.	5	5
pH	6.5 to 8.5	6.5 to 8.5
Magnesium as Mg, mg/l, max.	100	100
Chlorine concentration as Cl, mg/l	0.2-0.5	Nil
Calcium as Ca, mg/l	250	250
Ammonia as (N), mg/l, max.	0.5	0.5

Circumstances may arise where it is not practical to produce treated water that is in compliance with the aesthetic water quality requirements listed in Table 2-7. In such cases (as defined in the 2005 Design Manual) the maximum allowable limits for certain parameters can be raised. These parameters and the higher permissible limits are listed in Table 2-8.[12]

Table 2-8. Permissible Aesthetic Quality[13]

Parameter	Unit	Guideline Value
Chloride	mg/l	600
Color	TCU	50
Copper	mg/l	1.5
Iron	mg/l	1.0
Manganese	mg/l	0.5
pH	-	6.2 – 9.2
Solids	mg/l	1500
Turbidity	NTU	25
Zinc	mg/l	15
Other Constituents	-	As in table "Desirable aesthetic quality"

2.2.2 Wastewater Treatment Effluent Requirements

Kenya does not have a corresponding "Design Manual" for wastewater treatment effluent requirements. However, water pollution regulations are contained in the Water Act and include national effluent standards

for discharge of wastewater into public sewers and for discharge of treated effluent into watercourses. Typically, certain other publications and associated guidelines are referenced for wastewater treatment design criteria. Frequently referenced documents include:

- *Waste Stabilisation Ponds Design Manual for Eastern Africa.* Lagoon Technology International, Leeds, England, 1992.
- *Report No. 9, Selection and Design Criteria for Sewerage Projects.* World Health Organization, 1973.
- *Aftercare Study on the National Water Master Plan in the Republic of Kenya*, JICA, November 1998 (1998 Aftercare Study)

Typically regulated wastewater treatment effluent parameters include[14]:

- Organic matter (as biological oxygen demand (BOD) or chemical oxygen demand (COD))
- Suspended solids
- Nitrogen (as total nitrogen, ammonia, and oxidized nitrogen)
- Total phosphorus
- Fecal coliform bacteria count
- Human intestinal nematode eggs count (*Ascaris lumbricoides*, *Trichuris trichiura*, and the human hookworms)
- Human trematode eggs count (*Schistosoma* spp.)

The last three parameters are especially relevant when effluent re-use is intended.

Design requirements for wastewater treatment facility discharges are typically dependent on a variety of factors including receiving water quality and quantity and downstream uses including re-use. According to the *Waste Stabilisation Ponds Design Manual for Eastern Africa*, most countries in the region (especially former British colonies) base effluent requirements on the United Kingdom Royal Commission 20/30 standard (20 mg 5-Day Biological Oxygen Demand (BOD_5)/l, 30 mg Suspended Solids (SS)/l). Most countries have adjusted these requirements based on the type of receiving water because these standards are not appropriate for all local conditions.[15]

The national effluent standards for discharge to public sewers are included in Table 2-9. These standards are based on the U.K. Royal Commission standard.

Table 2-9. "A" National Effluent Standards for Discharge to Public Sewers[16]

Parameter	Effluent Concentration Limits
BOD_5	450 mg/l
pH	6 to 9
Temperature	< 35° C
Suspended Solids	300 mg/l
4 hrs oxygen absorption for permanganate	N./80 at 27° C < 100 mg/l
Greases	< 100 mg/l of greases that dissolve in Ethyl-ether
Oil, Petrol, Kerosene or other combustible materials	Not permitted
Toxicity	No toxic materials permitted

Notes:

1) In addition the waste should no contain materials that might damage pipes or treatment works.
2) The flow must not exceed the capacity of the sewerage system and a meter is to be provided with a log book to record flows which can be inspected by the City Engineer of Medical Officer of Health.
3) Quarterly tests will be carried out, at the expense of the industry concerned, in accordance with the "Standard Methods of the Examination of water, sewage and Industrial wastes", issued by the American Public Health Association.

The national effluent standards for discharge to natural water courses are included in Table 2-10.

Table 2-10. "B" National Effluent Standards for Direct Discharge to Natural Water Course[17]

Parameter	Effluent Concentration Limits
COD	10 mg/l
Total Nitrogen exclusive NO	1 mg/l
Total Nitrogen exclusive NH_3	1.5 mg/l
BOD_5	20 mg/l
pH	6 to 9
Temperature	< 25° C
Suspended Solids	30 mg/l
Total Dissolved Solids	1,500 mg/l
4 hrs oxygen absorption for permanganate	N./80 at 27° C < 15 mg/l
Nitrate as NO_3	< 45 mg/l

Notes:
1) All other standards regarding greases, oils, and toxic materials described in "A" also apply.

The standards described above are thought to be met in very few treatment facilities in Kenya. Reasons cited for this lack of adequate performance include[18]:

- Organic overload
- Mechanical failures or incorrect operation of conventional works
- High quantity of algae in effluent of Waste Stabilization Ponds (WSPs) contributing to high BOD
- No control on the discharge of industrial wastes
- Poor maintenance practices, e.g. sludge accumulation in ponds.

For wastewater discharged to public sewers, including industrial wastes, pretreatment programs should be established to ensure wastewaters do not exceed the limits in Table 2-9. Table 2-11 presents parameters and recommended limits typically followed in Kenya. Ranges are presented due to the fact that effluent discharges to surface water bodies are dependent on characteristics of the receiving stream. The limits presented in Table 2-11 will be used for general planning purposes in this project.

Table 2-11. Wastewater Effluent Concentration Limits [19]

Parameter	Effluent Concentration Limits
BOD_5	20 - 30 mg/l
COD	50 - 60 mg/l
Total Suspended Solids	30 mg/l
pH	6 - 9
Electrical Conductivity	1,000 mS/cm
Ammonia (mg N/l)	1.5 mg/l
Nitrate as (mg N/l)	2 mg/l
Total Nitrogen (mg N/l)	10 mg/l
Total Phosphorous (mg P/l)	1 – 10 mg/l
Fecal Coliform (surface water discharge)	≤ 5,000 / 100 ml (varies, may be as low as 100 / 100 ml)
Fecal Coliform (unrestricted irrigation[a])	≤ 200 – 1,000 /100 ml [c] (geometric mean)
Fecal Coliform (restricted irrigation[b])	≤ 5,000 /100 ml
Intestinal nematodes[c] (unrestricted irrigation[a,d])	≤ 1 (arithmetic mean)
Intestinal nematodes[c] (restricted irrigation[b,d])	≤ 1 (arithmetic mean)

[a] Unrestricted irrigation includes crops likely to be eaten uncooked, sports fields, and public parks.
[b] Restricted irrigation includes cereal crops, industrial crops, fodder crops, pasture and trees. In the case of fruit trees, irrigation should cease two weeks before fruit is picked, and no fruit should be picked off the ground. Sprinkler irrigation should not be used.
[c] A more stringent guideline (≤ 200 fecal coliforms per 100 ml) is appropriate for public lawns, such as hotel lawns, with which the public may come into direct contact.
[d] Intestinal nematodes include *Ascaris lumbricoides*, *Trichuris trichiura*, and the human hookworm

It should be noted that fecal coliform standards vary widely. The British Government's Statuatory Instrument 1991 No. 1597 for freshwater bodies used for bathing (HMSO, 1991) sets a limit of 2,000 / 100 ml. Data published by the World Health Organization (1989) shows that 45% of 110 rivers tested worldwide have fecal coliform levels above 1,000 / 100 ml and 15% have levels over 10,000 / 100 ml. However, requirements in Kenya are often sometimes < 500 / 100 ml. This is less than some generally accepted requirements for unrestricted irrigation. It is unlikely that this requirement is met in many freshwater streams, let alone discharges from wastewater treatment facilities.

The re-use (irrigation) standards presented in Table 2-11 are based on suggested guidelines from *Waste Stabilisation Ponds Design Manual for Eastern Africa, (1992)*. Water reuse regulations in the United States[20] generally require E. coli counts of ≤ 200 / 100 ml for commercially processed food crop irrigation, nonfood crop irrigation, restricted access irrigation, or wetlands habitat. E. coli counts of zero / 100 ml are typically required for urban reuse, food crop irrigation, and recreational impoundments.

BOD limits may be significantly different for waste stabilization pond effluent, where a less stringent or filtered BOD standard may apply to account for BOD represented by algae. It should be noted that after entering receiving waters, algae disperses quickly and may be consumed by zooplankton, limiting the BOD exertion of the algae. Where pond effluent with algae is diverted to agricultural re-use, the algae can present a benefit as a fertilizer.[21]

2.2.3 Wastewater Sludge Disposal Requirements

Kenya does not have official requirements for the disposal of sludge, but is developing these requirements. According to the *World Health Organization Report No. 9 (1973)*, the generally recommended disposal of sludge in Kenya is burial without treatment in cases where a guaranteed market for the final product does not exist[22].

However, if disposing of the sludge by means of untreated burial will impact underground water resources, then the sludge should be treated.

The *World Health Organization Report No. 9* recommends the following two sludge treatment methods for use in Kenya:

- Composting with either community solid waste or vegetation.
- Aerobic stabilization (for small installations) or anaerobic digestion, followed by de-watering via open drying beds.

Other treatment methods include air drying on sand beds or other media and lime stabilization. Additional advanced processes for pathogen reduction include heat treatment, heat drying, irradiation, and pasteurization. In the case of sludge from anaerobic and facultative ponds, sludge drying beds are a relatively easy, cost effective means of sludge disposal.[23]

The resultant treated biosolid product may be used as:

- Soil conditioner / fertilizer for agriculture and small gardens
- Organic base for compound fertilizers (sold to fertilizer company)
- Fill or covering for tipped refuse.[24]

Re-use criteria for biosolids are not provided in *World Health Organization Report No. 9*. The Aftercare Study on the National Water Master Plan notes that sludge from drying beds should be stored and dried for over 12 months to ensure it is pathogen free.[25]

In the United States, biosolids capable of reuse are classified into two categories as follows:

Class A biosolids contain pathogens (including enteric viruses, pathogenic bacteria, and viable helminth ova) below current detectible levels. If such biosolids are sold or given away for land application they must contain fecal coliform at less than 1,000 Maximum Probably Number (MPN)[26] / g total dry solids.

Class B biosolids contain pathogens at levels unlikely to present a threat to public health and the environment under certain conditions and represent the minimum level of pathogen reduction for land application or surface disposal. The only exception is when disposed solids are covered daily. Class B biosolids may not be sold or given away in bags or other containers or applied on lawns or home gardens. Class B biosolids must feet fecal coliform limits of less than 2.0×10^6 MPN / g total dry solids.

Final requirements for sludge re-use will need to be established during preliminary design. For planning purposes, it will be assumed that biosolids will need to meet U.S. requirements.

ENDNOTES

[1] 2005 Design Manual, Section 3.1.1
[2] 2005 Design Manual, Section 3.2.2
[3] 2005 Design Manual, Table 3.1
[4] 2005 Design Manual, Section 3.2.3
[5] 2005 Design Manual, Section 3.2.4
[6] 2005 Design Manual, Table 3.2
[7] 2005 Design Manual, Section 3.3.1
[8] 2005 Design Manual, Table 3.3
[9] 2005 Design Manual, Table 3.4
[10] 2005 Design Manual, Table 3.5
[11] 2005 Design Manual, Table 3.6
[12] 2005 Design Manual, Section 3.3.3

[13] 2005 Design Manual, Table 3.7
[14] *Waste Stabilisation Ponds Design Manual for Eastern Africa*, Section 4.1
[15] *Waste Stabilisation Ponds Design Manual for Eastern Africa*, Section 4.1
[16] Reproduced from The Aftercare Study on the National Water Master Plan, Table 2.2.3
[17] Reproduced from The Aftercare Study on the National Water Master Plan, Table 2.2.3
[18] The Aftercare Study on the National Water Master Plan, Page III-18
[19] Based on conversations with local consulting engineers in Kenya, WHO Report No. 9, the The Aftercare Study on the National Water Master Plan, and *Waste Stabilisation Ponds Design Manual for Eastern Africa.*
[20] U.S. EPA Manual – Guidelines for Water Reuse, EPA/625/R-92/004, U.S. Environmental Protection Agency and U.S. Agency for International Development, Washington, D.C.
[21] *Waste Stabilisation Ponds Design Manual for Eastern Africa*, Section 4.1
[22] Report No. 9, Selection and Design Criteria for Sewerage Projects. World Health Organization, 1973. Section 2.5.2
[23] The Aftercare Study on the National Water Master Plan, Page III-39
[24] Report No. 9, Selection and Design Criteria for Sewerage Projects. World Health Organization, 1973. Section 2.5.2
[25] The Aftercare Study on the National Water Master Plan, Page III-39.
[26] MPN, or Most Probable Number, is based on the application of the Poisson distribution to provide a statistical estimate of the actual concentration.

3. INSTITUTIONAL ARRANGEMENTS 3-1

3.1 Overview of Existing Institutional Arrangements 3-1
3.1.1 The Water Act and National and Regional Institutions 3-1
3.1.2 Lake Victoria South Water Services Board 3-3

3.2 Theoretical Management Structure Options 3-6

3.3 Review of Actual Management Structures in Place 3-10
3.3.1 National Water and Sewerage Corporation (NWSC), Uganda 3-10
3.3.2 Massachusetts Water Resources Authority (MWRA), United States 3-10

3.4 Comparison of LVSWSB to Theoretical and Actual Structures in Place 3-11

3.5 Lake Victoria South Water Services Board Recommendations 3-12

3. INSTITUTIONAL ARRANGEMENTS

3.1 Overview of Existing Institutional Arrangements

The current institutional arrangements for regulating and managing water resources in Kenya can be traced back to 1974 with the implementation of the National Water Master Plan whose primary aim was to ensure availability of potable water to all households within a reasonable distance from the source. The goal of the master plan was to implement this by the year 2000. There were two primary governmental agencies responsible for water services in the Republic of Kenya. The Department of Water Development was the Government of Kenya (GOK) agency responsible for the development, conservation and control of water. The National Water Conservation and Pipeline Corporation (NWCPC) is an autonomous agency created to manage government-operated water supply systems that could be run on a commercial basis.

The *National Environment Action Plan (NEAP) Report of 1994*, followed by *Sessional Paper No. 1 of 1999 on National Policy on Water Resources Management and Development*, serve as the basis for the present legislative and regulatory regime and associated reforms affecting the provision water and wastewater services to the Republic of Kenya. The development of this framework culminated in the enactment of the Water Act 2002 as the legal instrument to implement the water sector reforms.

3.1.1 The Water Act and National and Regional Institutions

The Water Act established ownership and control of water with the Government of the Republic of Kenya through the newly established Ministry of Water and Irrigation (MWI). Under Part II of the Act, it states:

> *"Every water resource is hereby vested in the State, subject to any rights of user granted by or under this Act or any other written law. The Minister shall have and may exercise control over every water resource in accordance with this Act."*

The Water Act 2002 clearly defined the functions of the MWI and other water sector institutions established by the Act, including: the Water Resource Management Authority (WRMA); the Water Services Regulatory Board (WSRB); seven regional Water Services Boards (WSBs); the Water Services Trust Fund (WSTF); and the Water Appeal Board (WAB). The day-to-day management of the Ministry of Water and Irrigation is the responsibility of the Director of Water.

The institutional framework as established by the Water Act 2002 is shown in Figure 3-1. It is the framework established by the Act that govetns the ownership, control and use of water resources and operation and management of water and sewerage services in the Republic of Kenya. The water and wastewater functions of the former Department of Water and the National Water Conservation and Pipeline Corporation (NWCPC) are being transferred to the Water Services Boards (WSBs) in accordance with a transfer plan.

With the passage of the Water Act, primary responsibility for the protection of water resources, delivery of potable water and the collection of wastewater now falls under the MWI. The MWI issues licenses to entities providing "water services to more than twenty households" and for supplying "more than twenty five thousand litres of water a day for domestic purposes; or more than one hundred thousand litres of water a day for any purpose."

The MWI fulfills these responsibilities through the Water Resource Management Authority and Water Services Regulatory Board at the national level and through the Water Services Boards and their Water Service Providers at the regional and local level.

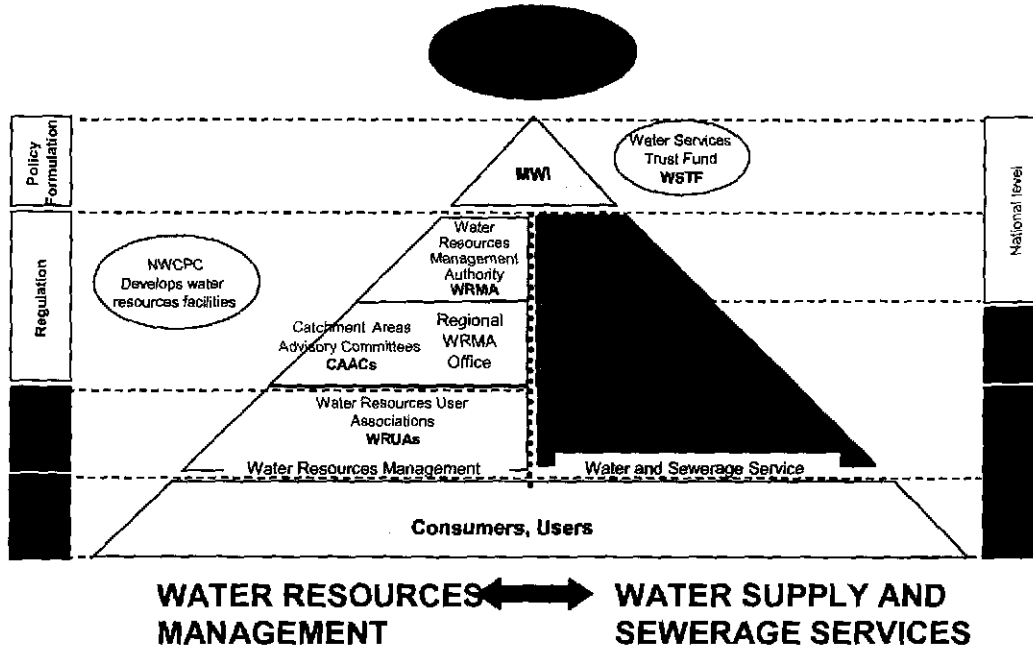


Figure 3-1. Institutional Framework for Water Resources Management and Water and Sewerage Services in Kenya per the Water Act 2002

The Water Services Trust Fund, established by Section 83 of the Water Act, is managed by trustees that are appointed and holding office under a trust deed drawn up by the Minister. The objective of the Fund is to assist in financing the provision of water services to areas of Kenya which are without adequate service.

The Water Appeals Board, established by Part VI of the Water Act, is governed by a Chairman appointed by the President on the recommendation of the Chief Justice and two other persons appointed by the Minister. The WAB is responsible for the determination of appeals and disputes of "any person having a right or proprietary interest which is directly affected by a decision or order of the Authority, the Minister or the Regulatory Board concerning a permit or license under this Act, and the Board shall hear and determine any such appeal." The judgment of the WAB shall be final "provided that on a matter of law, and appeal shall lie to the High Court."

The Water Resource Management Authority (WRMA) was established under Part III of the Water Act within the Ministry of Water and Irrigation. WRMA operates under the direction of a governing board consisting of a Chairman appointed by the President and ten other board members appointed by the Minister. The WRMA is responsible for regulation of water resources issues. The WRMA is directed "to develop principles, guidelines and procedures for the allocation of water resources" and to monitor and reassess the national water resources management strategy, to issue permits for the use of water, to enforce conditions of the permits, and to regulate and protect water resources and their catchments. The WRMA "may, with the consent of the Attorney-General given under the Criminal Procedure Code, undertake the prosecution of any offences arising under this Act or in connection with the performance of its functions."

The Water Services Regulatory Board (WSRB) was established by Part IV of the Water Act within the Ministry of Water and Irrigation. WSRB operates under the direction of a governing board consisting of a Chairman appointed by the President and ten other board members appointed by the Minister. The WSRB is essentially the regulatory arm of the MWI and oversees Water Services Boards established by the Minister after publication in the Gazette.

Water Services Boards (WSBs) were established by Section 53(l) of the Act which directs that each "Water Services Board, as a licensee, be responsible for the efficient and economical provision of water services authorized by the license." Section 55(l) of the Act authorizes the WSB to "arrange for the exercise and performances of all or any of its powers and functions under the license by one or more agents, to be known as water service providers."

Within this framework, it is the Water Services Boards have the responsibility of providing potable water and sanitation services to the people of Kenya for their respective area of responsibility. The WSBs contract with Water Service Provider companies (WSPs) for the operation of water and sanitation infrastructure, which is owned by the WSBs. The WSPs pay lease fees to the WSBs. The Lake Victoria South Water Services Board is one of seven WSBs under the MWI. The WSB areas are depicted in Figure 3-2.

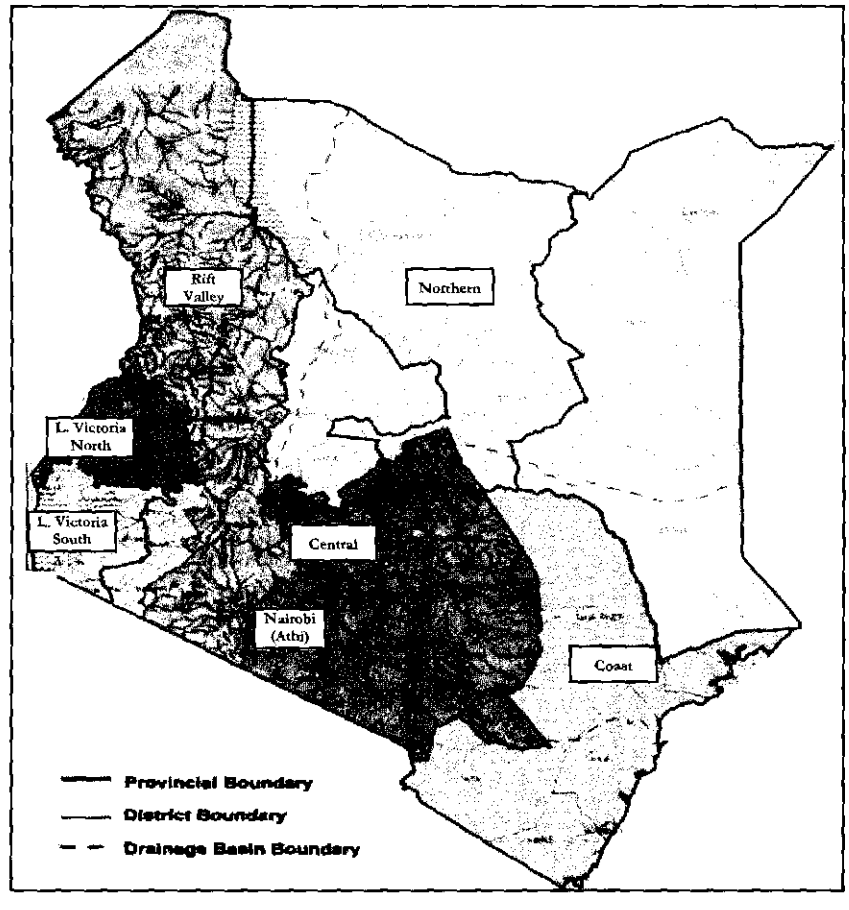


Figure 3-2. Kenya Water Services Boards (WSBs)

3.1.2 Lake Victoria South Water Services Board

Lake Victoria South Water Services Board is one of seven boards providing water services to a population of over 6 million (1999 Census) in an area of 21,720 km^2 comprising of 17 administrative districts in Nyanza and Rift Valley (south Rift part) provinces. The districts include Kisumu, Kericho, Nandi South, Siaya, Bondo, Nyando, Kisii Central, Kisii North (Nyamira), Kisii South (Gucha), Trans Mara, Bornet, Buretti, Rachuonyo, Suba, Kuria and Migori. From the rapid assessment carried out by the MWI in November 2004, the LVSWSB area of jurisdiction has 388 water schemes and 5 wastewater schemes. Of these, the water schemes

that were previously managed by the MWI and NWCPC were handed over to LVSWSB and leased to the new Water Service Providers for operation and maintenance. The sewerage schemes operated by local authorities are to be leased by LVSWSB for operation and maintenance to the new Water Service Providers. As of July 2006, contracts had been established with Water Service Provider companies in all three of the study towns (Kericho, Kisii, and Migori).

The Lake Victoria South Water Services Board will plan and develop water services infrastructure, own and manage water-related assets, develop and enter into Service Provision Agreements (SPAs) with Water Service Providers, and seek to obtain adequate funds for its operation. LVSWSB is organized into five departments operating under the direction of a Chief Executive Officer as depicted in Figure 3-3.

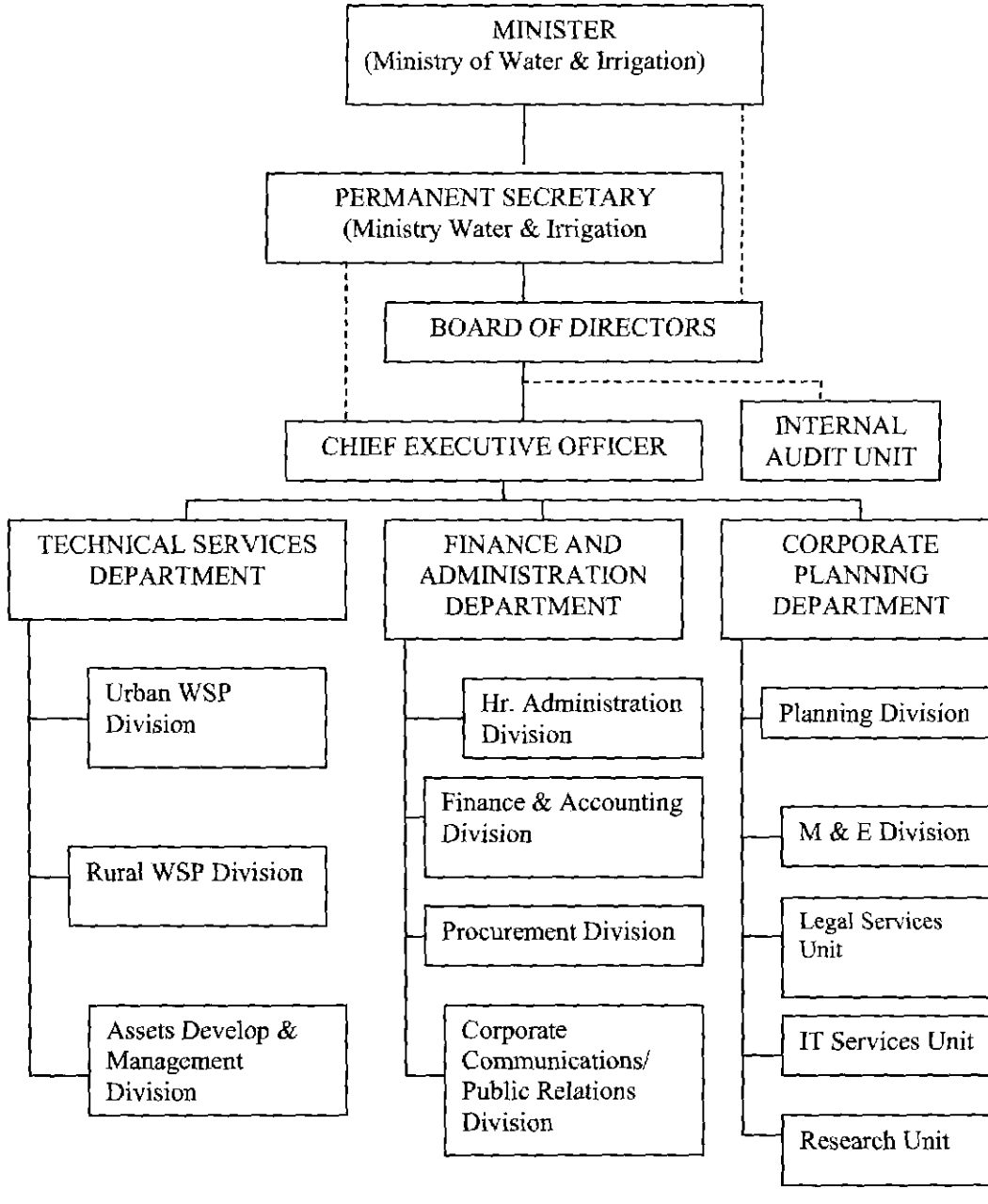


Figure 3-3. Lake Victoria South Water Services Board Organizational Structure

The following description of the Board of Directors, Chief Executive Officer's Office, Internal Audit Unit, and the three departments (Technical Services, Finance and Administration, and Corporate Planning) is taken directly from the Lake Victoria South Water Services Board Draft Business Plan:

According to the organization structure, the Board of Directors is responsible for formulation of policies. The Chief Executive Officer is the accounting officer responsible for the day to day operations and administration of the organization in consultation with the Board of Directors. The Chief Executive officer and the functional heads are responsible for dealing with policy matters prior to submission to the Boatd for direction and/or approval and subsequent implementation.

The functions of the Internal Audit Unit include:

- Development and implementation of audit systems
- Ensure compliance with policies and procedures
- Ensuring availability and safe guarding of assets
- Ensure adequacy of accounting, financial and other operating controls
- Ensure adequacy and reliability of financial reports and other accounting and expenditure data
- Carry out routine and system audit
- Maintain checks and balances in the Board transaction

LVSWSB has a total of three departments namely Technical Services, Finance and Administration and Corporate Planning. Technical services department has 3 divisions namely Urban WSP, Rural WSP and Assets Development and Management. The Finance and Administration has 4 divisions namely Human Resource and Administration, Finance and Accounting, Procurement Corporate Communications/Public Relations. The Corporate Planning department has two divisions and three units namely planning division and Monitoring and Evaluation division, Legal Services unit, IT unit and Research unit. Internal Audit unit reports directly to the Chief Executive Officer.

Technical Services Department

Key functions of the Technical Services Department are contracting, monitoring and enforcement of agreements, efficient and economic provision of water services, assisting community based organizations obtain funding from water services trust fund, custodian of water service provision assets, maintenance / management of assets, development of assets, bulk water supply and direct water supply in the event it is not possible to contract a water service provider.

Finance and Administration Department

Key functions of the Finance and Administration Department are accounting of Board funds, expenditure, management accounting, budget preparation and management, investment and revenue improvement, management of financial information system, management of credit control, human resource planning, management and development; procurement and stores management, corporate communication and customer relations, public relations management

Corporate Planning Department

Key functions of the Corporate Planning Department are business and strategic planning, monitoring and evaluation of Projects, performance contracts and Water Service Providers performance, development and

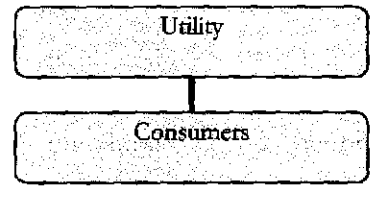
management of Information communication technology system of the organization, provision / enforcement of legal requirements, documentation management and research services.

3.2 Theoretical Management Structure Options

The management of water and wastewater systems can be divided into two major categories – centralized and decentralized. In a completely decentralized organization, one entity would manage all the potable water and wastewater disposal needs for a specific area without input or oversight from any external forces. This would include ownership of all assets including the potable water sources and receiving waters for wastewater disposal. At the lowest basic level this could also be referred to as a completely centralized organization. However, in general, when referring to centralized and decentralized management structures, one is usually referring to a larger organization and how far down independent management of a function is allowed to extend. In actual practice, water and wastewater organizations tend to be somewhere between the two extremes depending on the size of the organization, the area of responsibility either geographical or functional, and the controls that are put in place by the senior level of the organization.

At a 2004 workshop hosted by the non-profit organization Building Partnerships for Development in Water and Sanitation (BPD), participants from seven Non-Governmental Organizations (NGOs) identified five variations of a basic model for providing water supply and wastewater services to consumers.[1] The basic model could be considered to be a totally decentralized organization (or totally centralized at the lowest basic level). The following is a brief description of the basic model (The Ideal: Direct Utility) and five variations of the basic model.

The Ideal: Direct Utility – Consumer Relationship

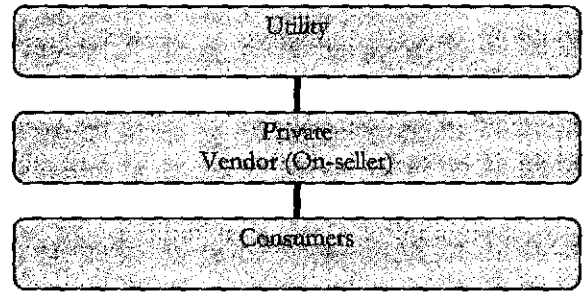


The consumer would enter into a contract with the utility by connecting to the network; the contract being that the utility would provide water and the consumer would pay for the services. Ideally, the water is available to the consumer on a continuous basis so that the consumer does not have to worry about storage, and the water received is of high quality that can be used directly by the consumer. The participants agreed that, given the high level of service it allows (piped water in the house), and its equity and efficiency, this is the ideal model for service delivery, which all utilities should aspire to for all consumers. However, the workshop participants identified as the main weakness of this model is that the poor are often excluded. The foundation of this model is the private connection, and poor people are often unable to get connections because:

- They live in areas that are far from the network;
- They lack land tenure, which is required to be eligible for a connection;
- They cannot afford the connection fees (especially if they must be paid as a large one-time "up-front" payment).

While the direct relationship of utility to consumer model is considered the ideal, the workshop participants recognized these primary weaknesses along with its strength. As such, the workshop participants identified five variations of this model to offset its weaknesses. However, as each variation was identified, the workshop participants realized that each variation had its own strength and weaknesses.

Variation 1: Water On-selling by Private Third Parties



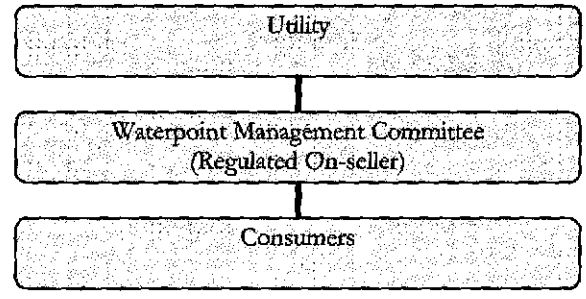
The first variation of this ideal model is the water on-selling by private third parties. In many urban areas of developing countries the distribution network is usually limited and serves only a portion of the city. As such, many customers are not connected and must rely on other means of obtaining water. One of these is the "on-sellers" who may purchase utility water and deliver it to the unconnected consumer, collecting payment that reflects their costs (the water itself, the overhead costs needed to keep the delivery system working, and often a profit or margin of surplus). The delivery mechanisms may be:

- A stand post or "kiosk" from which consumers must fetch the water;
- Delivery by hand cart (in small volumes);
- Delivery by tankers (usually in large volumes, to storage tanks).

The workshop participants identified the following weaknesses:

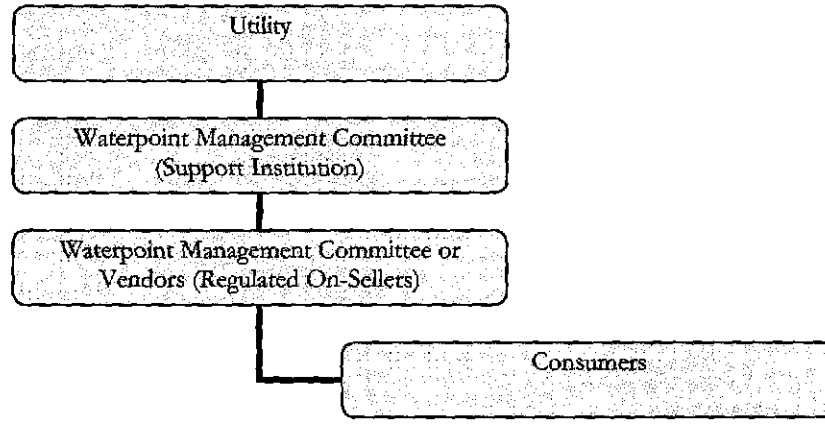
- Private providers tend to be unregulated;
- Private providers tend to charge higher prices;
- Some private providers take advantage of times of shortage and lack of alternatives to "price-gouge";
- Quality of water from private vendors is often low;
- Private vendors may lack an understanding of what needs to be done to protect water quality and public health;
- Private vendors tend to have an unofficial status and in many cases are often illegal.

Variation 2: Water On-selling by Community- Based Organizations or Regulated Vendors



The second variation of the ideal model implemented by NGOs to address the problems with Variation 1 was to establish alternative arrangements for on-selling water, in the form of community-based organizations such as waterpoint committees, or individual vendors who are organized and regulated. While this variation helped to address some of the weaknesses of variation 1, its primary weakness is still price.

Variation 3: Water On-selling with Support Institution

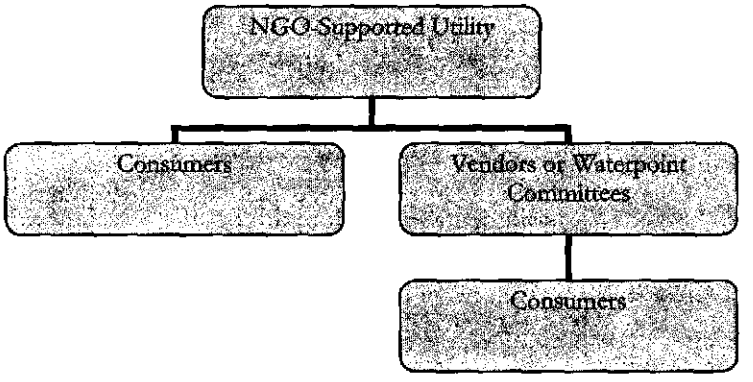


A further variation on the ideal model is to set up another level of institution between the managers of waterpoints (whether they are private or community-based) and the utility to provide support. This support could be in the form of:

- Advice
- Capacity support
- Advocacy
- Intermediation
- Management assistance

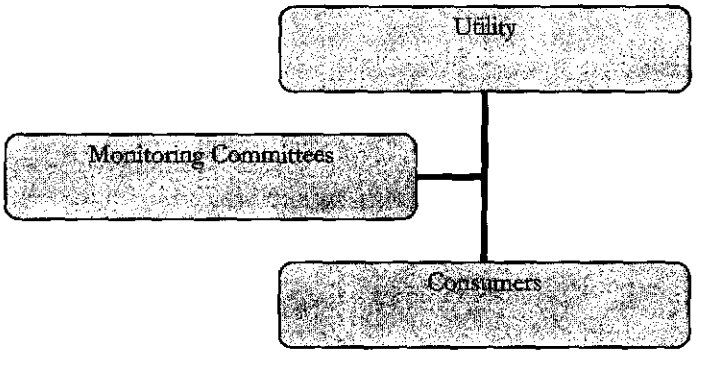
The workshop participants identified as the main problem with this model is that it adds yet another layer of costs, as the support institutions must be sustained. The support institutions may have the same problems with legal recognition and status that community groups have. The support institutions may also duplicate functions of other organizational entities and as such need to have their roles clearly defined.

Variation 4: NGO – Supported Utilities



In some cases, non-governmental organizations (NGOs) involvement in water service delivery has gone to the point of NGOs creating utilities themselves. The NGO supported utility would implement schemes for supplies of water (e.g. boreholes, river intakes, treatment works, water towers) and establish a network of vendors to on-sell water on behalf of the utility at waterpoints on a commission basis. As with previous model the major weakness of this variation is again cost. Not all NGOs have the magnitude of funding to establish a water system from the ground up.

Variation 5: Customer-Monitored Utilities



The workshop participants recognized that adding layers of control between the utility and consumer may solve some problems but also added other problems. The final variation of the ideal model was to provide monitoring committees that would not be directly involved in the delivery of services but serve as a "watchdog" for the utility.

Through all these model variations, the workshop participants recognized that corruption could become a major problem adding to unreliable and expensive service and made recommendations for utilities to implement conttols against corruption.

While these models were focused on providing water services, they could also apply to wastewater services.

3.3 Review of Actual Management Structures in Place

3.3.1 National Water and Sewerage Corporation (NWSC), Uganda

The National Water and Sewerage Corporation (NWSC) was formed in 1972 as a utility parastatal 100% owned by the Government of Uganda following recommendations by the World Health Organization. The Corporation provides water and sewer services to 22 towns throughout Uganda, with a total population of approximately 2.4 million, including about three quarters of all large urban centers. NWSC has been referenced as a model organization by the UN-HABITAT and other organizations.

NWSC has a basic centralized organizational structure consisting of a Managing Director, a Board of Directors (that includes the Managing Director), and five divisions each headed by a Chief Manager. The five divisions represent functional areas and are: Commercial and Customer Service, Engineering Services, Finance and Accounts, Internal Audit, and, Management Services. Since its formation in 1972 NWSC has gone through various changes. It originally provided services to three communities and over the years additional communities were added to NWSC's service area. NWSC "legislative framework was strengthened by the NWSC Statute, Statute No. 7 of 1995. NWSC was given more autonomy to collect revenues sufficient to cover all costs including debt, depreciation and a return on investment.

NWSC managed the water delivery and wastewater collection of the fifteen service areas through area managers and heads of support services departments. Support services departments consisted of maintenance, procurement and stores. Other support services were provided by NWSC Headquarters as well as centralized oversight of the fifteen service areas.

Area Managers for fourteen of NWSC's service areas were selected through internal competition, in which NWSC staff bid a fee for managing services in each service area exclusive of the services provided by NWSC Headquarters. An Internally Delegated Area Management Contract was awarded to the lowest bidder for each area.

The largest service area under NWSC is Kampala and accounts for approximately 70% of the water produced by NWSC. Because of the size of this service area, NWSC engaged the international water operator, Ondeo Services to manage the Kampala service area from 2000 to 2004. With the management contract due to expire in June 2004 and NWSC having experience with internally selected area managers for the other fourteen areas, NWSC management decided to test its area manager concept for Kampala. By July 2004 Internally Delegated Area Management Contracts were in place for all fifteen of the present service areas.

A recent case study summed up NWSC management approach for its service areas: "The opportunity to earn bonus pay and the increased autonomy that enabled managers to adequately control resources have been the most important factors in NWSC's turnaround."[2]

3.3.2 Massachusetts Water Resources Authority (MWRA), United States

The Massachusetts Water Resources Authority (MWRA) in the Commonwealth of Massachusetts, United States of America was established in 1985 by the Massachusetts Water Resources Authority Act, Chapter 372 by the state legislative body to provide better water and wastewater services to approximately two and a half million residents living in 60 communities in the eastern part of Massachusetts. The reasons for creating the MWRA were similar to the reason why the Lake Victoria South Water Service Board was created; that is to provide better and more efficient delivery of potable water and the removal of wastewater for people within its service area. In particular, the establishment of the MWRA was intended to achieve full cost recovery for the services provided. In October of 2006, representatives of LVSWSB made an official visit to the MWRA which was sponsored by the U.S. Trade and Development Agency.

Prior to the creation of the MWRA in 1984, the water and wastewater services were provided by a state agency called the Metropolitan District Commission (MDC). The MDC provided regional services to the eastern metropolitan area of Massachusetts. These services were the delivery of water and the collection of wastewater from the communities in the region of service, parks and parkways, and regional police services. These services were funded through annual appropriations by the state legislature. The executive head of the MDC reported to the Governor of the Commonwealth through a Secretary of Environmental Affairs. Annual appropriations for the MDC had to compete with other needs of the state and as a result the MDC did not receive sufficient funds each year to maintain its regional services, especially in the delivery of water and the collection of wastewater from the communities it served.

With the creation of MWRA, an agency was put in place to address the issues of federal and state regulatoty agencies and governmental institutions to cope with the need for environmentally sound sewage disposal for Eastern Massachusetts. Despite numerous studies and a number of attempts by the then-existing governmental agencies to provide adequate services, by the late 1970s Boston Harbor was recognized as one of the most polluted harbors in the nation. By the early 1980s, the Commonwealth of Massachusetts was a defendant in both state and federal court in cases brought by the City of Quincy, the Conservation Law Foundation and the United States Environmental Protection Agency (EPA). In response to these lawsuits, the Governot of Massachusetts created a panel to study the problem and make recommendations for a solution to the Governor. While the panel's primary charge was to address the wastewater issues, it became quickly apparent that similar issues of inadequate funding on the water side existed. The recommendation by this panel was to create a separate authority that had independent funding authority by charging the user for its services and the ability to sell bonds for capital improvements.

The MWRA is governed by an eleven person Board of Directors with an Executive Director, selected by the Board of Directors, as the day-to-day executive head of the agency. The Board of Directors was established by MWRA's enabling legislation and members are appointed for three year terms by various interests. Five members of the Board of Directors are appointed by the Governor. The Governor appoints a representative from each of the two watersheds serving the water system, a representative from the City of Quincy and the Town of Winthrop which host the wastewater treatment facilities, and the chairperson who is the Secretary of Environmental Affairs appointed by the Governor. Three members are appointed by the Mayor of the City of Boston which is the largest user of water and wastewater services. The remaining three members are elected by the MWRA Advisory Board which was primarily made up of the elected heads of the communities served by the MWRA. The MWRA provides services through various departments consisting of operations, engineering, procurement, legal, and administrative.

The MWRA is a success story for how effective institutional arrangements can result in full cost recovery, drastically improved service provision, and environmental. Although initial tariff increases were protested by in the service area, the customers can now see the benefit of the program which is the creation of a self-sufficient and sustainable utility that provides high quality services and protects the environment.

3.4 Comparison of LVSWSB to Theoretical and Actual Structures in Place

Neither of the two example entitles reviewed above nor LVSWSB, due to the size of their service areas, fits the basic ideal model of the utility having a direct contractual relationship with the consumer. Each does fit some variation of the basic ideal model, however. In a basic sense, Variation 1 fits the needs of these three agencies. The utility (MWRA or NWSC or LVSWSB) provides its services through a third party to the consumer. In the case of the MWRA, bulk services are provided to the member communities and the communities in turn bave their own infrastructure and provide the services to the consumer. In the case of NWSC, services are provided directly through responsible area managers of the 15 areas within their jurisdiction. Each area manager basically operates their area as an independent profit center. NWSC is as

close to the ideal model with the utility (NWSC) directly serving the consumer through its area managers. In the case of LVSWSB, they provide their services through Water Service Providers (WSP) to the consumer. The WSPs have contractual obligations with LVSWSB as to what their responsibilities are and how they are required to provide the services to the consumer.

The National Water and Sewage Corporation are governed by a board of directors that includes the Managing Director of the agency. Its funding comes from income derived from charging the consumer for its services and other governmental sources.

The Massachusetts Water Resources Authority is governed by a board of directors that does not include the Executive Director of the agency. Its funding comes primarily from income derived from charging the communities it services for its services and some funding that may be appropriated by the state legislature.

Lake Victoria South Water Service Board is governed by a Board of Directors that includes the executive head of the agency with dedicated funding from income provided from the sale of services and from various governmental sources and other donors.

The two examples, the National Water and Sewerage Corporation, Uganda and the Massachusetts Water Resources Authority, United States, were entities created to provide better water and wastewater services to their service area than was provided by a previous entity. In both of these cases, the primary recognition is that the entity must have control over its own financial destiny as is the case with Lake Victoria South Water Service Board.

3.5 Lake Victoria South Water Services Board Recommendations

The primary recommendation for LVSWSB is to maintain and improve on its financial autonomy. As the water and wastewater services improve and, on the water side, unaccounted for water is reduced, LVSWSB will begin to realize an increasing revenue stream from the services it provides reducing its reliance on government or other financial donors. The two examples given show that in both cases the governing bodies recognized that for improved services, fiscal autonomy was required. In the case of the Massachusetts Water Resources Authority, this was accomplished with the creation of the Authority in 1984. In the case of the National Water and Sewerage Corporation, Uganda, this was done by strengthening an existing agency's fiscal autonomy by Statute No. 7 in 1995.

The organizational structure of LVSWSB is close to Variation 1 of The Ideal model with LVSWSB providing its services through Water Service Providers for each of the regions. This is similar to National Water and Sewerage Corporation originally providing its services to its largest area, Kampala, through a contracted water operator, Ondeo Services. In the short term, LVSWSB should continue to improve its services through its Water Service Providers as outlined in LVSWSB's "Strategic Plan" for 2005-2010. As LVSWSB becomes a more mature organization, as NWSC did with Kampala and its other fourteen service areas, LVSWSB should look long term to become more like The Ideal model with services being provided directly to consumers by the Water Service Providers and continue encouraging each Water Service Provider to treat each service area as an independent profit center.

Also, as LVSWSB becomes a more mature organization, certain services should be centralized for economies of scale, such as planning and engineering for new assets, the acquisition and management of assets, human resources, financial, and other similar services. However, obviously, the operation of the water delivery and wastewater collection systems, maintenance and stores needs to remain at the local level.

The organizational structure that Lake Victoria South Water Services Board has in place should serve them well in meeting short term goals. As the organization matures, the organization should be adjusted. The

organizational structure is not the most important aspect of an agency. But it is important for an organization to recognize that change is needed as it matures and to makes those changes (and manage the changes effectively) as the service area and the service requirements transform. As these changes occur, it is important for the organization to recognize remaining as close to The Ideal model as possible.

Additional town-specific recommendations regarding management and operation and maintenance ate included in each town section.

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3. *Lake Victoria South Water Services Board Draft Strategic Plan 2005-2010.*
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10. *Case Studies of Bankable Water and Sewerage Utilities Volume II: Compendium of Case Studies.* August 10, 2005 Prepared by ARD, Inc. for review by the U.S. Agency for International Development.

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[1] "Local Management Models for Water Supply and Sanitation for the Urban Poor", Draft Workshop Report, December 2004, Building Partnerships for Development, www.bpdws.org , prepared by Clarissa Brocklehurst.
[2] "Case Studies of Bankable Water and Sewerage Utilities Volume II: Compendium of Case Studies" August 10, 2005 Prepared by ARD, Inc. for review by the U.S. Agency for International Development

4. LAKE VICTORIA SOUTH WATER SERVICES BOARD **4-1**

4.1 Overview **4-1**

4.2 Needs Evaluation **4-1**

4.3 Recommendations **4-4**
4.3.1 Toolkits and Standardization / Certification Programs 4-4
4.3.2 Regionalization 4-7

4. LAKE VICTORIA SOUTH WATER SERVICES BOARD

4.1 Overview

During the course of the study, it became apparent that in order to cost-effectively establish viable water and wastewater utilities in each of the three study communities, additional suppott from the Lake Victoria South Water Services Board (LVSWSB) would be particularly useful in carrying out certain recommended tasks. Without a framework and guidelines available, most communities would be starting "from scratch" as they embark upon crucial recommended local tasks such as establishing a watershed protection program, establishing an asset management program, commercializing water kiosks and public toilets, and a host of others. Regionalization efforts are also recommended to take advantage of economies of scale offered by the regional WSB-WSP arrangement, but coordination at the Board level will be required in order to bring about the potential increased efficiency and cost savings that such efforts are expected to produce.

The activities recommended to be undertaken by LVSWSB in support of this effort may be categorized into two principal groups. The first group includes the development of **toolkits and standardization programs** to assist WSPs as they work to improve service provision. By developing these toolkits and standardization programs and assisting WSPs in their use, LVSWSB will be encouraging WSPs to put in place the systems that are vital for the establishment of sustainable utilities. The toolkits and standardization programs will also simplify LVSWSB's task of monitoring and promoting progress of the WSPs. The second category includes **regionalization** of some services as appropriate to take advantage of economies of scale to reduce costs and improve efficiency. The toolkits, standardization programs, and regionalization efforts included in this Section are referenced in each of the following Town Sections 5, 6, and 7, assuming tbey will have been completed or underway as the towns begin analogous efforts at the local level.

4.2 Needs Evaluation

A water and wastewater **system inventory** and asset management plan should be created for each LVSWSB town. Accurate inventories ate required before meaningful planning can be accomplished. A standardized format will make the process easiet for the towns to implement and enable LVSWSB to efficiently review plans from all towns. The system inventories will be important for almost all future work including Operation & Maintenance Plans, infrastructure planning, mapping, tariffs analysis, staffing planning, accounting and other activities.

Creating a system inventory is the first step towards creating an **asset management plan**. Once the inventory is created, assets should be valued and prioritized into an asset management plan for future rehabilitation, replacement, or upgrade. Fully defining existing assets and creating a documented, prioritized plan for upgrades and maintenance will also enhance the utilities' attractiveness to potential grant and loan entities. The asset management plan should be a "living" document that is followed consistently and reviewed and updated at least annually.

Most LVSWSB towns are in need of setting system-specific **water and wastewater service tariffs** to achieve cost recovery and build reserve funds. Currently, tariffs in many towns are set at levels that do not cover the cost of normal operation and maintenance. As a result, service is often poor, customers are dissatisfied, systems operate at a financial loss, and service quality and physical assets continue to degrade. However, in

many towns the willingness and ability to pay for services are relatively high and people ate generally willing to pay more for reliable, quality services. By not implementing cost recovery tariffs and re-investing into the systems, many towns are in a cycle that leads to declining service quality instead of improving service quality. Tariff rate increases are expected to be required in most communities and should be based on real data and reasonable projections, not arbitrary values. By utilizing a transpatent methodology for justifying rate increases, obtaining "buy-in" from customers will be much more likely. Special attention will need to be paid to tariff levels that apply to the poorest residents, namely tariffs paid at kiosks, public toilets, and individual connections with low water use and wastewater flows.

A **structured program for training, testing, and certification of operators** should be created and administered at the LVSWSB level. Requiring certification of water and wastewater facilities operators and continuing education will develop competency of local staff, ensure operator safety, and enable LVSWSB to reap maximum benefits from its infrastructure investments. Local managers should also be trained in various topics including computer use, billing and collections management, handling illegal connections, public relations, on-site wastewater management, and kiosk and public toilet management.

In order to maximize equipment lifespan and operating efficiency, all WSP should develop documented **preventative maintenance plans**, follow them closely, and be vigilant about recording maintenance histories for equipment.

Illegal water service connections are a problem in many LVSWSB communities. Kisii reported that their staff received threats from residents during attempts to remedy illegal connections. A structured approach and toolkit should be developed to assist communities in handling this issue and changing the mindset of residents who still feel that having an illegal connection is acceptable.

Some towns have reported difficulties in **collecting arrears and transitioning to billing based on metering data**. LVSWSB should provide guidance to towns regarding this process and offer helpful suggestions for a smooth transition. In addition, towns require assistance on transitioning to new technology including computetized billing systems and consideration of using remote reading water meters. Appendix 4-2 contains a sample informational brochure on remote water meters.

Watershed protection is ctucial to improving and maintaining water quality for the long term. Many water sources in the LVSWSB area are facing increasing pressure and contamination threats from loss of riparian vegetation, expanding agriculture, poor stormwater drainage and solid waste disposal practices, and various forms of development. Communities require assistance to address these issues and protect water sources.

Many **on-site wastewater systems** (latrines, cesspools, soak pits, septic systems, tight tanks, etc..) are expected to be failing and represent an acute public health hazard and a public nuisance. Failing on-site systems contaminate local public and private groundwater and surface water supplies. LVSWSB should develop standard methodologies for creating an on-site system **inventory and tracking system** so that this important infrastructure serves as a public health benefit, not a liability. On-site systems can adequately protect public health and are often more cost effective than public sewers. However, these systems must be appropriately designed and maintained in order to protect public health.

Water kiosks and public toilets will serve as an important component in many towns' water and wastewater systems. **Water vendors** currently attempt to meet the water needs of unserved neighbothoods and are relied upon where infrastructure is unavailable. In order to function effectively, these systems need to be **properly designed, regulated, managed, and maintained**. LVSWSB should develop a toolkit to assist Towns with developing, regulating, managing, and maintaining this important infrastructute. Where piped connections are unavailable, efforts should be made to provide kiosk water within 400 meters of residences.

An informed customer base is vital in effectively protecting public health, garnering support for LVSWSB projects, and ensuring successful project implementation. LVSWSB should develop and distribute **public education tools** for use by towns and WSP.

Establishing a positive relationship with customers and cooperative relationships among WSP, municipal departments and citizens groups is crucial to the successful implementation of water and wastewater projects. LVSWSB and local staff should be dedicated to fostering effective **public relations**. This includes establishing transparency regarding proposed investments, rate increases, supply intetruptions, permit violations, etc. Customers and municipal departments should be involved in the planning and implementation process so that they become vested and committed to success. In fact, complete success is only possible through collaborative efforts between LVSWSB, WSP, and the customers. When citizens are assured their money is being spent wisely and can see tangible positive results, it will create trust and lead to successful project implementation.

LVSWSB towns currently handle **procurement** of chemicals and other needs individually. By **bidding for services at the LVSWSB level**, towns may be able to secure lower rates for frequently used commodities by establishing exclusive agreements at the LVSWSB level and contracting with a limited number of suppliers.

The **LVSWSB garage** facility behind LVSWSB offices may be suitable for a number of centralized activities including equipment repair and testing, storage of bulk supplies, spare parts, training, and other activities. This valuable resource should be upgraded and utilized effectively.

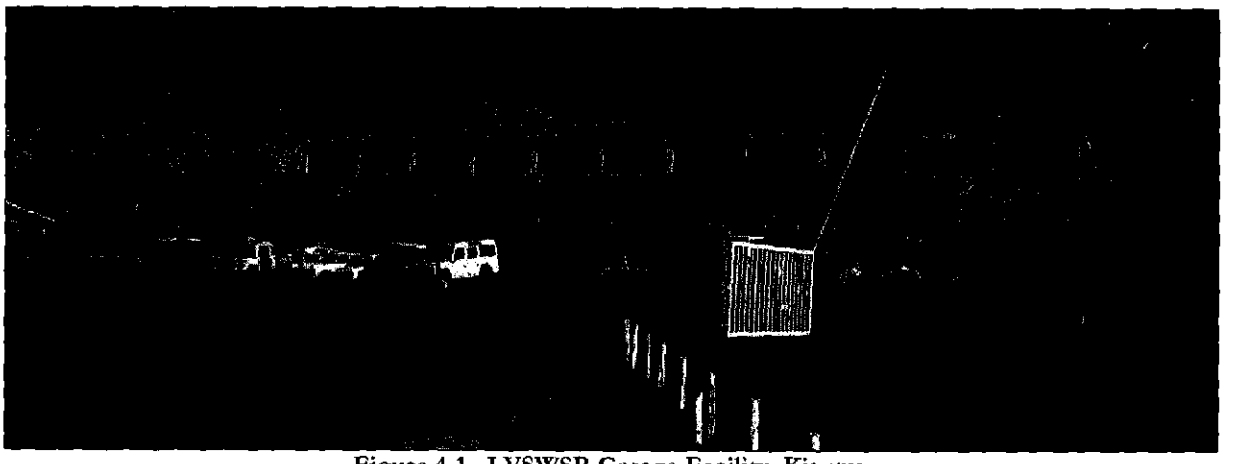


Figure 4-1. LVSWSB Garage Facility, Kisumu

The **laboratory at LVSWSB Headquarters** is a valuable resource and should be effectively utilized for analyses requiting expensive equipment and for regular quality assurance and quality control (QA/QC) of town sampling. LVSWSB should ensure that proper sampling, testing, QA/QC, and recordkeeping techniques are being employed in local labs by establishing a **laboratory inspection and certification program.**

Unaccounted-for-water (UfW) is high in most LVSWSB communities. Investments in leak detection and repair will increase revenues, improve system pressures and the number of customers served, and delay the need for expensive investments in source augmentation and pumping and treatment capacity. However, investing in **leak detection equipment** and specialized training may not be cost-effective for individual communities that only require the service annually or less frequently. Effective use of leak detection equipment requires experience and is best done by a specialist. LVSWSB should develop leak detection capacity and charge WSPs a fee for the service.

Insufficient **septage exhausters and sewer / drain cleaning equipment** exist in LVSWSB area. Many towns do not own such equipment and either borrow or rent from other towns or do not perform these services. Some towns may not have sufficient budget or need to own their own equipment. Small equipment is also required for enabling exhausting of sludge from informal settlements and other systems with difficult access. A **water bowser** is required at the LVSWSB level for dispatching to towns during emergencies.

4.3 Recommendations

The LVSWSB recommendations are categorized into 'Toolkits and Standardiztaion Programs' and 'Regionalization' as listed below and subsequently described in detail. Some task categories overlap. The cost of each of the LVSWSB recommended activities is evaluated in Appendix 4-1 and is estimated at approximately $700,000.

Toolkits and Standardization / Certification Programs

Toolkits
- System Inventory and Asset Management Planning
- Tariff Analysis
- Preventative Maintenance
- Illegal Connections
- Watershed (Catchment) Protection
- On-Site Wastewater Management
- Water Kiosks, Water Vendors, and Public Toilet Management
- Public Education
- Local Revenue (arrears collection, transitioning to metering systems)

Standardization / Certification Programs
- Laboratory Certification
- Operator Training and Certification
- Management Training

Regionalization
- Community Public Relations and Communications Program
- Bulk Procurement Evaluation
- Upgrade LVSWSB Garage for Regional Activities
- LVSWSB Headquarters Centralized Laboratory Testing and QA/QC
- Leak Detection and Repair Equipment and Operators
- Septage Exhauster, Sewer and Drain Cleaning Equipment
- Water Bowser

4.3.1 Toolkits and Standardization / Certification Programs

LVSWSB should develop a **standardized methodology for creating system inventories and asset management plans**. Inventories should include all major equipment, piping, tanks, and treatment systems. Available data such as age, expected useful life, condition, service history, and nameplate data should be included. Financial value of assets and list of depreciated assets should be included. This system may be created using available standard forms, or by purchasing and customizing available software (recommended) to create inventories and subsequently convert to an asset management plan by prioritizing assets and estimating future needs and costs. Priority should be given to critical infrastructure at or past the end of its useful life. The United States Environmental Protection Agency (USEPA) Total Electronic Asset Management System (TEAMS) may be useful as a guide. Local hydraulic modeling may be required to

prioritize investments. The priority list and cost estimates will enable Towns to determine the magnitude of reserve funds required for future projects. After Towns prepare inventories and asset management plans, LVSWSB should follow up with towns to ensure they are implementing the plans and that they review and revise the plans at least annually. The system inventories should also be used to develop a separate **spare parts inventory** and to determine appropriate stocks of spare parts. LVSWSB should assist WSPs to effectively utilize the toolkit to meet LVSWSB service goals.

Develop a **toolkit to assist towns in the process of establishing new tariff structures.** The Water Services Regulatory Board is responsible for developing guidelines for fixing tariffs and reviewing tariff increase requests. However, LVSWSB should assist towns in assembling data required to request rate increases. Using available guidelines including the November 2006 Draft Tariff Guidelines created by WSRB, LVSWSB should clearly define a rational, stepwise process for towns to follow to assemble the information required for defining required tariffs. This will include clearly defining current and expected future costs of service provision (including expected future capital expenditures). The inventory and asset management plan will be very useful in defining current and future costs. When evaluating tariffs, consideration should be given to lowering up-front costs (i.e. connection fees) and implementing incentive programs to encourage more residents to connect to existing water and wastewater systems. Special attention will need to be paid to setting kiosk, public toilet, and low flow water and sewer rates to ensure the poorest residents have access to services.

Develop a structured **program for training, testing, and certification of operators and training of managers.** Programs should meet or exceed operator training requirements set by the Kenyan national government. LVSWSB should train in-house staff or hire independent consultants to serve as operator and manager trainers. Trainers should function as "circuit-riders" and visit various towns for periodic training sessions to ensure participation, tailor training to local facilities/equipment, and to minimize travel time for operators. Some training may need to be performed at LVSWSB headquarters in Kisumu when required. Training should also include "soft" subjects such as maintaining professional appearance, customer relations, etc.

Figure 4-2. Project Meeting at LVSWSB Headquarters Conference Room Facility in Kisumu

Develop a **model preventative maintenance and maintenance tracking system**, including all inventory components. The system may incorporate traditional maintenance catd techniques, "out-of-the box" software, or customized software. Software packages are now readily available to schedule and track all required preventative maintenance and are recommended. LVSWSB should assist WSPs to effectively utilize the systems to meet LVSWSB service goals.

Develop a **toolkit for handling illegal connections, including a model by-law with fines and penalties.** LVSWSB should include media materials for dissemination to educate users about the benefits of a legal connection and problems associated with illegal connections. Problems include potential cross-

contamination, low pressure, and increasing financial burden on those who have legal connections (i.e. if your neighbor has an illegal connection, your tariffs will rise to cover the cost of service to illegal connections). Include suggested incentive programs for encouraging illegal connections to become metered connections (i.e. amnesty from fines if a proper metered connection is installed prior to a certain date). Presently, many towns require consumers to purchase their own water meters, which leads to problems associated with meter theft and delayed connection due to costs. LVSWSB should purchase, install (via WSPs), and own the meters. The cost of meters is a long-term investment with a relatively short payback period, especially in towns with a large number of unmetered, flat rate connections. LVSWSB should assist WSPs to effectively utilize the toolkit to meet LVSWSB service goals.

LVSWSB should develop a toolkit with suggested programs for **transitioning to a fully metered system and collecting arrears**. This information should describe a stepwise process for making a smooth transition and sensitizing customers to new systems and the importance of accurate billing and payments. LVSWSB should also gather and evaluate information on available computerized billing systems and metering technology (including remote reading water meters), suggest appropriate technologies, and offer training to town staff.

Develop a **watershed protection toolkit** to assist communities in protecting water sources. Elements should include a model watershed protection by-law and a model local watershed protection plan. The Board and member towns may need to work with local Catchment Advisory Committees (CAC) and WRMA to develop and implement watershed protection plans including designation of protected areas and restricting certain activities within sensitive watersheds. USEPA's 'Draft Handbook for Developing Watershed Plans to Restore and Protect Our Waters' and similar documents may serve as a useful guide. The toolkit should cover farming best management ptactices (BMPs) including methods to reduce erosion and reduce fertilizer and chemical runoff, stormwater management and drainage practices, regulations for potentially hazardous activities including car repair shops and laundry facilities, and solid waste management practices. LVSWSB should assist WSPs to effectively utilize the toolkit to meet LVSWSB service goals.

Develop an **on-site wastewater management toolkit** including system design standards and methodology for creating an on-site system inventory, tracking system, and program for mandatory periodic inspections and pump-outs. The toolkit should include model by-laws and suggestions for data collection techniques, including sample surveys. The system should be integrated with electronic mapping systems to the extent feasible including a means of accepting customer complaints and identifying problem areas. This effort is likely to be daunting in towns which have thousands or tens of thousands of on-site systems. Programs should focus on areas with known on-site wastewater management problems within the public water supply watershed. "Off-the-shelf" software programs may be used, but should be customized for local conditions. USEPA's 'Management Handbook for Septic/Decentralized Systems' (2005) and USEPA's free software called 'The Wastewater Information System Tool' (TWIST) may serve as a useful guides. The toolkit should include provisions for management of private septage haulers including a manifest system, setting dumping fees, and mandating discharge only at approved facilities. LVSWSB should assist WSPs to effectively utilize the toolkit to meet LVSWSB service goals.

Develop **guidance standards for the design, regulation, management, and maintenance of water kiosks and public toilets**. Guidance should include: design and maintenance standards for kiosks and public toilets including metering and piping, security, cleanliness, lighting, and signage requirements (logos and fonts, prices, hours of operation, contact information, etc.); training and certification standards for private kiosk and toilet operators; standard lease agreements for facilities; regulations regarding fixing prices and billing standards; and inspection procedures including water quality sampling. Guidance should also be provided for implementing a **vendor training, certification, and water sampling program** to ensure vendors are distributing safe water. LVSWSB should assist WSPs to effectively utilize the toolkit to meet LVSWSB service goals.

LVSWSB should develop a quiver of resources for **public education and public relations**. LVSWSB should develop and distribute pamphlets, "bill stuffers", and newsletters to towns for local dissemination. Topics should include: water and energy conservation and associated financial savings; health awareness including dangers of obtaining water from potentially contaminated sources including water vendors; proper use and maintenance of on-site sanitation systems including hand-washing; source water protection; etc. LVSWSB should develop a template for brief annual WSP reports (newsletter-style) to customers including information about their water sources, distribution systems, and wastewater collection and treatment systems. Sample U.S. 'Consumer Confidence Reports' are provided as an example in Appendix 4-3. Develop and distribute education program packages for schools or use readily available materials such as those available through USEPA or Government of Kenya. Consider creating a mascot character and including educational games and activities for children in distributed materials. LVSWSB should assist WSPs to effectively utilize the toolkit to meet LVSWSB service goals.

4.3.2 Regionalization

Consider designating an **LVSWSB staff person for public relations.**[1] Develop a plan for establishing 'Community Stakeholders Collaboratives' in each town (similar to programs developed by UN-Habitat in Kisii) including representatives from interested community groups and municipal departments. Cooperation with local town departments responsible for planning, zoning, by-laws enforcement, and police and law enforcement will be important for effective implementation of water and wastewater projects. LVSWSB should encourage towns to designate local public relations liaisons to foster communications between departments and citizens groups and garner collective support for projects. Encourage WSPs to hold public meetings to discuss water and sanitation related issues while LVSWSB continues to assist WSPs in administering such meetings. Community stakeholder meetings and information dissemination should take place frequently to inform residents of upcoming and ongoing water and wastewater projects and gather customer input. Continue to develop and distribute LVSWSB newsletter to customers. Consider using advertising to defray costs.

Evaluate feasibility of bidding for procurement of bulk needs at the LVSWSB level. Such needs include chemicals, water meters, water savings devices, etc. Towns would be required to sign on to exclusive agreements and obtain goods from a limited number of suppliers. Storing large amounts of chemicals or other goods at LVSWSB headquarters is unlikely to be necessary as suppliers would deliver directly to Towns. Consider bulk purchase of water saving devices including sink aerators and low flow showerheads for distribution to towns.

A more detailed evaluation of the **feasibility of upgrading the LVSWSB garage** and converting to a useful facility for centralized activities should be undertaken. Potential activities include equipment repair and testing, storage of bulk supplies and spare parts, training, and other activities. Additional security and landscaping will be required.

[1] The LVSWSB Business Plan 2006-2011 notes that one of the functions of the Financial and Administration Department includes some of these types of activities. There is a position titled 'Corporate Communication/Public Relations Officer', but the position is currently not filled.

Figure 4-3. LVSWSB Garage Facility Interior Including Office, Storage Areas, and Vehicle Repair Bays

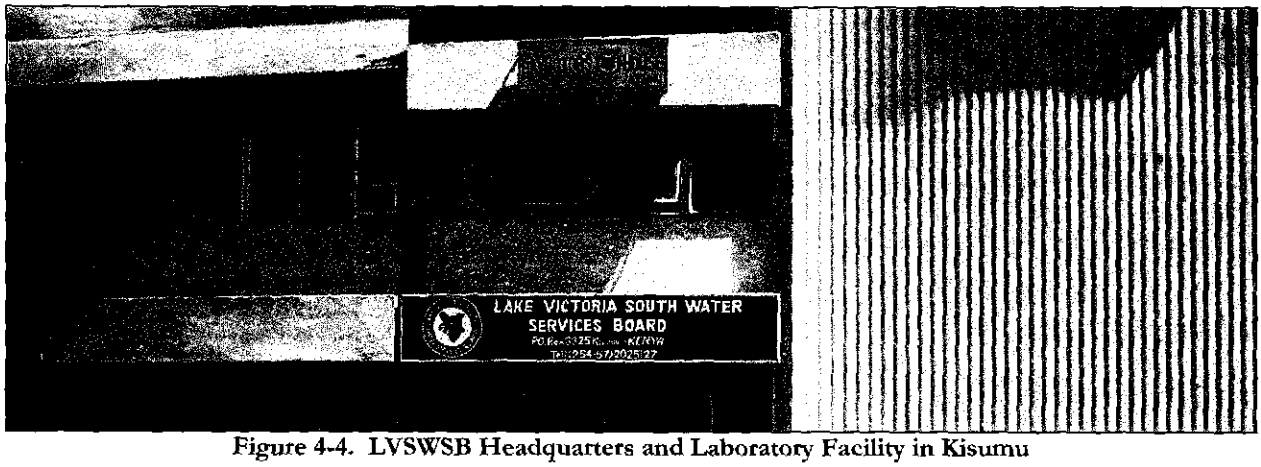


Figure 4-4. LVSWSB Headquarters and Laboratory Facility in Kisumu

Develop **structured program for LVSWSB laboratory** to be used as regular QA/QC check on Towns' sampling programs to ensure compliance with permit requirements. Define which types of sampling should be done locally and which should be done at LVSWSB based on cost effectiveness to avoid unnecessary equipment and labor cost duplication. Patameters that must be sampled daily or weekly should be done locally, while less frequent sampling may be done more cost effectively at LVSWSB. Final determinations will need to be based on facility-specific permit requirements. Develop a **laboratory inspection and certification program** to ensure town laboratories are utilizing ptoper techniques.

Evaluate available options and **purchase leak detection equipment at the LVSWSB level and train LVSWSB staff in its operation.** Develop rental fee rates for WSPs as part of a leak detection "circuit rider" program. Educate WSPs about the availability of leak detection services and encourage utilization of the service to meet LVSWSB UfW goals. This activity could also be undertaken as a private entrepreneurship opportunity or LVSWSB could lease the equipment to a private operator.

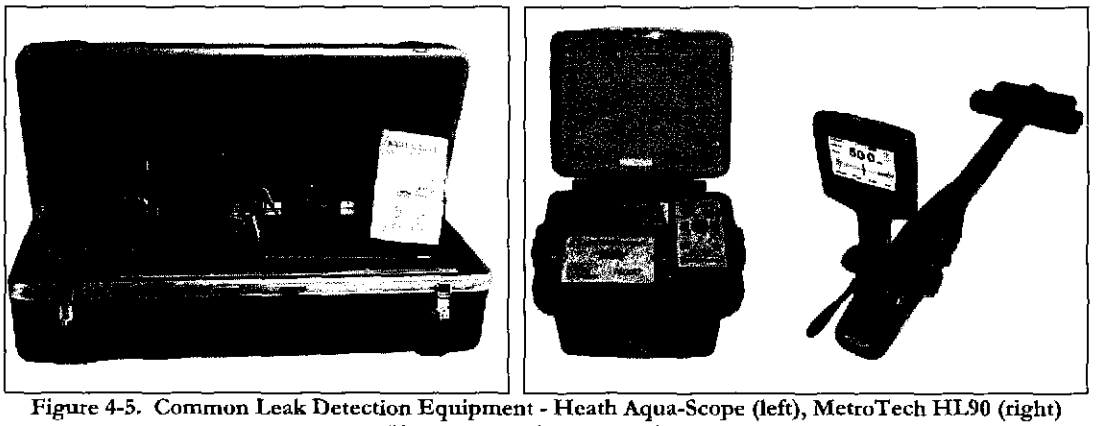


Figure 4-5. Common Leak Detection Equipment - Heath Aqua-Scope (left), MetroTech HL90 (right)
Photos www.metrotech.com, www.heathus.com

Evaluate available options and **purchase septage exhauster, sewer / drain cleaning equipment, and Vacutug machines** at LVSWSB level to be dispatched to towns as required. Develop a fee structure for this service and ensure that towns require pumping of latrines and septic systems as included in local on-site system management plans. This activity could also be undertaken as a private entrepreneurship opportunity or LVSWSB could lease the equipment to a private operator. Purchase a **water bowser** for use during water emergencies.[2]

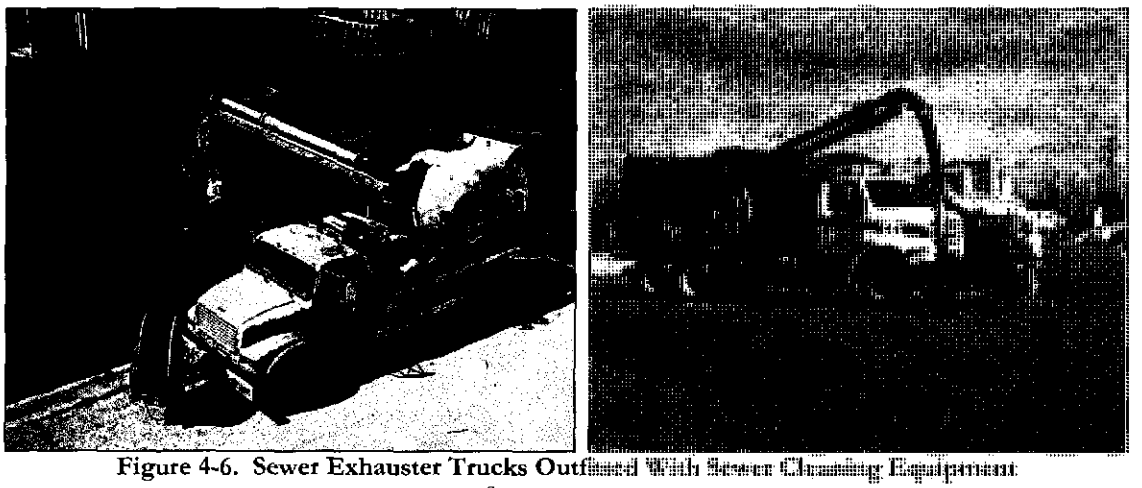


Figure 4-6. Sewer Exhauster Trucks Outfitted With Sewer Cleaning Equipment
Source: www.vactor.com

[2] During August 2006 visit a new bowser was noted in the LVSWB parking lot. A new bowser may no longer be needed.

Figure 4-7. "Vacutug" Exhauster for Pit Latrines and On-Site Systems with Difficult Access
International Water and Sanitation Centre (IRC) Photos from Kibera, Nairobi

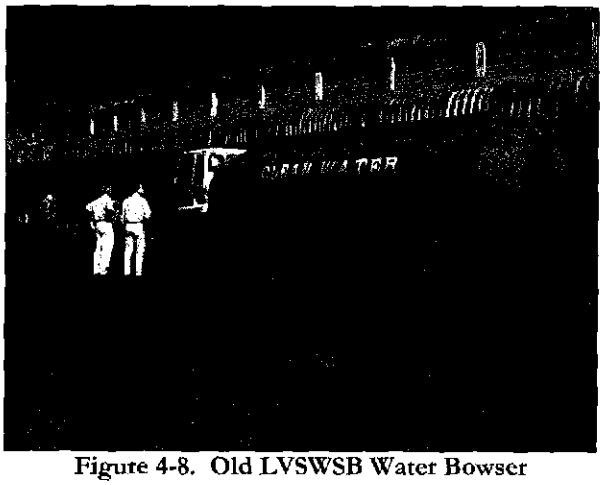


Figure 4-8. Old LVSWSB Water Bowser

5. KERICHO **5-1**

5.1 General Information and Projections **5-1**
5.1.1 Location 5-1
5.1.1 Topography, Geology, and Climate 5-1
5.1.2 Land Use and Roadway Infrastructure 5-1
5.1.3 Power Supplies 5-3
5.1.4 Population 5-5
5.1.5 Water Demand and Service Goals 5-6
5.1.6 Wastewater Flow and Service Goals 5-8

5.2 Water **5-10**
5.2.1 Water System Overview 5-10
5.2.2 Water Sources and Intakes 5-11
5.2.2 (a) Water Sources and Intakes Description 5-11
5.2.2 (b) Water Sources and Intakes Needs 5-14
5.2.2 (c) Water Sources and Intakes Improvement Options 5-15
5.2.2 (d) Water Sources and Intakes Recommendations 5-17
5.2.3 Water Treatment 5-18
5.2.3 (a) Timbilil Water Treatment Works Description 5-18
5.2.3 (b) Timbilil Water Treatment Works Needs 5-20
5.2.3 (c) Timbilil Water Treatment Works Recommendations 5-21
5.2.3 (d) Kimugu Water Treatment Works Description 5-21
5.2.3 (e) Kimugu Water Treatment Works Needs 5-22
5.2.3 (f) Kimugu Water Treatment Works Recommendations 5-23
5.2.4 Water Distribution 5-23
5.2.4 (a) Water Distribution Description 5-23
5.2.4 (b) Water Distribution Needs 5-28
5.2.4 (c) Water Distribution Recommendations 5-30

5.3 Wastewater **5-30**
5.3.1 Wastewater Overview 5-30
5.3.2 Wastewater Collection 5-31
5.3.2 (a) Wastewater Collection Description 5-31
5.3.2 (b) Wastewater Collection Needs 5-36
5.3.2 (c) Wastewater Collection Recommendations 5-38
5.3.3 Wastewater Treatment, Disposal, and Residuals Management 5-38
5.3.3 (a) Wastewater Treatment, Disposal, and Residuals Management Description 5-38
5.3.3 (b) Wastewater Treatment, Disposal, and Residuals Management Needs 5-42
5.3.3 (c) Wastewater Treatment, Disposal, and Residuals Management Recommendations 5-43

5.4 Management and Operation and Maintenance (O&M) **5-44**
5.4.1 Management and O&M Description 5-44
5.4.2 Management and O&M Needs 5-51
5.4.3 Management and O&M Recommendations 5-54

5. KERICHO

5.1 General Information and Projections

5.1.1 Location

Kericho Town is located in Kenya's western highlands within the Rift Valley province on the national trunk road (B1) that connects Nakuru, Kisii and Kisumu. In 1998, the town boundary was expanded from 66 km^2 to its present area of 111 km^2. It should be noted that Kericho Town is officially classified a Municipality, but is commonly referred to in the region as Kericho Town or Kericho, as it is in this report. Kericho is the headquarters of Kericho District, which covers 2,111 km^2 and includes many small villages and some other Towns including Londiani and Kipkelion. Maps 5-1 and 5-2 show the greater Kericho and central Kericho, respectively.

5.1.1 Topography, Geology, and Climate

Topography

Kericho Town lies on the western slopes of the Mau Escarpment and is characterized by rolling hills. The landscape generally slopes from northeast to southwest, therefore streams and rivers generally flow in a southwesterly direction toward Lake Victoria. Kericho Town is located just west of the watershed divide separating the Lake Victoria drainage basin from the Rift Valley drainage basin. Therefore, streams in Kericho drain into the Sondu River system, which enters Lake Victoria in Winam Gulf near Kisumu. The area is part of the Kericho Plateau, which slopes from approximately 2,500 meters (8,202 feet) to 1,800 meters (5,905 feet) above sea level.[1] The Town itself lies between 2,200 and 1,900 meters above sea level.

Geology

Kericho District is in the Lake Victoria Basin and the geology is characterized by volcanic, igneous, and metamorphic complexes. Kericho Town is covered primarily by Tertiary volcanics including Kenya Phonolites and Trachytoid Phonolites. Kericho Phonolites (Losugota Type) also exist in some areas. Despite the hilly nature of Kericho District, soil erosion is generally not a problem in most areas because vegetation cover is prevalent.[2]

Climate

Kericho District has a sub-tropical highland climate with moderate temperature, low relative evaporation, and high rainfall. Average annual rainfall is approximately 1,800 mm.[3] Peak rainfall occurs during April, May, and August and the driest months are December through February.[4] Temperature variations in Kericho are small and the natural vegetation is characteristic of a cleared highland forest community. Clearing activities took place in the south and east of Kericho Town for tea growing, and in the north and west for small farms and cattle.

5.1.2 Land Use and Roadway Infrastructure

Prior to expansion of the town boundaries, the 66 km^2 municipality was made up of the square shaped old township boundary and central business district (10 km^2), tea estates (19 km^2), and rural areas (37 km^2). The expanded area includes 45 km^2 of mostly rural areas to the north and west of the previous town boundary along the E 222 roadway. These rural areas contain many small farms. A few small market centers exist to the northwest of the Dionsoyiet River.

Kericho is in the upper midland agro-ecological zone and is suitable for growing coffee, tea, sunflower, maize, cotton, and raising livestock[1]. Privately owned tea estates and small scale agriculture are the primary land uses and sources of income in the Kericho area. Dairy farming is also a source of income in Kericho Town.

It is expected that the tea industry will continue to dominate the Kericho economy and therefore tea estates will continue to dominate the landscape throughout the study period. Expansion of residential, commercial, and industrial development is limited by large swaths of privately owned tea estates. However, it is expected that such development will continue within the municipal boundaries and increase in density. Town staff indicated that one large commercial and residential development (Chelimo Residential Estate) was planned along on the south side of Kimugung River near the town center, although a timeline for construction was unknown.

Existing roadways are in relatively good condition in comparison to other towns in the region. The B1 paved road running from southwest to northeast through the Town center is in very good condition, as are most of the smaller roads in the town center. Roadways northwest of the Dionsoyiet River are less well maintained and many unpaved roadways exist in the area.

A landing strip is located near the town, although it is not served by commercial flights. Telecommunication systems adequately serve Kericho via both landlines and a mobile network.

Figure 5-1, Figure 5-2, and Figure 5-3 depict land use and roadway infrastructure in Kericho.

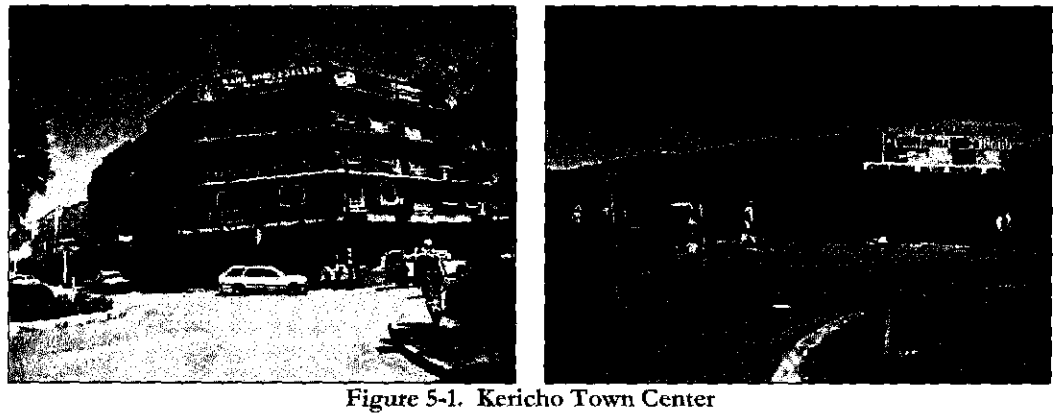


Figure 5-1. Kericho Town Center

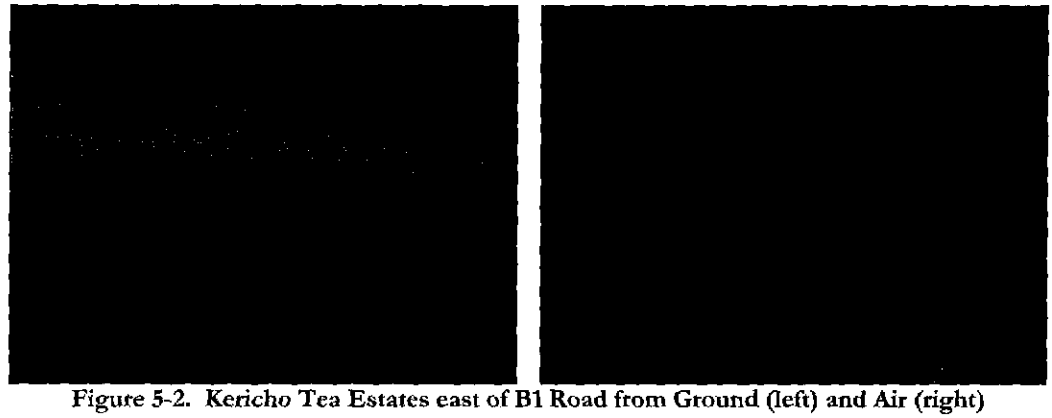


Figure 5-2. Kericho Tea Estates east of B1 Road from Ground (left) and Air (right)

Figure 5-3. Kapkugerwet Market Area (northeast Kericho along B1 road)

5.1.3 Power Supplies

Detailed information on the reliability of electrical power supplies in Kericho is unavailable, but anecdotal information indicates that reliability is better than other towns in the region. During the Project Team visits in January and April 2006, Kericho Water and Sanitation Company Ltd. (KEWASCO) staff indicated that blackouts occur on a weekly basis. The KEWASCO offices have a small generator which is used to provide backup power for lighting and office equipment.[5] In May 2006, KEWASCO noted that "The reliability of electrical power supplies is getting worse with blackouts occurring almost on daily basis for long hours at the town centre." KEWASCO provided data on blackouts occurring at Timbilil Water Treatment Works from 10 February through 30 April 2007. Blackouts occurred on 15 days and lasted from less than one hour to as long as 24 hours.

The water distribution and wastewater collection networks primarily utilize gravity, so a lack of power reliability is less problematic in Kericho compared with towns that rely on pumping systems. According to the KEWASCO Annual Report for 2004/2005, approximately 1% of its total operating expenditure is for electricity. Present electricity rates paid by KEWASCO to Kenya Power & Lighting Company are approximately 6.70 KShs/KW-hr.

The topography and resulting hydrology of Kericho are well suited for the development of hydropower supplies. However, as noted above, the need for additional power supplies for water and wastewater systems are currently low due to the gravity nature of the existing systems. A hydroturbine is currently used at the Timbilil Water Treatment Works to harness energy from incoming raw water to pump water to an elevated storage tank used for backwashing.

Hydropower has been successfully utilized at several tea estates to meet tea processing energy requirements. One such hydropower facility is located at the James Finlay Tea Estates (Tagabi Power Station, Map 5-1) and has been in operation since 1989 (Figure 5-4). The system consists of a run-of-river stream diversion to a penstock located approximately 34 meters above a hydroturbine facility, which discharges back to the same stream. The pipeline between the penstock and hydroturbine is 234 meters in length and flow during Project Team's visit in January 2006 was 1.9 m^3 per second. The James Finlay hydropower facility reportedly cost less than 100 million KShs to construct in 1989 (exact cost figures were unavailable). During the dry season, the cost of upkeep is reportedly 300,000 KShs/month. For three months out of the year, during the wet season, the facility has the capacity to sell excess electricity to the local grid. The payback period for this facility was 10 to 15 years, but the payback period for hydropower facilities used by other tea estates was reportedly as short as five years.

Some tea estates burn eucalyptus trees for heat required in the tea drying process. At least one tea factory (KETEPA) utilizes a small power generating station for some of its energy needs (Figure 5-5). Many residents in the region currently rely on wood and charcoal for domestic energy needs.

The Kericho District Development Plan (2002-2008) includes proposals for increasing renewable energy use through solar and wind power promotion programs. However, it is unclear if any projects have been implemented. In general, it is expected that while solar power may be cost effective for small demands such as backup power for offices, it is not yet cost effective for larger demands such as pumping. Drawbacks associated with wind power include variability resulting in the need for large, costly energy storage facilities. An analysis of wind power potential is beyond the scope of this study.

It is recommended that preference be given to gravity systems for future water and wastewater infrastructure improvements to avoid problems associated with power reliability and costs. Renewable energy sources may be appropriate for some systems and should be explored during more detailed design phase work.

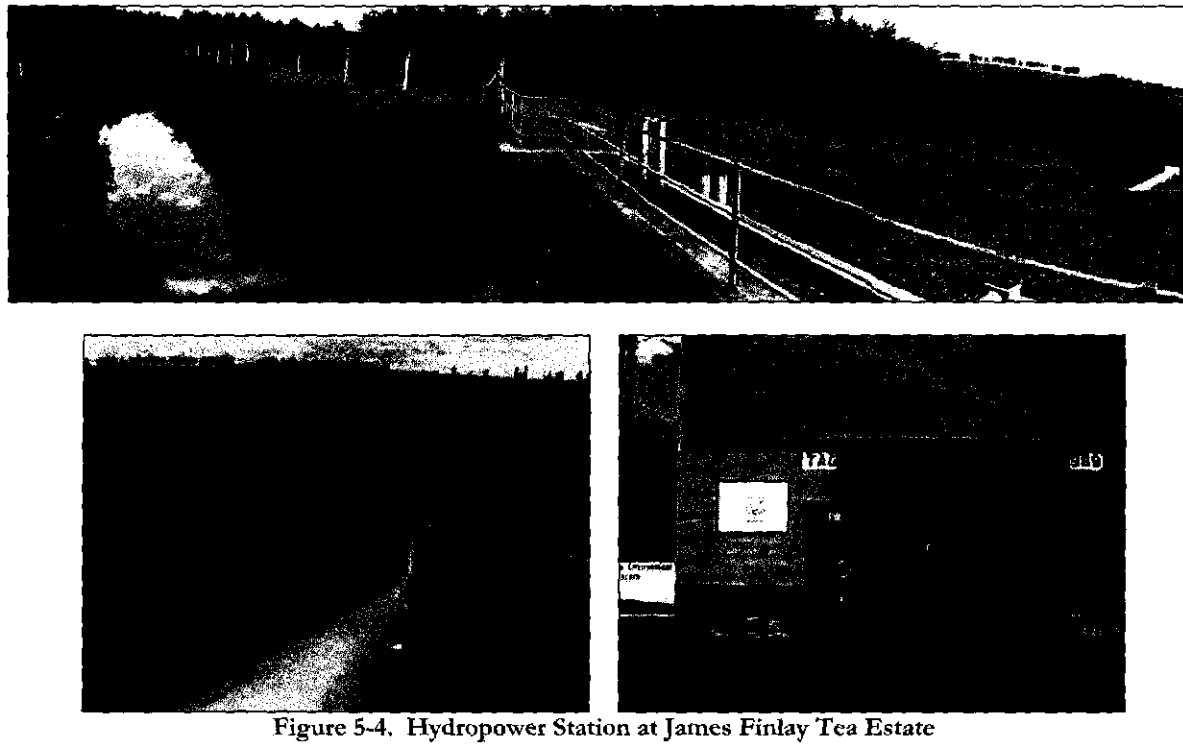
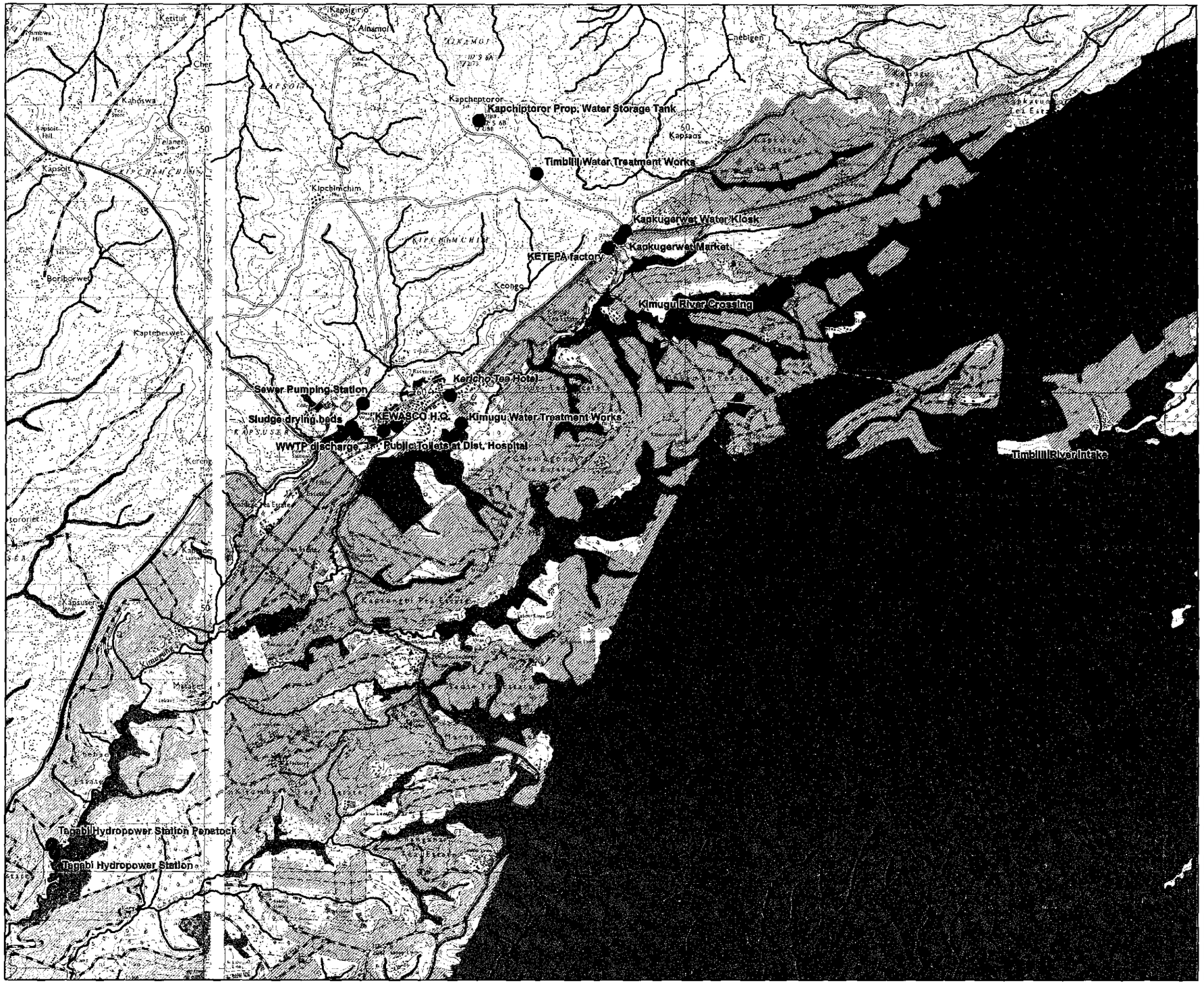


Figure 5-4. Hydropower Station at James Finlay Tea Estate
Stream Diversion and Penstock (top, bottom left), Generating Station (bottom right)



Lake Victoria South Water and Wastewater Feasibility Study

Map 5-1
Greater Kericho

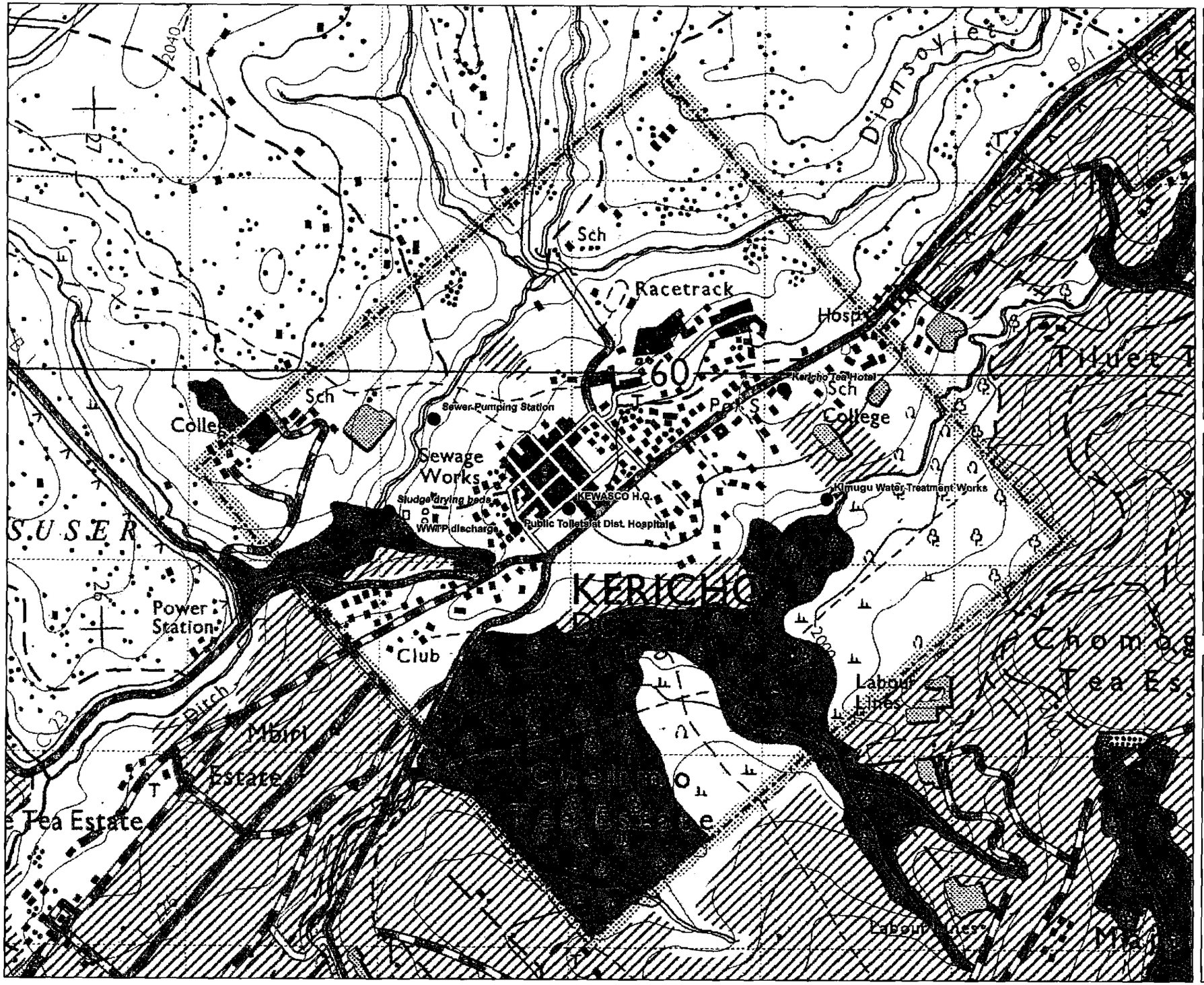
COLER & COLANTONIO INC
ENGINEERS & SCIENTISTS

Points of Interest

Rivers

1:80,000

0 1,250 2,500 5,000 Meters



Lake Victoria South Water and Wastewater Feasibility Study

Map 5-2

Central Kericho

COLER & COLANTONIO INC
ENGINEERS & SCIENTISTS

Points of Interest

Rivers

1:20,000

0 300 600 1,200 Meters

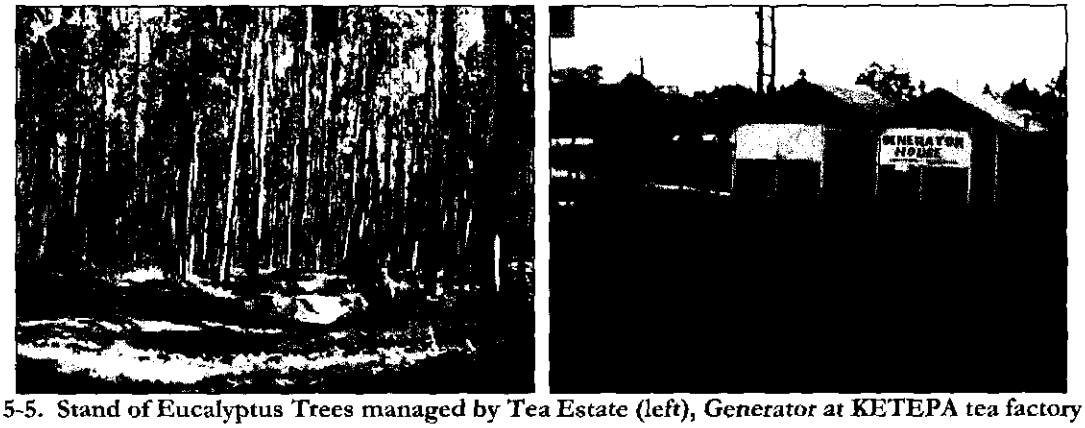


Figure 5-5. Stand of Eucalyptus Trees managed by Tea Estate (left), Generator at KETEPA tea factory (right)

5.1.4 Population

5.1.4 (a) Existing Population

Based on extrapolation of the most recent (1999) Kenya Census figures, the present population of Kericho Town is approximately 113,000. According to KEWASCO, approximately 20% of Town residents live in informal settlements.[6] Informal settlements are areas where housing units have been constructed on land to which the occupants have no legal claim, or where housing is not in compliance with current planning and building regulations and clearly defined roadways and addresses do not exist. The average annual income of Kericho residents is estimated to be approximately 7,000 KShs (although uncertainty regarding this figure exists) and the area is highly dependent on the tea industry (Figure 5-6).[7] Other industries include a small dairy, a bakery, and motor and agricultural equipment repair workshops. The Central Business District is a busy commercial area with numerous multistory buildings that include a variety of shops, grocery stores, offices, hotels, bars, butcheries, petrol stations, cinemas, workshops, and government offices.

During Project Team visits to Kericho, it was noted by local officials that there is a problem of excess workforce in Kericho Town. Industrial development is currently limited but is expected to expand with population to provide job opportunities for the increasingly urban population.

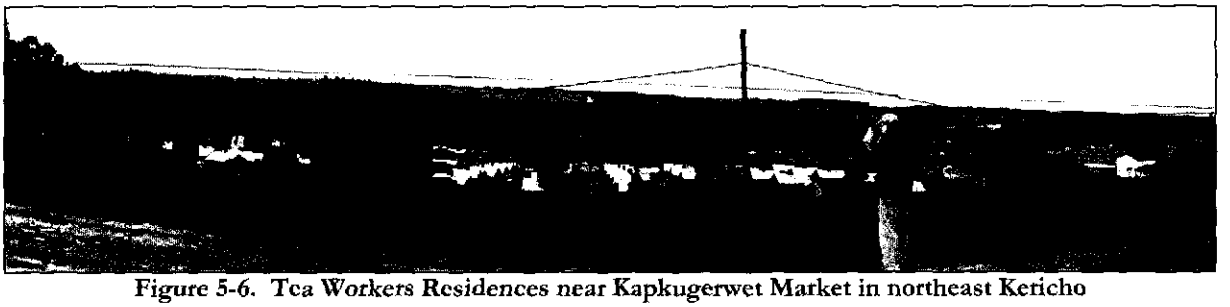


Figure 5-6. Tea Workers Residences near Kapkugerwet Market in northeast Kericho

5.1.4 (b) Population Projections

Available population projections were reviewed in order to develop projections for the purposes of this study. Estimates prepared by KEWASCO assume approximately 2.4% growth, while Government of Kenya projections assumed over 5% growth. Previous studies (H.P. Gauff, 1985) estimated growth of 4% after 1995. Unfortunately, utilizing census figures for estimates of population growth rates is problematic due to overlapping and changing district boundaries over the years. Based on the available data, it was resolved to estimate a growth rate of 3% per year.

A comparison of population projections by others and the Feasibility Study projections are presented in Table 5-1. Final town population projections used in the study and estimated income categories are presented in Table 5-2.

Table 5-1. Summary of Kericho Town Population Projections

	1	2	3	4
Year	'Kericho Water and Sewerage Project' Document (2006)	Kericho Water Supply Pre-Visit Survey and Data Request (2006)	'U.S. Investments in Water Treatment/Sewer Treatment Sector in Kenya' Document (2003)	Feasibility Study Projection (2006)
2005	110,000	110,000	109,000	110,000
2010	124,000	124,000	147,000	130,000
2015	140,000	141,000	206,000	150,000
2025	177,000	179,000	322,000	200,000

Notes:
1 - Document states current population 112,942 with growth rate of 2.4%
2 - Town projection has implicit assumption of 2.5% growth rate based on 2005 and 2025 projections.
3 - Projection assumes 5.8% growth annually. Estimates overestimate growth due to inclusion of town boundaries expansion in 1998 as part of normal Town population growth. Values provided for 2003, 2010, and 2025. Other points assumed by linear extrapolation.
4 - Assumes 3% growth rate.

Table 5-2. Projected Kericho Town Population and Income Distribution

	Initial (2006)	Future (2015)	Ultimate (2025)
Population	113,000	150,000	200,000
High / Medium Income %	25%	35%	45%
Low Income %	75%	65%	55%

Notes:
Income categories based on review of H.P. Gauff projections (1985), 'U.S. Investments in Water Treatment/Sewer Treatment Sector in Kenya' projections, and an assumed 1% change per year. 'U.S. Investments in Water Treatment/Sewer Treatment Sector in Kenya' assume high/medium income category increases from 10% in 2003 to 50% in 2025.

5.1.5 Water Demand and Service Goals

5.1.5 (a) Overview of Present Water Demand and Service Goals

Based on available information, it is estimated that approximately 90,000 of 113,000 Kericho Town residents live within the existing water service area. KEWASCO maintains approximately 7,900 registered water service connections, although less than 5,300 are classified as "active". Assuming approximately eight persons are served per registered connection (an estimate KEWASCO deems reasonable), it is estimated that approximately 62,200 residents are served by individual water connections (IWC). The number of residents currently utilizing water kiosks is unknown, but is estimated to be less than 2,000. Therefore, approximately 70% of the estimated service area population and 56% of the estimated total town population is served by a piped water connection or water kiosk.

According to the 2004/2005 KEWASCO Annual Report, average day water production in Kericho is approximately 7,300 m^3/day, while average daily water consumption (based on consumer water meter readings) is approximately 3,660 m^3/day. Therefore, unaccounted-for-water (UfW) is slightly less than 50%. Based on the service population calculated above, per capita consumption is estimated at 59 liters per capita

per day (lpcd) and per capita demand including UfW is estimated at 115 lpcd. These are aggregate values including all commercial, municipal, and industrial demands.

Existing town and service area population and service population goals are presented in Figure 5-7. In order to meet the 2015 Millennium Development Goal (MDG) for water service, the existing unserved population in the service area should be reduced from its present value of 30% to 15% by 2015. This can be accomplished by increasing the number of customers served from approximately 63,600 to 106,700 (includes expected population increase).

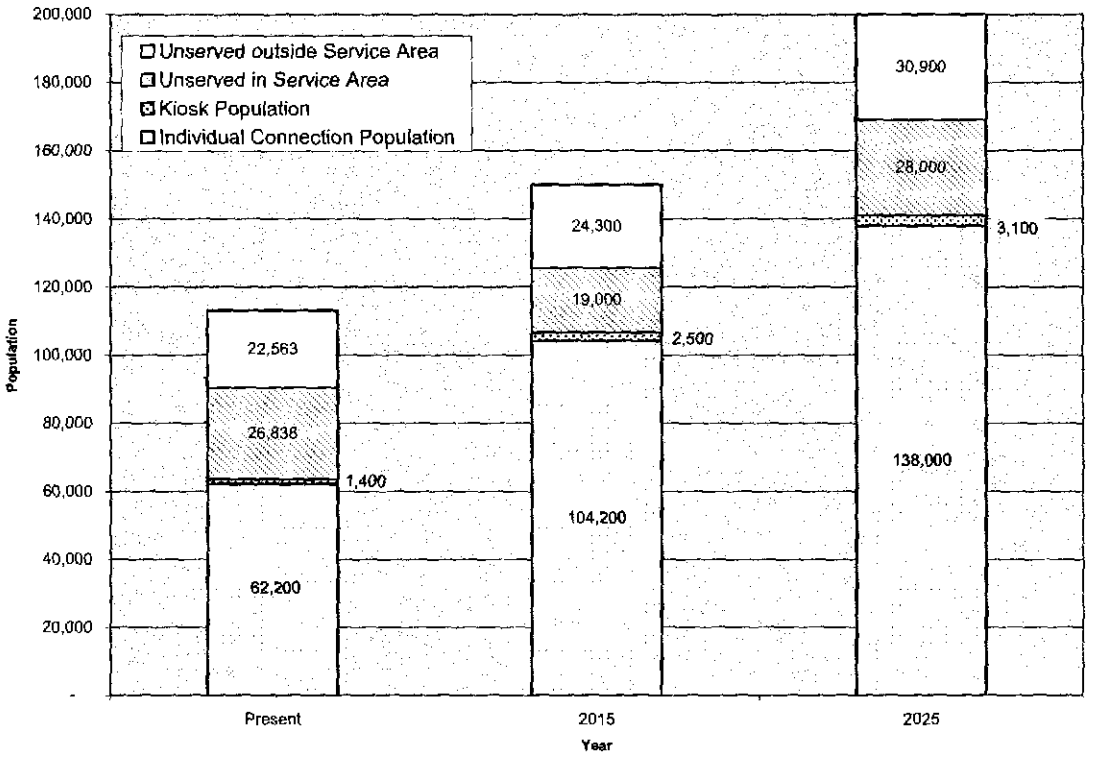


Figure 5-7. Kericho Existing Water Service Population and Future Service Goals

5.1.5 (b) Domestic Water Use

Domestic water demand projections were developed based on the methodology described in Section 2. The projections are based on a variety of data and assumptions, including:

- Available consumption, demand, and UfW data
- Expected service area population growth
- Estimated current and future customer income levels
- Estimated per capita water demand growth
- Expected reduction in UfW

Detailed tables containing the basis of the domestic water demand calculations are presented in Appendix 5-1.

5.1.5 (c) Large Water Users

Water use projections for large users were developed based on the methodology described in Section 2. KEWASCO provided water use records for the ten largest water users in Kericho. Large water users include schools, commercial and industrial establishments, hotels, hospitals, and prisons. A total of 15 primary schools, eight secondary schools, and two colleges exist in town. The municipality also has a district hospital and six private hospitals. Local industries include a small dairy, a bakery, and motor and agricultural equipment repair shops. Other smaller commercial establishments exist, mostly within or near the central business district in the town center.

KEWASCO's largest water customer is the KETEPA tea company, which uses an average of 225 m^3/d. Other large users include the District Hospital (91 m^3/d), Kericho High School (84 m^3/d), and the Tea Hotel (72 m^3/d). Actual water use records provided by KEWASCO may be inaccurate because many existing water meters are old and expected to be under-recording flows. Additional allotments for other large water users have been assumed. Large water user demands are assumed to grow at the same rate as the Town population.

Detailed tables containing the basis of the large user water demands and projections are presented in Appendix 5-1.

5.1.5 (d) Projected Water Demand

Table 5-3 presents a summary of existing and projected water demand and consumption for the study period. Per capita water demand and consumption are expected to rise with an anticipated growth of population in medium and high income categories. UfW is expected to be reduced over time and reach 15% by 2025. It should be noted that these water demand projections are based on a variety of assumptions and should be revisited and revised as appropriate during preliminary design when new data is available.

Table 5-3. Kericho Existing and Projected Water Demand and Consumption

	Initial (2006)**	Future (2015)	Ultimate (2025)
Water Production (m^3/d)	7,279	12,960	22,000
Per Capita Water Demand (lpcd)*	115	122	156
Unaccounted for Water (UfW)	50%	25%	15%
Water Sold (m^3/d)	3,658	9,720	18,700
Per Capita Consumption (lpcd)*	59	91	133

**Aggregate value including individual domestic connections, large users, and kiosks.*
***Initial water demand and consumption shown are actual values based on 2004/2005 KEWASCO Annual Report.*

5.1.6 Wastewater Flow and Service Goals

5.1.6 (a) Overview of Present Wastewater Flow and Service Goals

Based on available information, it is estimated that less than 15,000 of Kericho Town's 113,000 residents live within the existing wastewater service area. KEWASCO maintains approximately 1,700 sewer connections. Based on wastewater flows received at the wastewater treatment facility and per capita flow estimates, approximately 9,600 residents are served by an individual sewer connection (ISC), or 5.6 persons per connection. The number of residents currently utilizing public toilets is unknown, but is estimated to be less than 100 for the purposes of this study. Therefore, approximately 65% of the estimated service area population and 9% of the estimated total Town population are served by a piped sewer connection or public

toilet. The remainder of residents and businesses utilize on-site wastewater systems, usually pit latrines, for wastewater management.

According to the 2004/2005 KEWASCO Annual Report, average day wastewater flow to the wastewater treatment facility was 501 m^3/d. Assuming no infiltration and inflow, per capita wastewater flow is therefore 52 lpcd. These are aggregate values including all commercial, municipal, and industrial demands.

Existing town and service area population and service population goals are presented in Figure 5-8. In order to meet the 2015 MDG for wastewater, the existing unserved population in the service area should be reduced from its present value of 34.6% to 17.3% by 2015. This can be accomplished by increasing the number of customers served from approximately 9,700 to 26,300 (including expected population growth). As detailed in the wastewater section below, all residents relying on on-site wastewater systems should be included in a proposed on-site wastewater management program.

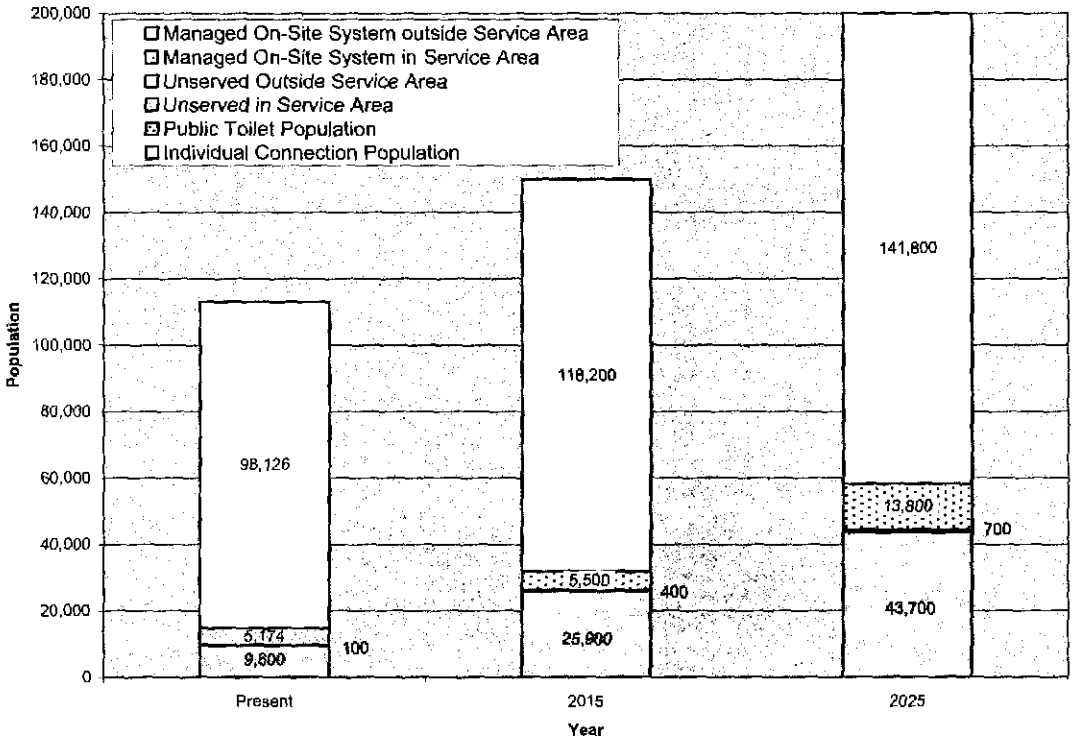


Figure 5-8. Kericho Existing Wastewater Service and Future Service Goals

5.1.6 (b) Domestic Wastewater Flows

Domestic wastewater flow projections were developed based on the methodology described in Section 2. The projections are based on a variety of data and assumptions, including:

- Available flow data and current per capita flow estimates
- Expected service area population growth
- Estimated per capita water demand growth

Detailed tables of domestic wastewater flow calculations are presented in Appendix 5-1.

5.1.6 (c) Wastewater Flows from Large Water Users

Wastewater flow projections for large water users were developed based on the methodology described in Section 2. The calculations assume wastewater flows are 80% of water consumption. KEWASCO indicated which large water users are currently connected to the existing wastewater system. It was assumed that all large water users near the town center will eventually be connected to the wastewater system. Wastewater flows from large water users are assumed to grow at the same rate as the Town population. Actual water use records provided by KEWASCO, from which wastewater flow estimates were derived, may be inaccurate because many existing water meters are old and expected to be under recording flows. Additional allotments for wastewater flows from other large water users have been assumed.

Detailed tables of wastewater flows and projections from large water users are presented in Appendix 5-1.

5.1.6 (d) Projected Wastewater Flow

Table 5-4 presents a summary of existing and projected wastewater flow for the study period. Per capita flow is expected to rise with an anticipated growth of population in medium and high income categories. However, per capita wastewater flow is expected to remain stable or decrease slightly during the period 2015 through 2025 due to an assumption that many customers added during that time period will be of lower income and therefore have lower water consumption and wastewater generation. It should be noted that these wastewater flow projections are based on a variety of assumptions and should be revisited and revised as appropriate during preliminary design when new data is available.

Table 5-4. Kericho Existing and Projected Wastewater Flows

	Initial (2006)**	Future (2015)	Ultimate (2025)
Wastewater Flow (m^3/d)	501	1,900	3,150
Per Capita Wastewater Flow (lpcd)*	52	72	71

**Per person served. Aggregate value including individual domestic connections, large users, and public toilets/latrines.*
***Initial wastewater flow shown is actual value based on 2004/2005 KEWASCO Annual Report.*

5.2 Water

5.2.1 Water System Overview

Kericho Town is supplied with water from two water treatment facilities: Timbilil Water Treatment Works and Kimugu Water Treatment Works. Average daily water production from July 2004 through June 2005 was 7,279 m^3/d. Average day production remained relatively constant throughout the year, ranging from a maximum of 7,625 m^3/d in January 2005 to a minimum of 6,717 m^3/d in March 2005. Unaccounted for Water (UfW) during this period was reported at 50%. According to the KEWASCO 2004/2005 Annual Report, water service was provided on a 24-hour basis with no rationing. However, in the 2003/2004 and 2005/2006 reporting periods, KEWASCO noted that "rationing had to be done due to severe dry season". Total water production in February 2006 was less than 6,000 m^3/d.

Assuming future reductions in UfW, water demand is estimated to rise to 12,960 m^3/d by 2015 and 22,000 m^3/d by 2025. Therefore, UfW reduction and production increases are required to meet expected demands. The existing water supply system was designed to meet demands through 2005 (including a dam which has not yet been constructed) and serve the previous municipal area of 66 km^2 (now 111 km^2).

Timbilil Water Treatment Works receives raw water via a gravity pipeline from the Timbilil River and currently has capacity to produce up to 8,640 m^3/d. However, production is limited by flow availability in the Timbilil River during the dry season (December through March). The treatment works are located at an elevation of approximately 2,130 m above sea level and can therefore provide water to the entire existing distribution network via gravity.

Kimugu Water Treatment Works draws water from the Kimugung River and serves as a supplementary facility to augment capacity during the dry season when flows in the Timbilil River are low. This facility currently has capacity to produce approximately 2,500 m^3/d, although its design capacity is 4,000 m^3/d. During the Project Team's visit in January 2006, 45% of the total water distributed by KEWASCO was from this facility. Situated 1,980 m above sea level, pumping is required at this facility to provide water to the distribution system.

The water distribution network contains approximately 100 km of water mains varying from 63 mm (2.5 inch) to 315 mm (12 inch) diameter and 11 storage tanks.[8] With the exception of pumping from the Kimugu Water Treatment Works, the entire system is operated by gravity. Water quality sampling indicates that finished water quality meets National and World Health Organization standards.

5.2.2 Water Sources and Intakes

5.2.2 (a) Water Sources and Intakes Description

Present water sources for Kericho Town include the Timbilil River (primary source), which provides raw water to the Timbilil Water Treatment Works, and the Kimugung River (supplemental source), which provides water to the Kimugu Water Works. In addition, residents without access to piped water sources draw water from one of several streams and springs located throughout the Town or utilize private wells and rainwater harvesting systems.

The **Timbilil River intake** (Figure 5-9) is situated approximately 13 kilometers east of the central business district in the South Western Mau Forest and provides water via a gravity pipeline to the Timbilil Water Treatment Works located approximately 6 km northeast of the central business district.

The intake is composed of a concrete weir and stilling basin connected to a gravity raw water main. The weir is designed to allow flow to pass downstream during most of the year. During the dry season (December through March), the Kimugu Water Treatment Works operates to augment KEWASCO's water production capacity. During the Project Team visit to the Timbilil intake in January 2006, almost no flow was passing downstream.

KEWASCO provided flow data for the Timbilil River from 117 measurements taken during the period November 1988 through February 1992. The data indicate a mean flow of 827 lps (71,453 m^3/d). According to KEWASCO, a permit exists for abstracting 150 lps (12,960 m^3/day) from the river. This abstraction is equivalent to the capacity of the existing raw water main. Flow measurements taken during the dry season averaged 208 lps (17,950 m^3/day) and fifteen of the 117 flow measurements indicated flow of less than 150 lps (12,960 m^3/day). According to a March 1993 study by H.P. Gauff, taking into account downstream water rights, "Abstraction from the Timbilil River at the intake site can, thetefore, be estimated to be itt the order of 50 lps [4,320 m^3/day] in a 1 in 5 years dry weather flow"[9].

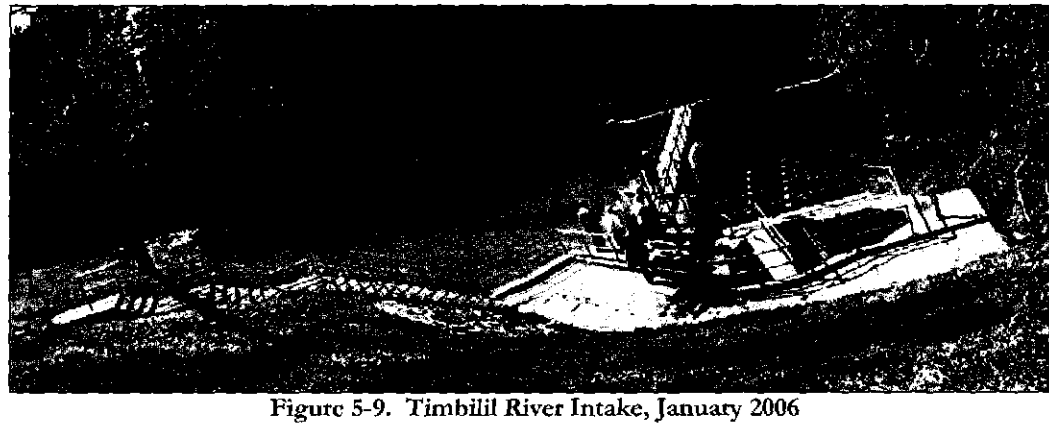


Figure 5-9. Timbilil River Intake, January 2006

The raw water main was installed in 1990 and is approximately 14.9 km long. The capacity is 150 lps (12,960 m^3/day) and consists of approximately 6.4 km of 450-mm diameter steel main and 8.5 km of 350-mm diameter steel main with air release valves and washouts installed along its length. The elevation change from the intake to the treatment works is 87 meters. The raw water main runs along an unpaved road maintained by KEWASCO. The road is rough and most appropriately accessed with a four wheel drive vehicle.

The Mau Forest is a nature reserve and according to KEWASCO staff contains a variety of wildlife including elephants, antelope, monkeys, and baboons. Due to its protected status, relatively few threats to water quality reportedly exist in the area. However, the 'Githima Settlement Scheme', apparently a relatively new residential development upstream of the intake, was cited as a cause of increased raw water turbidity in a 1993 report by H.P. Gauff.[10] De-siltation of the intake is performed manually approximately once per year by KEWASCO staff. KEWASCO has noted it has required increased coagulant dosage at the Timbilil Water Treatment Works as a result of increasing raw water turbidity since the facility came online in 1991. Due to seasonal fluctuations in turbidity, identifying raw water quality samples for quantitative comparison is problematic. However, anecdotal evidence seems to suggest that turbidity levels have increased over time, possibly as a result of increased erosion due to deforestation or other human activities in the watershed.

Raw water sampling performed on the Timbilil River by a government chemist on 16 March 2004 is presented in Table 5-5. According to the Republic of Kenya Government Chemist's Department, these results indicate the water is "of low mineral content and fair organic quality. Recommended for ordinary use." Bacteriological samples taken on 16/4/2004 and 15/10/2004 had fecal coliform counts ranging from 2/100 ml to 82/100 ml, indicating that disinfection is recommended before domestic use.[11]

Table 5-5. Timbilil River Raw Water Analysis[12]

Parameter	Result 16/3/04
pH	7.09
Free CO_2	5 mg/l
Phenolphthalein alkalinity	Nil
Nitrites	Trace
Chlorides	2 mg/l
Total hardness as $CaCO_3$	10 mg/l
Total alkalinity as $CaCO_3$	16 mg/l
Non-Carbonate hardness as $CaCO_3$	0 mg/l
Oxygen absorbed 4 hr (PV) at 27° C	0.2 mg/l
Free/saline ammonia (NH_3)	0.06 mg/l
Electrical conductivity	87 mg/l
Total dissolved solids (TDS)	5 mg/l

The **Kimugung River intake** (Figure 5-10) is located within approximately one kilometer of the town center, adjacent to the Kimugu Water Treatment Works. Due to its location at an elevation below most of the service area, pumping is required to reach the distribution network, which is located several hundred kilometers away.

According to a March 1993 study by H.P. Gauff, the Kericho Municipal Council has water rights on the Kitenges/Kimugu River amounting to 2,000 m^3/day from a 1987 permit.[13] However, an earlier permit held by the Ministry of Water for the same supply reportedly exists in the amount of 4,795 m^3/day. KEWASCO noted that it holds Permit No. wrma/lvsc/230 for maximum abstraction of 2,000 m^3/day.

Data provided by KEWASCO for three flow measurements taken in February 2003, September 2004, and April 2005 indicate flows of 310 lps (26,800 m^3/day), 147 lps (12,700 m^3/day), and 943 lps (81,500 m^3/day), respectively. Data recorded as part of a study by Gauff Ingenieure indicated Kimugung River flows in March 1994 varying from 140 lps (12,100 m^3/day) to 193 lps (16,700 m^3/day).

Figure 5-10. Kimugung River Intake Location

Due to its location near the center of Town, farming and other human activities within the watershed pose threats to water quality in the Kimugung River. According to the 2004 KEWASCO Environmental Audit Report, "The water quality of the river is threatened by human activities along its course prior to the intake point. As compared to Timbilil water, Kimugu water is more polluted because of diverse human activities along its course". The river passes through tea farms which apply chemicals and fertilizers. During the

Project Team visit to the facility in January, 2006 it was noted by KEWASCO staff that the raw water includes small amounts of phosphates. Increasing urbanization in the watershed, including development around the main Kericho business district and Kapkugerwet market area, are resulting in increased potential for erosion and pollution. Table 5-6 presents raw water data from the Kimugung River. According to the Republic of Kenya Government Chemist's Department, the 2004 sample data indicates the water is "of low mineral content and doubtful organic quality."

Table 5-6. Kimugung River Raw Water Analysis[14]

Parameter	Result (16/3/2004)
pH	6.9
Ftee CO_2	4 mg/l
Phenolphthalein alkalinity	Nil
Nitrites	0.003 mg/l
Chlorides	2 mg/l
Total hardness as $CaCO_3$	14 mg/l
Total alkalinity as $CaCO_3$	14 mg/l
Non-Carbonate hardness as $CaCO_3$	0 mg/l
Oxygen absorbed 4 hr (PV) at 27° C	0.2 mg/l
Free/saline ammonia (NH_3)	0.06 mg/l
Electrical conductivity	97 mg/l
Total dissolved solids (TDS)	65 mg/l

5.2.2 (b) Water Sources and Intakes Needs

Assuming 1 in 5 years dry weather flow abstraction from the Timbilil River of 4,320 m^3/day and 2,000 or 2,500 m^3/day from the Kimugung River (permit status is unclear), KEWASCO's total low flow water production capacity is less than 7,000 m^3/day. As noted previously, average day water production from July 2004 through June 2005 was 7,279 m^3/d and the lowest average day production for any month during that period was 6,717 m^3/d (March 2005). KEWASCO has noted that the period for which data was provided (July 2004 – June 2005) was an exceptional case when there was no major dry season. During March 2006, KEWASCO noted that the daily combined water production from Timbilil and Kimugu Water Works was 5,950 m^3/d. KEWASCO noted that water rationing was conducted during the dry seasons in the 2003/2004 and 2005/2006 reporting periods.

The existing system was designed to meet water demand until the year 2005 for the former municipal area of 66 km^2 and was intended to include a dam on the Timbilil River. The municipal boundary was expanded to 111 km^2 in 1998, which prompted the need to extend the water service area to include the new town boundary lines. Several areas including Kapcheptoror, Ngecherok, and the proposed Chelimo Residential Estate are expected to be served in the coming years. As a result of the lack of seasonal raw water storage, continued population growth and recent and projected service area expansion, the capacity of the existing system has been reached. Increased abstraction will be required to meet short and long term demands, which are expected to increase to 22,000 m^3/d by 2025. Increased abstraction of approximately 15,000 m^3/d will therefore be required by the end of the study period.

Current Timbilil and Kimugung River flow and raw water quality data are required for an accurate assessment of potential water abstraction increases from the two existing sources. Data should be collected in accordance with Government of Kenya requirements for assessing new water supply abstractions. In addition, clarity is required regarding existing permit status and potential for increased abstraction.

No leakage testing has been done on the existing raw water main from the Timbilil intake to the Timbilil Water Treatment Works. Incoming flow to the treatment works is measured with a weir, but flow is not measured at the intake. Therefore, no means exists for performing a simple water balance to confirm that water is not lost along the raw water main. Although the main was installed relatively recently (1990), the 14.9 km pipeline could be a source of UfW. According to the December 2004 KEWASCO Environmental Audit Report, "there was a pipe burst spilling raw water from Timbilil intake".[15]

Source water protection is required in both the Timbilil and Kimugung River watersheds. Quantitative and anecdotal evidence indicate increasing levels of turbidity and development pressure within the watersheds. Watershed management programs are needed to reduce erosion and pollution which have adverse effects on raw water quality. Land purchase should be considered for permanent protection of water sources. No public education programs are currently in place regarding source water protection and water conservation.

5.2.2 (c) Water Sources and Intakes Improvement Options

Previous studies, KEWASCO, and this study have identified three principal options for augmenting water supplies for Kericho Town:

1. Dam and Reservoir on Timbilil River upstream of existing intake
2. Pumped Injection of Raw Water from Kitenges River into existing raw water main from Timbilil Intake
3. Upgrades to Kimugu Water Treatment Works to allow for increased abstraction from Kimugung River

Construction of a **dam and reservoir on the Timbilil River** would increase flow to the Timbilil Water Treatment Works and eliminate problems associated with low flow availability during the dry season. A 1,500,000 m^3 gross storage dam on the Timbilil River was recommended in the 1983 Final Design Report by H.P. Gauff for the 'Kericho Water Supply Scheme'.[16] According to the study, "Run-of-river abstraction from either or both of the Kimugu and Timbilil Rivers cannot therefore in the future provide the level of water supply security necessary for a major urban centre such as Kericho and storage is required to ensure the supply." The proposed dam location is approximately four kilometers upstream from the existing intake. There is currently no roadway access to the proposed dam site. Advantages of this option include the lack of pumping requirements for both raw and finished water, existing source water protection afforded by the Mau Forest nature reserve, and flow availability. Disadvantages include high initial cost.

The **injection of raw water from the Kitenges River** would be accomplished by pumping raw water from the river into the existing Timbilil raw water main at a point where the raw water main crosses the Kitenges River (Figure 5-12). The Kitenges River is a primary tributary to the Kimugung River upstream of the Kimugu Water Treatment Works. The confluence of the Kitenges and Kimugung Rivers is approximately one kilometer downstream from the proposed injection site. Measurements taken in March 1994 as part of a study performed by Gauff Ingenieure indicated flows in the Kitenges River varying from approximately 50 lps (4,579 m^3/d) to 100 lps (6,394 m^3/d). Advantages of this option include lower initial cost compared to the dam option. Disadvantages include the need for pumping, limited and variable flows, and potential water quality impacts from nearby tea estates and other human activities.

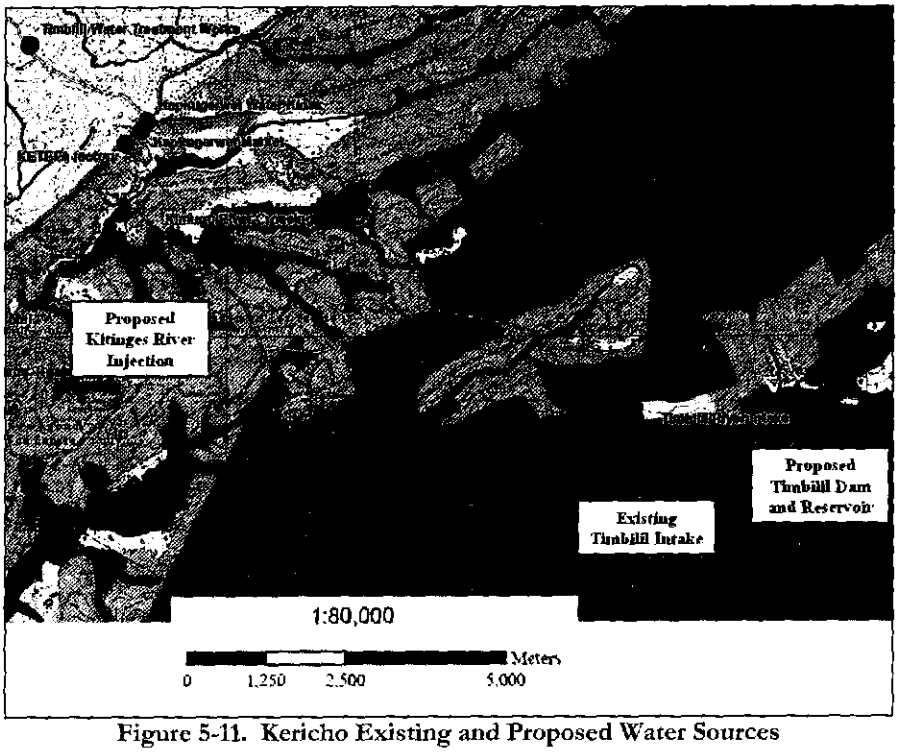


Figure 5-11. Kericho Existing and Proposed Water Sources

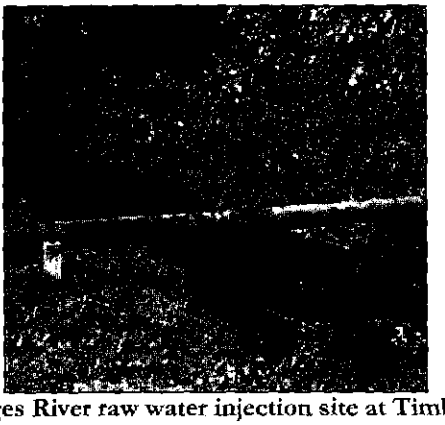


Figure 5-12. Proposed Kitenges River raw water injection site at Timbilil raw water main crossing

Upgrades to the Kimugu Water Treatment Works would allow for increased abstraction from the Kimugung River and increased production. The facility was constructed in the 1950s and was expanded in 1985-86 to increase capacity from 1,500 to 4,000 m^3/d.[17] However, KEWASCO has noted the facility is not currently capable of producing more than 2,500 m^3/d. Advantages to increasing output from this facility include lower initial costs compared to the dam option. Disadvantages include the need for pumping, limited and variable flows, and potential water quality impacts from nearby tea estates and other human activities.

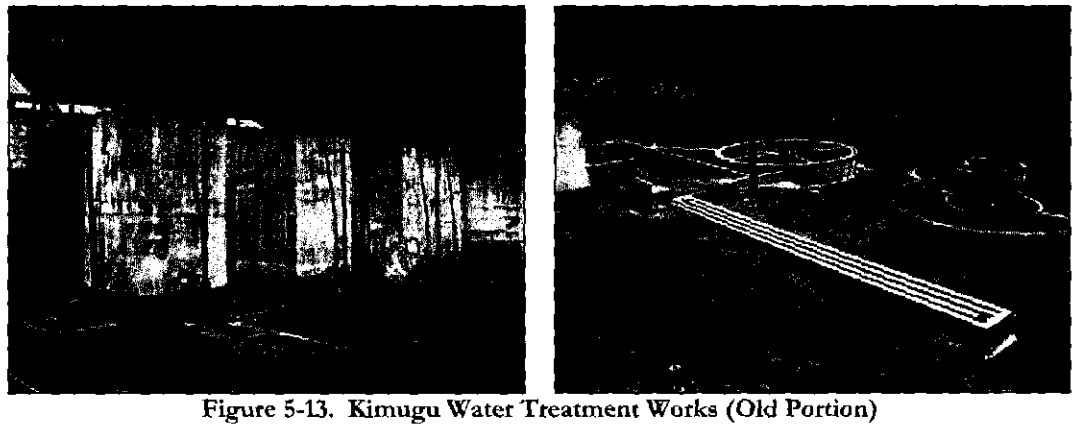


Figure 5-13. Kimugu Water Treatment Works (Old Portion)

A 1993 study conducted by H.P. Gauff noted the following:

> *"It had been anticipated during the project design stage* [for the Timbilil River intake and Timbilil Water Treatment Works] *that a dam situated in the upper reaches of the Timbilil River would be constructed to enable regulation of water during the dry weather months and especially in December, January, February and March. Such a dam had been expected to be on line at the end of the recommended phase 1 implementation* [expected by 1995] *of 8,640 m³/day supply from the Timbilil River. Due to a changed funding priority, the dam has not been constructed, hence the low run-of-river flows being experienced during the dry weather months".* [18]

In light of a lack of funding for the dam (preferred option), investigations into alternative source augmentation measures (Kitenges raw water injection and Kimugu Water Treatment Works upgrades) were undertaken in the early 1990s. Rehabilitation of the Kimugu Water Treatment Works to allow for increased Kimugung River abstraction was initially recommended despite slightly higher initial costs compared to raw water injection due to lower operational costs and the fact that it could be implemented as early as the 1993 dry season. However, the stakeholders subsequently agreed that pump injection at the Kitenges River was a more suitable choice in the long run because it enabled the available water supply to be treated from a single treatment works (Timbilil Water Treatment Works) at an elevation sufficient to serve the entire service area via gravity.[19] Neither the Kitenges raw water injection nor Kimugu Water Tteatment Works upgrades have been implemented. Limited upgrades have taken place at the Kimugu Water Treatment Works including a new pump controller in 1994 and miscellaneous upgrades in 2004/2005 (according to the KEWASCO Annual Report).

5.2.2 (d) Water Sources and Intakes Recommendations

A dam on the Timbilil River is the recommended option for augmenting water supplies for Kericho. Although up-front costs associated with this option will be higher than other options, it is the only option that can reliably produce a large supply of water during all seasons without the need for pumping. It is also the only option that provides water from a protected watershed.

At least until the dam and reservoir are constructed, Kericho will need to continue to rely on the Kimugung River and Kimugu Water Treatment Works as a supplementary source. Activities required for moving the dam project forward should begin immediately. Recommendations for sources and intakes and estimated costs and phasing are included in the detailed matrices (Appendix 5-2). Recommended activities include, but are not limited to the following:

- Undertake **source protection measures** including watershed delineation, water quality threat assessment, development of a watershed management program including farming best management

practices (BMPs), and consideration of land purchase for watershed protection. Develop public education programs regarding source water protection and conservation.

- **Measure flow at the Timbilil River intake** to determine if any losses are occurring in the raw water main.
- Obtain all available **historic flow data** for the Timbilil River from the Water Resources Management Authority (WRMA).
- Establish a **Timbilil River flow and water quality monitoring station** to gather data required for application for increased abstraction per Government of Kenya regulations.
- Clarify Timbilil River **permitted volumes, ownership of permits, and present status**; clarify potential for increased abstraction. Begin permitting process for increased abstraction.
- Conduct **preliminary design and detailed cost estimation for dam** project including comparison to other options with consideration of adding hydropower to minimize pumping costs for alternatives. Consideration of the need for additional raw water transmission capacity should be included in dam project costs.
- **Construct dam and raw water main** as recommended by detailed studies.

5.2.3 Water Treatment

5.2.3 (a) Timbilil Water Treatment Works Description

The Timbilil Water Treatment Works (Figure 5-14) is located in the northeast portion of Town on the E223 road just north of the intersection with the E222 road. The facility, which covers approximately 4 acres, was brought on-line in 1991 as part of the 'New Kericho Water Supply Project' and serves as the primary water treatment works for Kericho Town. The facility receives raw water via a 14.9 km pipeline from the Timbilil River.

The facility employs a conventional process consisting of coagulation, flocculation, sedimentation, filtration, and disinfection. It includes an influent flow measurement weir, chemical feed and mixing chambers, two flocculation basins, two rectangular horizontal flow sedimentation basins, four rapid gravity sand filters, a chlorination chamber, and a 1,250 m^3 finished water reservoir. Soda ash and aluminum sulfate are added to adjust pH, increase alkalinity, and facilitate coagulation. Calcium hypochlorite is used for disinfection. An elevated sectional steel water tank with 200 m^3 capacity is used for backwashing the filters and to provide water to the laboratory and staff quarters. The elevated tank is filled by either an electric pump or a hydroturbine driven pump which utilizes excess head from the raw water main. Separate buildings for chemical storage and chemical feed, laboratory equipment, and residential staff quarters also exist on site.

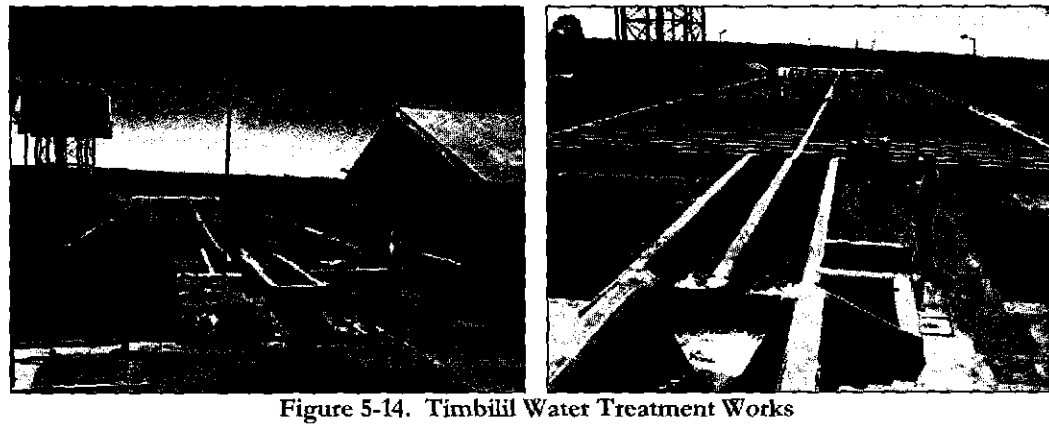


Figure 5-14. Timbilil Water Treatment Works

The design capacity of the treatment works is 8,640 m^3/d, although production is limited by Timbilil River flow availability during the dry season. The facility was designed to allow for a 50% expansion to 12,960 m^3/d and land is available adjacent to the existing facility for this purpose. This increased capacity may be accommodated by the existing raw water main, which has a total capacity of 150 lps (12,960 m^3/d). However, low flows in the Timbilil River will not allow this volume of water to be abstracted throughout the year without the addition of a dam for seasonal storage. The facility opetates continuously and is reportedly able to meet demands every month except during the dry season, when Kimugu Water Works provides supplemental supply.

Table 5-7 presents amounts of water treatment chemicals and electricity used during the 2004/2005 reporting year (total for both water treatment facilities).

Table 5-7. Water Treatment Chemicals and Electricity Used

Chemical Type	Amount Used
Aluminum Sulfate (powder form)	60,650 kg
Soda ash	14,225 kg
Calcium hypochlorite (65% chlorine)	1,605 kg
Electricity consumed	55,596 kW-hr

Source: KEWASCO Annual Report for the Year 2004/2005

Raw, finished, and distribution system water quality tests are conducted at the Timbilil Water Treatment Facility in accordance with Government of Kenya regulations. During the period July 2004 through June 2005, 466 residual chlorine tests, 466 pH tests, and 49 bacteriological tests were conducted by KEWASCO (for both Kimugu and Timbilil facilities and in the distribution system) and all tests reportedly met national and WHO standards.

Table 5-8 presents watet quality criteria provided by the KEWASCO as defined by the Kenya Bureau of Standards (KEBS). The standards are the same as those listed in the 2005 Design Manual. National Drinking Water Quality Standards are presented in Section 2.

Table 5-8. Drinking Water Standards, Kenya Bureau of Standards Requirements[20]

Parameter	Standards (KEBS)
Physical Tests	
Color	15
Taste	Not offensive to consumers
Odor	Not offensive to consumers
pH	6.5 – 8.5
Deposit	Nil
Turbidity	5 NTU
Chemical Tests	
Total alkalinity ($CaCO_3$)	250 mg/l
Phenolphthalein (CO_3)	250 mg/l
Methyl orange (HCO_3)	250 mg/l
Chloride (Cl)	250 mg/l
Sulfate (SO_4)	400 mg/l
Nitrate (NO_3)	10 mg/l
Nitrite (NO_2)	0.1 mg/l
Fluoride $(F)^-$	0.15 mg/l
Sodium $(Na)^+$	200 mg/l
Potassium $(K)^+$	150 mg/l
Calcium $(Ca)^{2+}$	250 mg/l
Magnesium $(Mg)^{2+}$	100 mg/l
Iron $(Fe)^{3+}$	0.3 mg/l
Manganese $(Mn)^{2+}$	0.1 mg/l
Ammonia-Free & Saline $(NH_3)^+$	0.5 mg/l
Total Hardness as ($CaCO_3$)	500 mg/l
Total Dissolved Solids	1,500 mg/l
Microbiological Limits	
Total Viable Count	100/ml
Coliform Bacteria	Nil
Bacteria (fecal)	Nil

5.2.3 (b) Timbilil Water Treatment Works Needs

The facilities at Timbilil Water Treatment Works generally appeared to be in good condition during the Project Team visits, although miscellaneous repairs and upgrades are required. When sufficient flow is available, the facility is able to produce at or near its rated capacity.

In order to meet demand through 2015, an expansion of the facility by 50% as allowed in the original design is required. Land is available on-site for this expansion and provisions have been included in the design to facilitate the expansion. In addition, recommendations for a variety of improvements were included in a March 1993 report prepared by H.P. Gauff including new backwash pumps, chemical stirrers, air blowers for filter scour due to increased influent turbidity, upgraded chemical feed piping and valves, and upgrades to the hydroturbine chamber. These improvements, plus upgrades of the existing laboratory equipment, and other miscellaneous upgrades are expected to be required.

Backwash water is currently discharged to a nearby stream where it is thought to cause environmental degradation by polluting downstream waters and causing hydrological imbalances. From July 2005 through June 2006, backwash discharges occurred on 302 days and averaged 78 m^3 per discharge. According to

KEWASCO's 2005 Self-Environmental Audit Report, normal dosing of aluminum sulfate (alum) is approximately 3,000 kg/month, but dosage increases to 7,000 kg/month during rainy seasons when turbidity increases. Testing has not been performed on the backwash water to determine its constituents. A treatment system incorporating sedimentation is expected to be required to mitigate environmental hazards posed by backwash discharge.

Tests performed in 2005 by the Kenya Bureau of Standards on the aluminum sulfate and calcium hypochlotite used in Kericho revealed deficiencies in chemical quality.[21] The testing indicated the presence of impurities in the aluminum sulfate and low available chlorine in the calcium hypochlorite. However, product water met applicable standards and therefore adjustments appear to have been made in dosage to compensate for chemical deficiencies.

To meet demands beyond 2015, additional treatment capacity is expected to be required. Land adjacent to the existing Timbilil Water Treatment Works is currently used for growing maize and tea. A portion of this area may be able to be purchased and used for additional water treatment works.

5.2.3 (c) Timbilil Water Treatment Works Recommendations

Recommendations for the Timbilil Water Treatment Works and estimated costs and phasing are included in the detailed matrices (Appendix 5-2). Recommendations include, but are not limited to, the following:

- Conduct **detailed study for upgrade and expansion** work at Timbilil Water Treatment Works including preliminary design, permitting requirements, and cost estimates. The study should include evaluation of options for backwash water treatment, which may include purchase of land below the existing facility for treatment.
- Upgrade **laboratory facilities** to allow for all frequently required testing to be performed locally.
- **Upgrade and expand** Timbilil Water Treatment Works.
- Consider requiring **improved quality control methods for chemical providers** and/or becoming part of a regional chemical purchasing association.
- Perform **planning for a new treatment facility** to meet needs beyond 2015.

5.2.3 (d) Kimugu Water Treatment Works Description

Kimugu Water Treatment Works is a conventional treatment facility located on a 3-acre parcel in a residential area directly adjacent to the Kimugung River, from which it draws raw water. The facility was constructed in the 1950s (Old Works) and rehabilitated and expanded in 1985-86 (New Works) to increase capacity of the Old Works to 1,500 m^3/d and add 2,500 m^3/d of new capacity for a total capacity of 4,000 m^3/d. However, KEWASCO notes the facility is not currently capable of ptoducing more than 2,500 m^3/d. The facility is typically operated only during the dry season when flow in the Timbilil River is low.

The Old and New Works ate supplied with raw water from intakes located on the Kimugung Rivet. Each portion includes soda ash and alum addition. The Old Works includes two sets of mixing channels followed by three trains containing settlers (one vertical flow, two horizontal sinuous flow) and filtration. The New Works includes two parallel flocculation chambers, followed by two parallel horizontal flow settling tanks with lamella plates, followed by four filters. Both the Old and New Works include chlorination with calcium hypochlorite. Separate finished water pumping facilities exist for the Old and New Works.[22] Water quality testing performed at the facility includes pH, alkalinity, and turbidity.

Due to its elevation at 1,980 m above sea level, pumping is required to transport water to distribution storage tanks several hundred meters away (near the Tea Hotel) at elevation 2,020 m. Water provided from this facility serves the lower urban area zone and the rural areas southwest of the town center.[23]

Facility upgrades were planned and designed in the early 1990s by H.P. Gauff in order to "enable the works to perform up to design capacity on an intermittent (dry weather) basis".[24] However, implementation of the Kitenges River raw water injection option was subsequently chosen in lieu of Kimugu Water Treatment Works upgrades as the preferred alternative for augmenting dry season supply. Neither the Kitenges River raw water injection nor Kimugu Water Treatment Works upgrades were implemented.

Recent improvements at the facility include a new pump controller installed in 1994 and miscellaneous upgrades in 2005 when "Kimugu Water Works was completely inspected and all non-operational components repaired or replaced. The plant was repainted and landscaping done to give the place a facelift"[25].

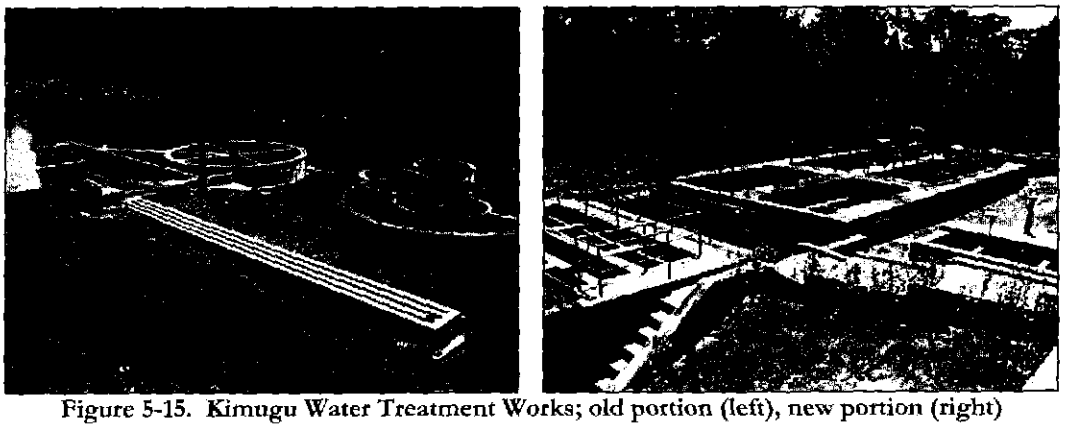


Figure 5-15. Kimugu Water Treatment Works; old portion (left), new portion (right)

5.2.3 (e) Kimugu Water Treatment Works Needs

According to the December 2004 Environmental Audit Report "it is evident that the two treatment plants [Old and New Works] need renovation to avoid contamination of treated water and industrial accidents... for instance some of the moving parts are broken down and inefficient. The pumping machines need protection of its moving parts and warning signs put in place".[26]

In order to continue to reliably serve as a backup facility, upgrades to existing equipment will be required. Although a detailed assessment of specific facility needs is beyond the scope of this study, it is expected that upgrades may include pumping systems, piping, and auxiliary power generation. A detailed assessment will be required in the next phase of work to identify specific needs.

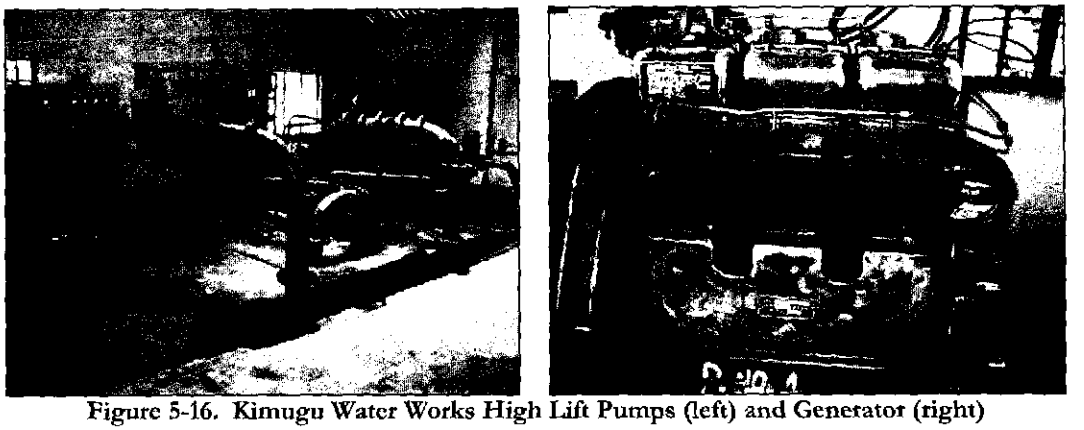


Figure 5-16. Kimugu Water Works High Lift Pumps (left) and Generator (right)

5.2.3 (f) Kimugu Water Treatment Works Recommendations

The Timbilil River and Timbilil Water Treatment Works are recommended to serve as the primary source of treated water in the future. However, the Kimugu Water Treatment Works will need to continue to serve as a supplemental source at least until the proposed Timbilil Dam is constructed. Therefore, **immediate upgrades** should be implemented to ensure the Kimugu Water Treatment Works can continue to reliably provide high quality water. A budget figure for making limited upgrades has been included in the cost estimates for feasibility analysis, but detailed requirements will need to be developed as part of preliminary design.

Decisions regarding the future use of the facility after the dam is constructed will need to be evaluated subsequently, but apparently deteriorating raw water quality and the need for pumping detract from the facility's attractiveness as a future source of finished water. The 1983 Final Design Report for the Kericho Water Supply Scheme noted that "the Kimugu works could continue to be utilized without additional capital investment at least until 1990 when pump and motor renewals would become necessary. They could however, with limited capital investment, be operational until 2000." The two primary options presented assumed the Kimugu Water Treatment Works would be abandoned either in 1990 or 2000.[27]

5.2.4 Water Distribution

5.2.4 (a) Water Distribution Description

5.2.4 (a) 1. Service Area

The Kericho water distribution network covers an area of approximately 70 km^2 and consists of approximately 100 km of water mains varying from 63 mm (2.5 inch) to 315 mm (12 inch) diameter and 11 storage tanks.[28] Most of the distribution network consists of polyvinyl chloride (uPVC) pipes. Less than 10 km of other types of pipe such as asbestos cement (AC) and galvanized iron (GI) exist, mostly in the older portions of town and at river and road crossings. The majority of the distribution system covers the rural area and was installed around 1990. Some of the oldest mains in the town center were replaced in the 1960s.

The distribution system is usually served entirely by gravity from water produced at the Timbilil Water Treatment Facility located at the northeastern end of the distribution system. From there, water generally flows southwest and is distributed to 11 storage tanks serving four pressure zones. The pressure zones step down from the Timbilil Water Treatment Works toward the southwestern portion of town. During the dry season, the Kimugu Water Treatment Works pumps supplemental finished water to water storage tanks located in the center of Town near the Tea Hotel.

KEWASCO has estimated that the network covers an area in which approximately 75% of the population of Kericho (85,000 people) reside. Estimates included in this study indicate that the present population served by either a piped direct connection or water kiosk is approximately 64,000. In the early 1990s, the distribution system reportedly covered an area of approximately 46 km^2, including approximately the 10 km^2 urban center and 36 km^2 of rural area.[29] Some expansions have taken place to extend services to additional areas including new areas resulting from the 1998 extension of Town boundaries from a 66 km^2 area to its present area of 111 km^2.

Detailed mapping of the distribution system was prepared in 1983 by H.P. Gauff and a hydraulic modeling effort was conducted in 1985. Distribution system mapping has not been updated since this time.

In order to keep pace with population growth and expand service to new areas, thousands of new water service connections will be required during the study period. In addition to new services within the existing

service area, three areas have been specifically identified by KEWASCO for future service extension. These areas include Ngecherok, Kapcheptoror, and the proposed Chelimo Residential Estate. These areas are depicted in Figure 5-17.

Ngecherok is located northwest of the existing Kericho distribution network adjacent to the B1 road extending northwest from the E222 road. This approximately 22 km^2 area is presently served by an independent water provider and includes a water storage tank located in Telanet, approximately four to five kilometers from the existing distribution network. Service would be provided to this area by adding pumping from the existing distribution network near the E222 road to the existing tank.

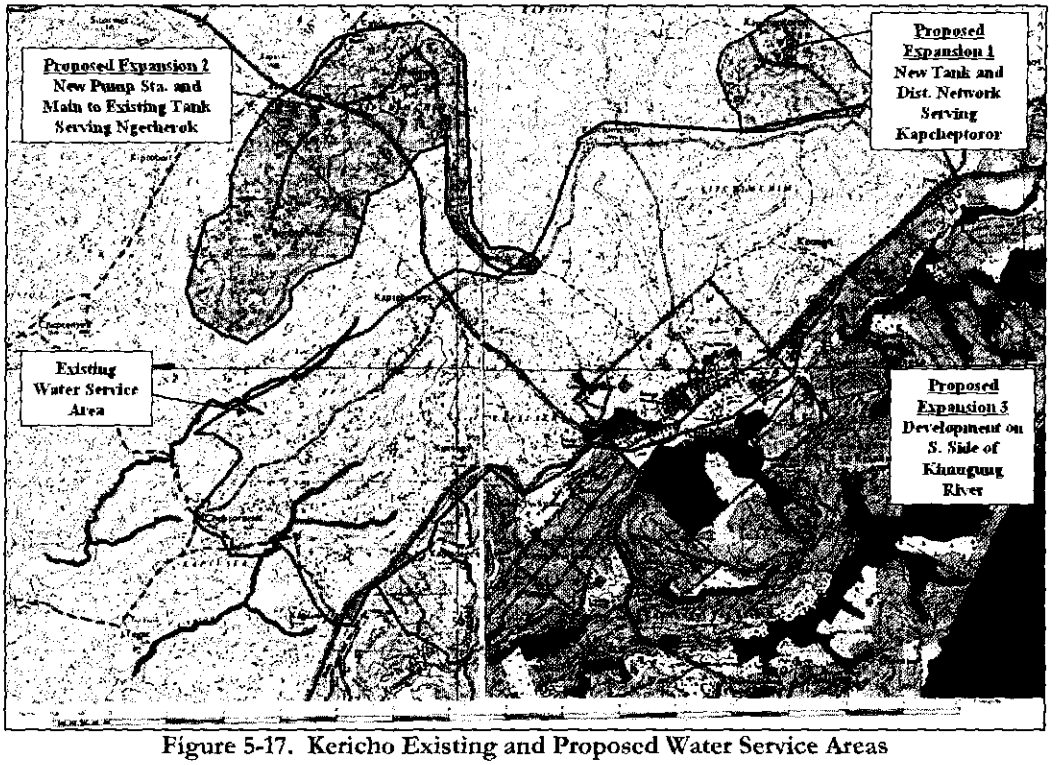


Figure 5-17. Kericho Existing and Proposed Water Service Areas

The Kapcheptoror area consists of approximately 10 km^2 located north of the water treatment plant. Land use in the area consists primarily of small scale agriculture. The area has two secondary schools, four primary schools, and approximately 300 homesteads and 2,000 residents. Land has been identified for locating a new water storage tank to serve the area (Figure 5-18).

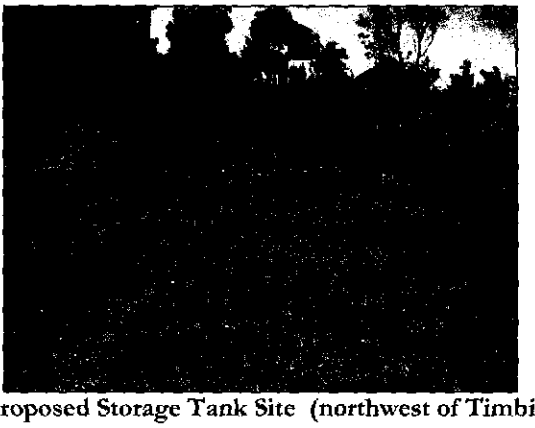


Figure 5-18. Kapcheptorot Proposed Storage Tank Site (northwest of Timbilil Water Treatment Works)

The Chelimo Residential Estate is a proposed future housing and shopping area to be located on the southeast side of the Kimugung River near the central business district. It is expected that the area will house over 1,000 people. A timeline for construction of this development has not been developed.

5.2.4 (a) 2. Pressure Zones

The water distribution network is divided into four pressure zones, each consisting of a looped pipe network. Each pressure zone is served by storage tanks located in the upper reaches of each zone (Table 5-9).

The pressure zones start from the Timbilil Water Treatment Works at the northeast end of the distribution system and extend southwest to Cheptororiet and Kapsuser at the southwestern end. Zone I extends from the Timbilil Water Treatment Works southwest into portions of Kipchimchim and Keongo. Zone II includes the upper part of the town center and areas to the northwest and northeast including Motobo and Kaboruso. Zone III includes the lower part of the town center and areas to the southwest of the old township boundary toward the Kerenga area. Zone IV includes the remainder of the distribution network extending southwest to Cheptororiet and Kapsuser.[30]

According to 1985 mapping prepared by H.P. Gauff associated with its hydraulic modeling efforts, static pressures vary significantly throughout the distribution network. A copy of the modeling study report was not available.

5.2.4 (a) 3. Storage

The Timbilil Scheme O&M Manual (Volume I, Description of Works) notes that 7,253 m^3 of water storage exist in Kericho (Table 5-9). This includes finished water storage at the Timbilil Water Treatment Facility plus 11 additional tanks located thtoughout the distribution system. According to KEWASCO, most of the tanks were installed around 1990, although one tank near the town center is 40 years old.

According to the 2004/2005 KEWASCO Annual Report, eleven storage tanks exist in Kericho with a total storage capacity of 5,980 m^3.[31] It is assumed that the Timbilil Water Treatment Works clear water tank has not been included in KEWASCO's volume calculation and that T304 is not operational [(7,253 m^3 total) – (1,250 m^3 at Timbilil) – (23 m^3 at T304) = 5,980 m^3]. Note that T23 has the same volume as the Timbilil Water Treatment Works tank, but its bulk water meter is reportedly working and it is the primary tank for the town center so it is assumed to be in service.

Based on the preceding analysis, the current available storage is therefore assumed to be between 5,980 m^3 and 7,253 m^3. According to the Timbilil Scheme O&M Manual (Volume I, Description of Works), adequate land for expansion of storage facilities has been acquired.

Table 5-9. KEWASCO Water Storage [32, 33]

Pressure Zone and Static Head (m)	Storage Tank Name and Location	Volume (m^3)
Zone I 2,123 m	Timbilil Water Treatment Works Clear Water Tank	1,250
Zone II 2,053 m	T301 (Chepsetyon Village)	375
	T304 (303?) Sumetyon Village	23
	T305 (Keongo Village)	90
	T307 (Saoset Village)	2,500
Zone III 2,026 m	T23 (Town Center)	1,250
	T23A (Town Center)	500
	T23B (Town Center)	450
	T13 (Chepkurbet Village)	500
Zone IV 1,963 m	T308 (Kapsoiyo Village)	90
	T310 (Kapkonyinyis Village)	90
	T313 (312?) (Kapsuser Village)	135
TOTAL		**7,253**

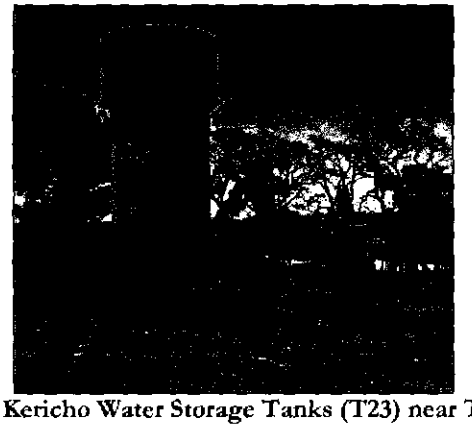


Figure 5-19. Kericho Water Storage Tanks (T23) near Town Center

5.2.4 (a) 4. Hydrants and Fire Protection

Mapping produced by H.P. Gauff in 1983 shows fire hydrants within the old township boundary. However, the Project Team did not observe any hydrants in Town and it is assumed that hydrants have not been installed. The 2004/2005 KEWASCO Annual Report notes that the purpose of existing storage facilities is "for balancing the variation of consumption and to cater for emergencies during breakdowns". The use of the existing distribution system for fire protection is not mentioned in the Annual Report.

5.2.4 (a) 5. Unaccounted For Water and Metering

Unaccounted For Water

Current UfW is estimated at approximately 50%. Therefore approximately 3,600 m^3/d are lost via leaks and unmetered usage. KEWASCO expects that the principal source of loss is leakage. If this percentage were immediately reduced to 15%, the number of people KEWASCO could serve would rise from approximately

63,000 to over 100,000. Clearly, nearly doubling the number of customers served without increasing water production would have a huge impact on the health and economic well being of the town as well as KEWASCO's revenues.

Unaccounted-for-water can be mote clearly identified and isolated through the collection and analysis of bulk and consumer water meter data. KEWASCO currently has a 'UfW Section' including staff whose duties include:

1. Investigations on unaccounted for water
2. Investigation on illegal consumptions
3. Dismantling illegal water connections
4. Scouting for theft of water
5. Supervising new connections according to set standards
6. Servicing of water meters and replacement of worn out meters
7. Preparation of detailed reports on results of unaccounted for water

Reports or data from the UfW Section were not provided.

Bulk Water Meters

Bulk meters are required to quantify UfW, assess system integrity, and isolate problem ateas. KEWASCO has reported that nine bulk meters exist in the system, six of which are reportedly working and three of which are missing countets (Table 5-10). A map provided by KEWASCO indicates the bulk meters are distributed throughout pressure Zones I and II and the upper part of Zone III. No master meters exist in southwest portion of system (lower portion of Zone III and Zone IV). It is unclear if master meters ate currently being used for UfW assessment, but KEWASCO noted that data from periodic readings is available.

Table 5-10. KEWASCO Bulk Water Meters[34]

Name	Location	Size (mm)	Status
M1	Near Timbilil Treatment Facility	300	Working
M2	Tank 307 (Saoset Village)	250	Working
M3	Tank 305 (Keongo Village)	100	No Counter
M4	Tank 304 (Sumetyon Village)	50	No Counter
M5	Tank 301 (Chepsetyon Village)	200	No Counter
M6	Tank 23 (Town Center)	100	Working
M7	Tank 13 (Chepkurbet Village)	200	Working
M8	Siloam	250	Working
M9	Bridge View	100	Working

Consumer Water Meters

At the end of June 2005, KEWASCO had over 7,867 registered customers, of which 5,259 (67%) were reportedly 'active'.[35] The remaining 2,608 'non-active' connections include accounts which were disconnected by the utility and have not been reconnected or customers who terminated their own connection. KEWASCO noted that although meters are issued to all customers, consumption is estimated for 2.4% of active accounts due to meter damage or inaccessibility. According to KEWASCO, ~75% of existing consumer meters are over 10 years old and many ate over 40 years old.

5.2.4 (a) 6. Public Water Kiosks and Water Vendors

Water Kiosks

There are 11 water kiosks installed throughout the distribution system, four of which are reportedly operational (Table 5-11). Water is sold from kiosks for two KShs per 20-liter jerrycan. The total number of 20-liter jerrycans sold daily from kiosks in Kericho is estimated at 49. However, the age of meters installed at functioning kiosks is unknown and KEWASCO records may underestimate actual volumes.

Table 5-11. KEWASCO Water Kiosks[36]

Name	Location	Status	Annual Water Sales (m^3)	Avg. No. of 20-liter jerry cans sold daily
W1	Kapkugerwet	Working	159	22
W2	Brook Market (Kapkugerwet)	Working	145	20
W3	Kipchimchim (near T301)	Not Working	N/A	N/A
W4	Kwa Michael Estare	Not Working	N/A	N/A
W5	Mjini (Somali Village)	Not Working	N/A	N/A
W6	Maji Kubwa (Motobo)	Working	42	6
W7	Kaptebeswet (near T13)	Working	10	1
W8	Tegat (far southwest)	Not Working	N/A	N/A
W9	Kapsuser (far southwest)	Not Working	N/A	N/A
W10	Kapkonyinyis (near T310)	Not Working	N/A	N/A
W11	Duka Moja (Mawelji)	Not Working	N/A	N/A
		TOTAL	**356**	**49**

Figure 5-20. Water Kiosk (W1) at Kapkugerwet Market

Water Vendors

According to KEWASCO, very few water vendors exist in Kericho. Most residents without access to a piped water source obtain water from one of the many streams in Town. KEWASCO has noted that private wells also exist, but the exact number of wells is unknown. Some residents also utilize private rainwater harvesting systems.

5.2.4 (b) Water Distribution Needs

As noted above, current UfW in Kericho is estimated at approximately 50%. If this percentage were immediately reduced to 15%, the number of people KEWASCO can serve would rise from approximately

63,000 to over 100,000 and revenues would increase dramatically. Reduction of UfW should be a main priority for KEWASCO.

Most of the existing distribution network was constructed within the past 20 years and is therefore relatively new. Most of the mains outside the old township boundary were constructed in 1988 or later. Mains within the old township boundary are older and likely to require replacement. The large UfW is partially attributable to leaks in the distribution system. KEWASCO has noted that the company is aware that some water mains are in need of replacement, but that the relatively high cost or replacement and lack of funding has prevented this from occurring. Leaks in the distribution system need to be identified and repaired.

A second potential source of UfW is illegal connections. KEWASCO expects that some illegal connections exist in Kericho, but that they contribute a relatively small percentage of overall UfW compared to other sources of UfW. Over 2,600 'non-active' service connections exist in Keticho, some of which may possibly have been reconnected illegally. Any illegal connections should be eliminated or metered and registered.

Existing bulk and consumer water meters are currently in need of repair and replacement, and new meters are required. Bulk metering is important for identification of UfW sources and troubleshooting, while consumer meters act at the "cash register of the water system". Consumer meters older than 10 years are generally expected to be under recording flows, thereby reducing KEWASCO revenue. Considering an estimated 75% of consumer meters ate over 10 years old, most meters in Town are in need of replacement. KEWASCO estimates that approximately 4,000 meters probably need replacement. Additional meters are expected to be required for registering illegal connections. Working bulk meters are needed throughout the distribution system and data should be recorded and analyzed regularly.

Additional service connections are required within the existing distribution system to keep pace with population growth and also to extend service to proposed expansion ateas resulting from expanded town boundaries and continued development.

According to the 2005 Practice Manual for Water Supply Services in Kenya, water storage volume should include balancing storage to reduce peak flows and emergency storage to safeguard against interruption of supply. Balancing storage should be 50% of the daily water demand of the area served by the tank, while emergency storage should provide water sufficient for a 12 hour supply breakdown. Therefore, assuming any 12 hour supply breakdown will require approximately 50% of daily water demand, total required storage is approximately one day's demand. Present storage capacity of approximately 6,000 to 7,000 m^3 is close to Kericho's average day demand (7,279 m^3/d in 2004/2005) and is therefore adequate for present conditions. Additional storage will need to be added as the service area expands and production increases. Existing and new storage facilities will require regular maintenance.

According to the 2005 Practice Manual for Water Supply Services in Kenya (pg A 28), it is recommended that "capacity for fire fighting should not be less than 10 lps for 2 hours". It also notes that providing fot piping not less than 100 mm or 150 mm in very high value commercialized ateas normally ensures adequate water supply at the bydrant (pg A 116). Consideration should be given to increasing diameters and capacity of water mains and installation of hydrants to allow for fire fighting capacity.

The condition of the water kiosk visited by the Project Team in Kapkugerwet (the most frequently used kiosk in Kericho) was poor. Although KEWASCO has noted there is not a major demand for water from kiosks in most areas, existing kiosks should be upgraded, standardized, and commercialized after an assessment of kiosk viability. It is expected that kiosks will serve as important infrastructure for informal settlements such as the one near Kapkugerwet market.

5.2.4 (c) Water Distribution Recommendations

The primary focus for immediate work related to the distribution system should be focused on reducing UfW and improving metering. Detailed planning for distribution system improvements and expansion is beyond the scope of this study, but preliminaty phasing and costs have been estimated for the purpose of feasibility analysis. More detailed analyses will be required to clearly define required projects and expansion areas. Recommendations regarding the distribution system and estimated costs and phasing are included in the detailed matrices (Appendix 5-2). Note that some distribution system-related recommendations are included in the 'Management' section of the matrices. Recommended activities include, but are not limited to the following:

- Repair existing **bulk water meters** and add new bulk water meters.
- Institute a program of **consumer meter replacements.** Identify and remove or register and meter **illegal connections** by implementing a comprehensive program utilizing the toolkit proposed to be developed by LVSWSB.
- Implement a **pilot consumer water meter replacement program** utilizing automatic reading water meter technology.
- Conduct a **water audit** to determine main sources of water losses.
- Perform **hydraulic modeling** of the water distribution system and develop a **distribution system improvement plan.**
- Perform **leak detection and repair.**
- Evaluate existing **water kiosks** and devise a plan for rehabilitation, standardization, and commercialization of kiosks. Train operators and make required improvements.
- **Expand service area and install new water service connections.** More than 7,500 new water service connections are expected to be required during the study period. New required facilities will include mains and service connections, valves, hydrants (to be determined), bulk and consumer water meters, storage, and pumping systems for remote high elevation areas.

5.3 Wastewater

5.3.1 Wastewater Overview

Kericho's wastewater system includes a piped collection system and centralized wastewater treatment facility. The collection system covers most of the central business district north of the main B1 road and a portion of town north of the Dionsoyiet River. A project is currently underway to extend the collection system to homes and business near the center of town on the south side of the B1 road. The wastewater treatment facility is located in the town center near the District Hospital and reportedly has a capacity of 990 m^3/d. The facility discharges treated effluent to the Dionsoyiet River.

The wastewater system serves an estimated 9,700 people via approximately 1,700 piped sewer connections and six public toilets (although at least one public toilet is not connected to the collection system). KEWASCO has estimated that approximately 60% of potential customers in the existing sewer service area are connected.[37] Calculations performed in this study estimate the connection percentage in the service area is approximately 65%. The remainder of the Town population (over 100,000 people) relies on on-site wastewater disposal methods, primarily pit latrines.

5.3.2 Wastewater Collection

5.3.2 (a) Wastewater Collection Description

Available mapping of the wastewater collection system provided by KEWASCO was prepared in 1978 and does not represent the full current extent of the sewer network. An approximation of the current extent of the sewer network is shown in Figure 5-21. In 1991, GKW Consult prepared a Draft Design Criteria Report for upgrades to the wastewater treatment facility. The document includes a description of the existing sewer network at that time.

According to KEWASCO and available mapping, the present collection system covers most of the area between the Dionsoyiet River and the B1 road extending northeast from the wastewater treatment facility to the Tea Hotel. All wastewater collected from this area south of the Dionsoyiet River flows to the wastewater treatment facility (elevation ~1,950 m above sea level) by gravity. Some areas on the north side of the Dionsoyiet River are sewered including Somali Village and portions of Swahili Village extending to the northwest corner of the old township boundary. The Kenya Cooperative Creameries (KCC) dairy located northeast of Somali Village is also connected to the sewer system. Wastewater from areas on the north side of the Dionsoyiet River is transported by gravity to a pump station located on the south side of the river, approximately ½ km northeast of the wastewater treatment facility (Figure 5-22). This is the only sewer pump station in Town and is called Somali Village Sewer Pump Station (Figure 5-23 and Figure 5-24).

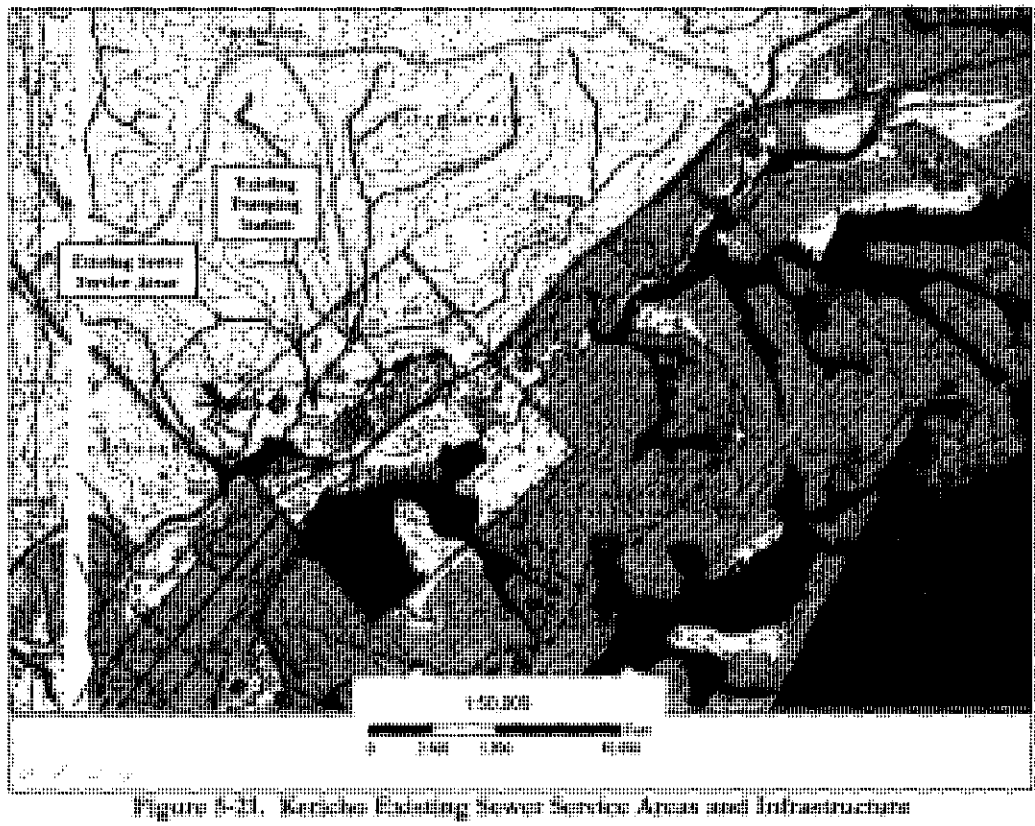


Figure 5-21. Kericho Existing Sewer Service Areas and Infrastructure

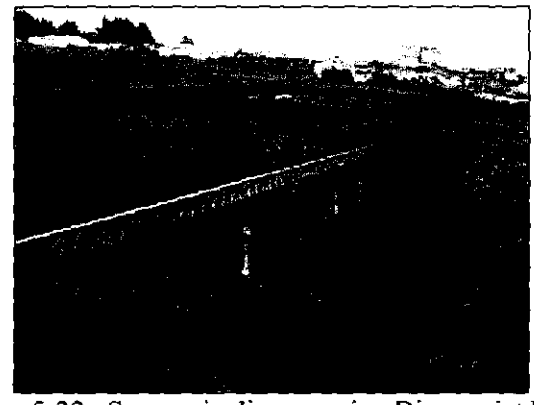


Figure 5-22. Sewer pipeline crossing Dionsoyiet River

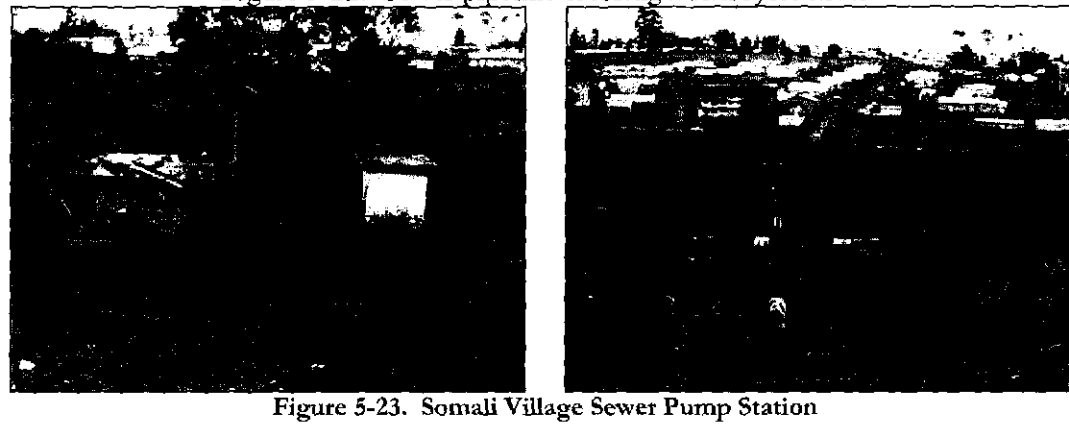


Figure 5-23. Somali Village Sewer Pump Station
Pump Station Buildings (left); Pump Station with Somali Village Area in Background (right)

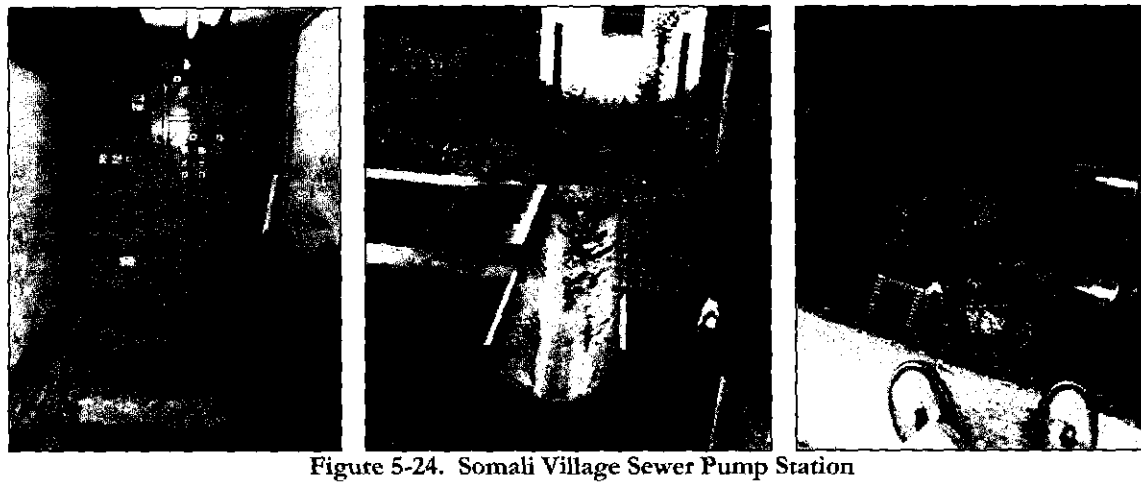


Figure 5-24. Somali Village Sewer Pump Station
Main panel (left); Screening and overflow (center); Overflow discharge (right)

The Somali Village pump station has no standby pump, no excess capacity, and experiences frequent pump failures, blockages and overflows. The facility is not equipped with a backup generator and therefore allows raw sewage to overflow into the Dionsoyiet River when power is not available. An existing sewer main on the north side of the Dionsoyiet River referred to as the 'KCC line' is reportedly prone to blockages during high flows, which KEWASCO has attributed to insufficient slope of the sewer main.

The existing collection system is a "partially separate" sewer in that it is intended to receive limited stormwater from specific authorized areas including the open air market and slaughterhouse adjacent to the

treatment facility. KEWASCO has noted that slaughterhouse blood is washed into sewers leading to the treatment facility, although some blood finds its way to the river. Stormwater from most other areas is diverted directly to the Dionsoyiet River. GKW Consult noted that all sewers are laid above existing groundwater levels and therefore negligible groundwater infiltration is expected. However, unauthorized stormwater is expected to be entering sewers due to illegal connections and through leaking manhole covers. KEWASCO has noted that it observes flow surges at the treatment facility during rain events. The GKW Consult report noted that the sewers should be designed for twice the sewage peak flow in order to accommodate stormwater entry and infiltration. The use of concrete pipes was recommended by GKW Consult and it is assumed that most piping is concrete with diameters of 225 mm or more for trunk and branch sewers and 100 mm or more for property connections.

Some large water users near the Town center are currently not connected to the existing wastewater treatment facility, including:

- Kericho Teacher's Training College (south of B1 road, currently has on-site lagoons)
- Kericho Central Hospital (adjacent to Teacher's Training College)
- Kericho Primary School (south of B1 road)
- Kericho Tea Secondary School (south of B1 road)
- Kericho Boys Boarding School (north of Swahili Village)
- Kericho Bible College (north of Swahili Village)
- Milimani Academy

The institutions located south of the B1 road are to be connected to the existing sewer system by 2008 as part of an ongoing sewer extension project to extend sewers south of the B1 road. As of August 2006, KEWASCO reported that 1.5 km out of an expected 5.4 km of sewer mains required to serve this area were completed. The expanded collection system is expected to utilize gravity only, but KEWASCO has noted that a pump station may be added to collect wastewater from additional areas. KEWASCO has noted its desire to extend sewers further southeast down the hill toward the Kimugung River in order to protect river water quality.

Public Toilets

KEWASCO provided information on seven public toilets in town (Table 5-12). Two of the seven public toilets are connected to the sewer, while the remainder utilize septic tanks. Only Public Toilets 1 through 6 are shown on mapping provided by KEWASCO. The 1991 Kericho Sanitation Project Draft Design Criteria Report (GKW Consult) envisioned that six public toilets would be constructed, four of which would be served by septic tanks, and two of which would be connected to the sewer (Somali Village and Green Stadium). The sizing for the public toilets was to be based on the theory that for 1,000 users, eight (8) slabs and four (4) urinals would be provided for males, and ten (10) slabs per 1,000 users for women[38]. The toilets are presently not commercialized. They are managed by Kericho Municipal Council, but KEWASCO expects to eventually take over operation of the facilities.

Table 5-12. Kericho Public Toilets[39]

Name	Location	Number of Stalls	On Sewer or Septic Tank?	Water Flush?	Water Available?	Security Adequate?	Lighting Adequate?	General Conditions
PT1	Kwa Michael Estate	6	Septic Tank	Yes	No	Yes	No	Good but not in operation
PT2	Green Stadium	6	Septic Tank	Yes	Yes	Yes	Yes	Good
PT3	Open air Market near Stadium	6	Septic Tank	Yes	No	No	No	Good
PT4	Nyagacho (Somali Village)	6	Septic Tank	Yes	No	No	No	Good
PT5	Kericho District Hospital	6	Sewer	Yes	Yes	Yes	Yes	Good
PT6	Kapsuser Market	6	Septic Tank	Yes	No	No	No	Good but not in operation
PT7	Uhuru Garden (Town Center)	4	Sewer	Yes	Yes	Yes	No	No information provided

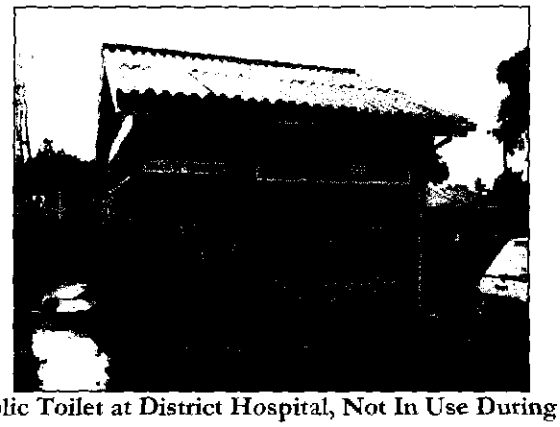


Figure 5-25. Public Toilet at District Hospital, Not In Use During April 2006 Visit

On-Site Wastewater Systems

Most residents in Kericho Town rely on on-site wastewater management systems. These typically include pit latrines for domestic use, although some tight tanks and septic tanks with soakage pits exist. Septic tanks and tight tanks are thought to be primarily limited to commercial, industrial, and municipal facilities outside the sewer service area, such as at the KETEPA Tea Company Factory near Kapkugerwet, which uses a septic system (Figure 5-26). It is expected that thousands of pit latrines exist in Kericho. Assuming one pit latrine or septic system exists for every 10 to 20 persons not connected to the sewer, there may be 5,000 to 10,000 on-site wastewater disposal systems in Kericho.[1]

[1] Assumes approximately 100,000 people not connected to sewer. Design standards used in the 1991 Kericho Sanitation Project Draft Criteria Report by GKW Consult note that one latrine would serve 16 people and one septic tank would serve 10 people.

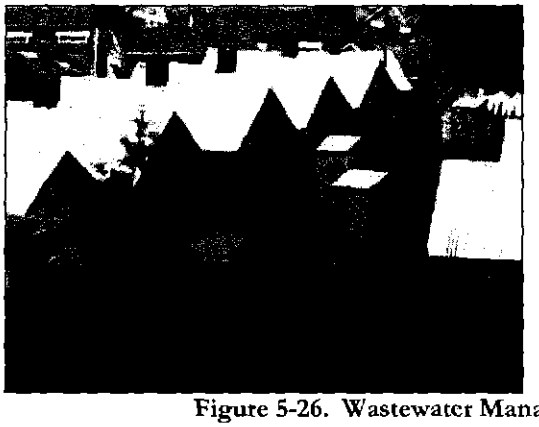
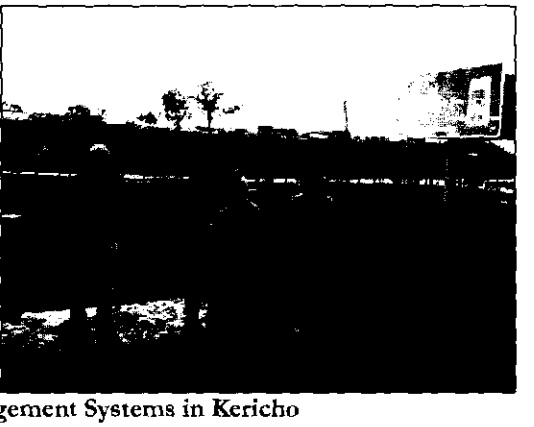



Figure 5-26. Wastewater Management Systems in Kericho
***Latrines* for tea worker residences near Kapkugerwet Market (left)**
Septic tank and leaching area at KETEPA Tea Company Factory (right)

Latrines, septic systems, and tight tanks require periodic pumping to remove accumulated solids or liquids and solids (septage). However, it is expected that solids are not removed from many household pit latrines and that they are simply abandoned when full. Septage removal is typically accomplished by one of four exhauster trucks and tractors operating in town. In August 2006, KEWASCO noted it owns and operates one septage exhauster (Figure 5-27) and that three private exhausters also exist in town. The private exhausters are owned by James Finlay Tea Company, Unilever, and the Tea Research Foundation. KEWASCO subsequently provided data on exhauster trips and total liters (Table 5-13).

Table 5-13. Kericho Town Exhauster Services Records (July 2005 to June 2006)

	TRIPS BY PRIVATE EXHAUSTERS			TRIPS BY KEWASCO EXHAUSTER		
	James Finlay	Unilever	Tea Research Foundation	From Unwin & Sons	From KETEPA	From Other
Jul-05	85	35	18	8	25	
Aug-05	93	44	15	16	15	
Sep-05	96	25	27	8	10	2
Oct-05	21	22	59	13	2	66
Nov-05	88	6	20	5	21	1
Dec-05	86	26	26	5	3	17
Jan-06	60	26	10	7	6	
Feb-06	50	27	11	6	2	2
Mar-06	87	25	6	9	27	1
Apr-06	41	24	12	5	25	3
May-06	68	25	2	13	1	2
Jun-06	82	25	6	10	2	1
TOTAL TRIPS	857	310	212	105	139	95
TOTAL m^3	2,571	1,240	840	525	695	475
m^3/trip	3	4	4	5	5	5
GRAND TOTAL (m^3/year)			6,346			
LITERS PER CAPITA PER YEAR			56	(based on town pop. of 113,000)		

Some facilities may utilize tight tanks and therefore discharge a greater volume per capita because it which would include liquids. According to the 1991 Kericho Sanitation Project Draft Design Criteria Report,

estimated sludge production rates from latrines and septic tanks are 60 liters/capita/year and 35 liters/capita/year, respectively.[40] The per capita figure listed in Table 5-13 may not correspond to these estimates because the figures may include tight tanks pumping solids and liquids. Also, it is expected that solids are not removed from many pit latrines and that they are simply abandoned when full.

All exhausters operating in Kericho Town are required to discharge at the wastewater treatment facility, where KEWASCO maintains a septage receiving facility near the headworks (Figure 5-27). KEWASCO noted that haulers typically obtain a minimum of 3,000 KShs per exhauster load, which reportedly varies from 5 to 7 m^3 (note that Table 5-13 indicates exhauster loads varying from 3 to 5 m^3). This charge includes the 1,500 KShs fee charged at the treatment plant, plus additional charges to cover mileage expenses and profit. The septage receiving station and sludge disposal are discussed under heading 5.3.3.

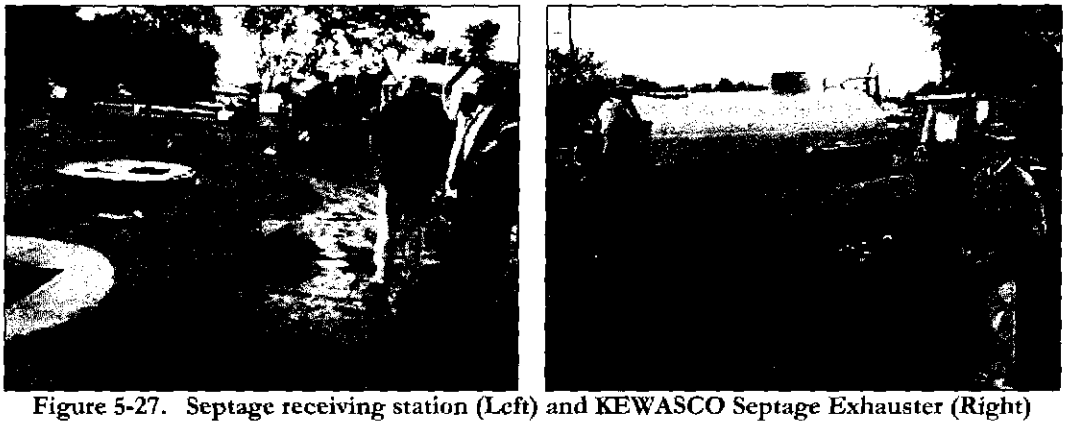


Figure 5-27. Septage receiving station (Left) and KEWASCO Septage Exhauster (Right)

5.3.2 (b) Wastewater Collection Needs

Revised sewer system mapping and clarification regarding which buildings have sewer connections is required before detailed collection system planning can take place. Also, clarity regarding where stormwater is intentionally diverted to the wastewater collection system is required. An infiltration and inflow (I/I) analysis should be conducted to determine the source of additional flow received during rainfall events and ensure downspout connections and other unauthorized connections do not exist.

KEWASCO has estimated that approximately 60% of potential customers in the existing sewer service area are connected.[41] The existing treatment facility has excess capacity. Therefore, there is an apparent need to increase sewer connections by "infill". A prioritized list of targeted new sewer connections is required, starting with large water users located within the existing sewer service area. All schools, hospitals, slaughterhouses, municipal buildings, public toilets/latrines, markets, sports stadiums, and other public buildings in the existing service area should be connected.

After the most cost-effective infill connections are made, the existing collection system should be expanded to include additional densely developed areas where the use of on-site systems is expected to be problematic. Four areas have been identified for sewer system expansion (Figure 5-28). These include:

1. **Area 1:** Unconnected areas along east bank of Dionsoyiet River, including stadium.
2. **Area 2:** West bank Dionsoyiet River, including some informal settlement areas, Bible college, boys school, and KCC dairy. This expansion may require a new or expanded river crossing.
3. **Area 3:** Area between B1 and Kimugung River, from behind Tea Hotel to and beyond town center. This area is currently being connected via new gravity sewer with expected completion by 2008.
4. **Area 4:** Northeast section of town from Tea Hotel to Kapkugerwet market area along B1 road. The first 2 km may be connected to the existing network by gravity. The remaining portion extending to

Kapkugerwet will require pumping or routing to an alternate treatment facility located along the B1 road.

Expansion Areas 1 and 2 are expected to require pumping, as may some localized areas. Proper design should be able to serve development along B1 to Tea Hotel by gravity, although extension of the sewer to the Kimugung River will require pumping. If a pump station is selected for Areas 3 and 4, it may be located in vicinity of the golf course.

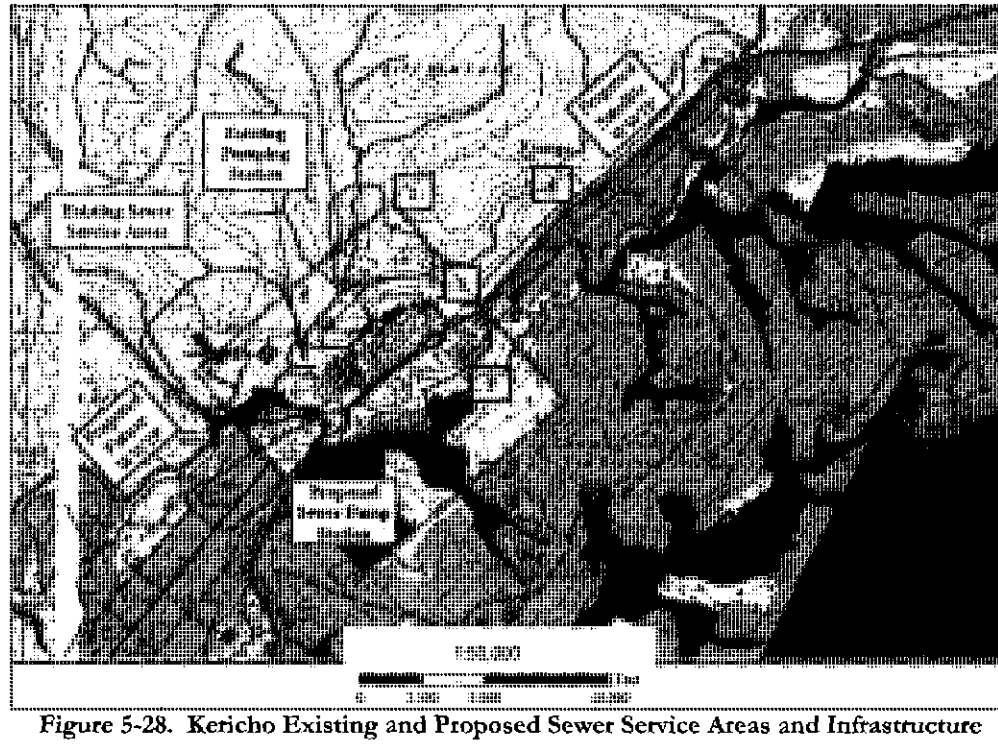


Figure 5-28. Kericho Existing and Proposed Sewer Service Areas and Infrastructure

The existing Somali Village Sewer Pump station is in need of a complete overhaul including new screens, pumps, controllers, and auxiliary power. Relocation of the existing station to near the sludge drying beds at the wastewater treatment facility is advisable in order to improve access to the station and enable auxiliary power to be available for use by both the sewer pump station and the treatment facility.

KEWASCO is in need of sewer flushing and cleaning equipment to quickly eliminate blockages when they occur, especially in the KCC line. KEWASCO has noted the need for a new rotary machine.

Public latrines and toilets are an important piece of wastewater management infrastructure and should be appropriately commercialized, regulated, maintained, and expanded where appropriate. A plan should be developed for KEWASCO to takeover operation of these facilities and ensure this infrastructure is safe, sustainable, and a source of local income generation.

Many on-site wastewater systems (latrines, septic systems, tight tanks, etc.) are expected to be failing in Kericho and may tepresent an acute public health hazard and a public nuisance. Failing on-site systems contaminate local public and private groundwater and surface water supplies. These systems can adequately protect public health and are often more cost effective than public sewers in low density areas. However, these systems must be appropriately designed and maintained in order to protect public health. KEWASCO should institute management systems to inventory and oversee operation of these facilities and ensure they are properly maintained, including periodic pumping of accumulated solids.

Although additional data is required on existing on-site wastewater systems and current amounts of septage pumped, KEWASCO has indicated it needs to replace its existing exhauster and purchase two additional exhausters. An analysis should be performed to detail the exact number of additional equipment required and what impact this will have on privately-operated septage haulers. Such analysis will require additional information and clarity on current septage pumping.

5.3.2 (c) Wastewater Collection Recommendations

The primary focus for immediate work related to the wastewater collection system should be focused on increasing infill connections within the existing service area. Detailed planning for collection system improvements and expansion is beyond the scope of this study, but preliminary phasing and costs have been estimated for the purpose of feasibility analysis. More detailed analyses will be required to clearly define required projects and expansion areas. Recommendations regarding the collection system and estimated costs and phasing are included in the detailed matrices (Appendix 5-2). Note that some collection system-related recommendations are included in the 'Management' section of the matrices. Recommended activities include, but are not limited to the following:

- Identify and begin **discussions / negotiations with large water users** not connected to the sewer collection system and develop incentives to connect them to sewer.
- Conduct **Infiltration and Inflow (I/I) Study** to determine the source of any authorized flow to treatment facility.
- Conduct **detailed planning study to refine proposed sewer expansion areas**. Create **infill connection priority list** based on present water use and proximity to existing sewer collection system. Begin to make infill connections utilizing the priority list.
- Construct **new relocated sewer pumping station** with auxiliary power at the existing treatment facility.
- Purchase **new exhauster(s) and sewer cleaning equipment** as required.
- Develop **on-site wastewater system inventory, tracking system, and program for mandatory periodic inspections and pump-outs including model by-laws**. Utilize toolkit proposed to be developed by LVSWSB. The system should be integrated with electronic mapping systems to the extent feasible. "Off-the-shelf" software programs may be used, but should be customized for local conditions. The system should include provisions for management of private septage haulers including a manifest system and requiring discharge only at approved facilities.
- **Expand service area and install new wastewater service connections.** More than 6,000 new sewer service connections are expected to be required during the study period.

5.3.3 Wastewater Treatment, Disposal, and Residuals Management

5.3.3 (a) Wastewater Treatment, Disposal, and Residuals Management Description

The Kericho Wastewater Treatment Facility was commissioned in 1962 and has been upgraded and expanded several times. It is located on a 9-acre parcel approximately 0.5 km west of the central business district. The facility abuts the Dionsoyiet River to the north and west and a municipal refuse dump to the south.

According to KEWASCO, the facility has a present design capacity of 990 m^3/d. The average daily volume of wastewater received at the treatment facility during the period from July 2004 to June 2005 was 501 m^3/d. Average daily flows varied from a high of 720 m^3/d in April 2005 to a low of 422 m^3/d in August 2004.

The Kericho Wastewater Treatment Facility is a hybrid facility utilizing attached growth biological reactors (trickling filters) as well as a series of lagoons. The facility consists of the following unit operations:

- Headworks including influent screening / grit removal and a septage receiving station

- Two (2) 140 m^3 primary sedimentation tanks
- Two (2) 1,100 m^3 trickling filters with rock media
- Two (2) 140 m^3 secondary sedimentation tanks (with recirculation to trickling filters)
- Two unheated sludge digesters
- Three (3) facultative ponds with approximate volume 7,500 m^3 and surface area of 5,000 m^2.
- Four (4) maturation ponds with approximate volume 18,200 m^3 and surface area 18,200 m^2
- Covered Sludge Drying Beds (approximately 3,000 m^2)

The original facility, commissioned in 1962, was designed by Ward Ashcroft and Parkman to treat wastewater from the town center only. In 1996 and 1997, improvements were made to increase capacity and allow wastewater to be accepted from a larger area. These improvements were designed by GKW Consult and included improvements at the headworks, new recirculation pumps, addition of the combined lagoon system, and sludge drying beds. In order to fully utilize the limited available area between the existing facility and the Dionsoyiet River, the lagoons were constructed in an arced pattern around the existing tankage, stepping down on a series of terraces toward the river. Additional renovations and repairs were completed in 2004 and 2005 including repairs to one trickling filter and one secondary sedimentation tank, both of which reportedly had not been fully operational since 1997. Other miscellaneous repairs included new fencing.

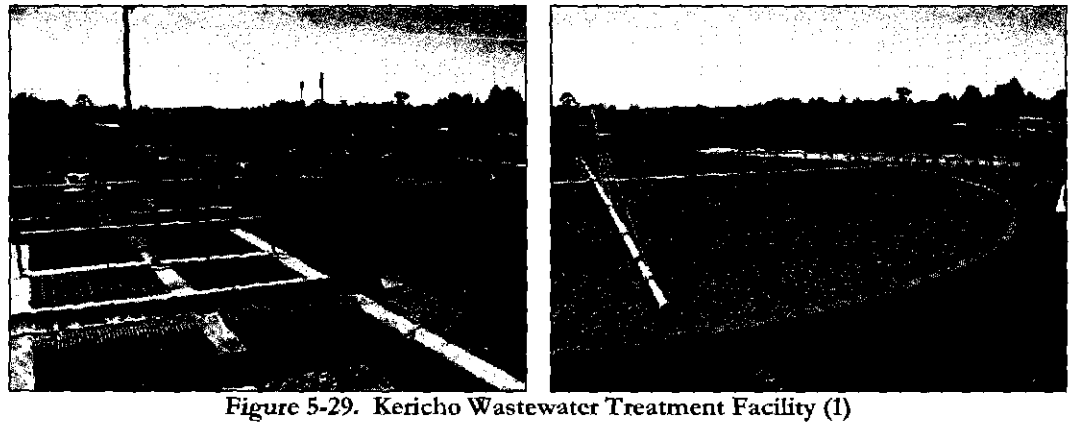


Figure 5-29. Kericho Wastewater Treatment Facility (1)
Headworks and primary clarifiers (left); Trickling filter with drying beds in background (Right)

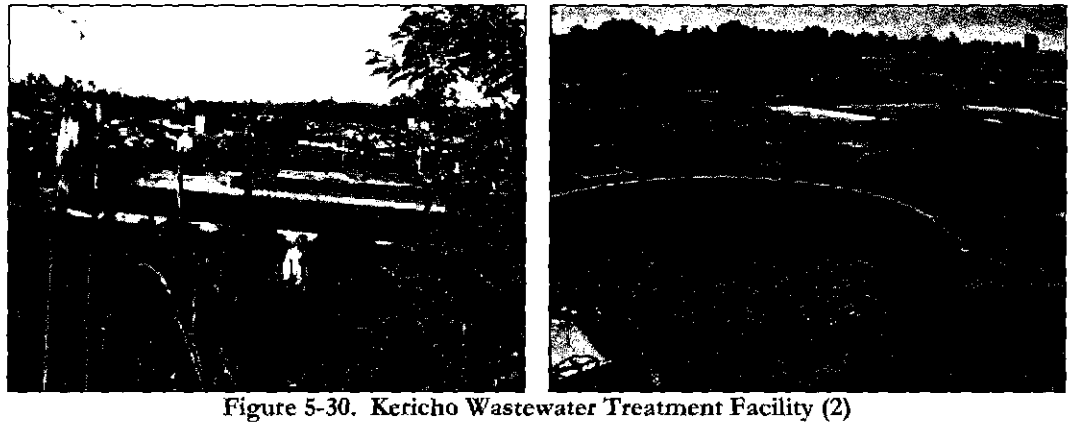


Figure 5-30. Kericho Wastewater Treatment Facility (2)
Terraced lagoons as seen from B1 Road (left); Sludge digesters and lagoons (right)

Figure 5-31. Kericho Wastewater Treatment Facility (3)
Covered sludge drying beds

Wastewater treatment standards provided by KEWASCO are presented in Table 5-14. It is unclear if these are official permit requirements or simply recommended standards suggested by the author of an environmental audit. These requirements are generally as stringent as or more stringent than the wastewater treatment standards presented in Section 2.

Table 5-14. Audit recommended monitoring guide for effluent discharge into Dionsoyiet River [2]

Water Quality Parameter	Limit of Concern After Treatment Not to Exceed
BOD_5	20 mg/l
TSS	30 mg/l
pH	6-9
Fecal Coliform / E. coli	300 / 100 ml
Oil and grease	Nil
COD	50 mg/l
Color/dye/pigment	5/nil/nil
Nitrate	30 mg/l
Chromium	0.5 mg/l
Copper	3 mg/l
Zinc	0.5 mg/l
Fluorine	2.0 mg/l
Cadmium	0.1 mg/l
Lead	1.0 mg/l
Iron	10 mg/l
Tin	1.0 mg/l
Silver	1.0 mg/l
Mercury	1.0 mg/l
Aluminum	1.0 mg/l
Manganese	10 mg/l
Sulfates	250 mg/l

[2] Table provided by KEWASCO from unidentified report (Table 4). Likely source is a Draft of the 2006 Environmental Audit Report.

Sampling is performed at the Kericho Wastewater Treatment Facility (WWTF) for BOD_5, pH, dissolved oxygen, temperature, and turbidity. Total Suspended Solids (TSS), fecal coliform, oil and grease, and other parameters included in Table 5-14 are not sampled by KEWASCO.

The 1991 Draft Design Criteria Report for the facility states that the fecal bacteria count in the effluent should not exceed 5,000 / 100 ml. This design target does not meet the standard presented in Table 5-14 of 300 / 100 ml. Considering the facility does not employ disinfection, it is expected that the effluent fecal coliform count probably does not meet the stated standard of 300 / 100 ml, but may meet the draft design criteria of < 5,000 / 100 ml.

Prior to installation of the lagoons and other upgrades in 1997, the effluent BOD_5 was reportedly near 100 mg/l. After upgrades performed in 2005 (including repairs to one trickling filter and one sedimentation tank), the BOD_5 of the treated effluent was reportedly reduced form 43 mg/l to 30 mg/l. Weekly BOD_5 sampling data was provided by KEWASCO for July 2005 through June 2006 and is summarized in Table 5-15.

Table 5-15. Kericho WWTF Summary of BOD_5 Sampling (mg/l) from July 2005 through June 2006

	Inlet	Primary Sedimentation	Trickling Filters	Humus (Secondary Sedimentation)	Maturation Pond 3	Effluent
	mg/l BOD_5					
Mean	886	446	212	84	40	30
Maximum	960	500	235	94	45	40
Minimum	800	380	180	74	32	27
Standard Deviation	40	28	13	4	2	3

The facility receives wastewater with a very high BOD_5 loading (average 886 mg/l). According to the Aftercare Study on the National Water Master Plan, the national standard for effluent discharged to public sewers is 450 mg/l. The source of the high BOD_5 is likely to be a result of low water use (i.e. high concentration) and inputs from high BOD industries such as slaughterhouses and dairies, which do not have pretreatment systems.

The data indicate an overall BOD_5 reduction rate of 97%. However, average BOD_5 concentrations in the effluent exceed the standard presented in Table 5-14 of 20 mg/l. It should be noted that the Draft Design Criteria Report noted a goal of BOD_5 reduction to 25 mg/l.[42]

Reported BOD_5 concentrations from samples taken throughout the facility remain remarkably consistent throughout the year. Despite a very high average influent BOD_5 of 886 mg/l, the standard deviation is only 40 mg/l.

According to the 1991 Draft Design Criteria Report, BOD_5 concentrations at the inlet to the facultative ponds should not exceed 250 mg/l.[43] The document also notes that the maturation ponds are aerobic and, in order to guarantee aerobic conditions within the pond, the BOD_5 load at the inlet should be between 50 – 70 mg/l. The sampling data appear to indicate that these criteria are probably being met most of the time.

Other recent sampling data provided by KEWASCO from Kericho WWTF is presented in Table 5-16. The data presented is from sampling performed at the effluent.

Table 5-16. Additional Kericho WWTF Sampling data from August 2005 through June 2006

	pH	Turbidity (NTU – assumed)	Dissolved Oxygen (mg/l assumed)	Temp (deg C)
Aug-05	Machine out of order	10.5	8.11	33.9
Sep-05		10.8	8.70	30.0
Oct-05		9.8	4.65	22.8
Nov-05		11.7	5.01	22.0
Dec-05		10.0	5.62	23.9
Jan-06		9.5	8.10	22.2
Feb-06		Machine out of order	7.03	22.1
Mar-06			7.64	23.4
Apr-06			4.14	23.3
May-06			1.51	20.1
Jun-06			1.31	36.4

Kericho has reported that it removes 2,016 tons of dried sludge from the treatment facility drying beds annually. Data on the solids content of the sludge and its chemical and biological composition is not available. All dried sludge (biosolids) is given away free of charge to local residents, who typically pick up the material using 1-ton pickup trucks.

5.3.3 (b) Wastewater Treatment, Disposal, and Residuals Management Needs

Available data indicate that the facility is functioning well and reducing incoming BOD from over 800 mg/l to 30 mg/l on average. However, clarity is required regarding the specific effluent requirements for the facility. A copy of the existing effluent discharge permit was not available during the study. It is unclear if the standards presented in Table 5-14 are the actual permitted standards.

The high BOD load received at the facility is likely to be caused in part by high strength discharges from local industrial and commercial facilities such as slaughterhouses and dairies. Pretreatment should be installed to ensure discharges meet standards for discharge to sewers.

During the Project Team visit, one of the trickling filter arms did not appear to be functioning and the second did not appear to be distributing flow evenly over the media. The arms are currently powered by hydraulic pressure, but electric motors should be added to ensure they consistently function properly. Other needed improvements include a digester mixing system and possible biogas production facility; new drying bed covers to replace existing covers which do not allow sufficient light to pass through; an algae baffle prior to the effluent discharge to reduce TSS and algae BOD; improvements to the septage receiving station including a decanting system; and addition of an aesthetic vegetative buffer around the facility.

Additional laboratory equipment is required to enable KEWASCO to measure TSS, fecal coliform, and other parameters relevant for its permit and for process optimization. In addition, periodic samples taken at the treatment facility should be sent to the LVSWSB laboratory for quality control checks.

Present average day flows of 501 m^3/d indicate that the existing wastewater treatment facility has significant excess capacity (based on reported design capacity of 990 m^3/d) and could therefore nearly double its present incoming flow rate. In order to add additional capacity and improve performance at the facility, aeration could be added to the lagoons and a third trickling filter could be added north of the existing filters. Such

upgrades may be capable of increasing the capacity of the existing facility by about 50% to 1,500 m^3/day. Additional detailed data and study is required to determine the potential for increased capacity at the existing site.

Once the capacity of the existing treatment facility site is reached, one or more additional treatment facilities will be required. The timing of the need for new facilities will depend on the pace of adding connections to the existing facility and how much additional capacity can be obtained at the existing site. However, it can reasonably be assumed that one or more new facilities will be required by the end of the study period. A site has been identified for a new treatment facility approximately 2 km southwest of the existing facility along the C23 road adjacent to the Dionsoyiet River. The parcel is over 2 ha in area and is at approximate elevation 1,920 m above sea level (the existing facility is at approximately 1,950 m above sea level). The parcel is currently owned by Unilever, but KEWASCO has noted the parcel is available for purchase. In addition, it is expected that a satellite facility may be the most cost-effective means of treating wastewater from the Kapkugerwet area. A specific site has not been identified for this facility, but could be located along the B1 road between Kapkugerwet and the Kwa Michael Estate. Additional detailed study of potential new treatment facilities is required.

According to KEWASCO the Town will most likely not consider re-using highly treated wastewater for non-drinking purposes. This is partly due to local customs and partly due to the fact that the high amount of rainfall received in Kericho has not created a significant demand for recycled water.

According to KEWASCO, there is potential in Town for utilizing treated wastewater sludge (biosolids) in local agriculture. In fact, this is already occurring. The existing sludge giveaway program should be formalized, quality should be monitored, and charges should be levied for the product. The sludge should be analyzed to ensure it meets applicable regulations, including limits for metals, and instructions should be provided regarding safe use of the material. Marketing efforts should be undertaken to enhance the attractiveness of the product for use in local agriculture. Such marketing efforts could entail utilizing the product for decorative plantings at the treatment facility and at public toilets with signs indicating the source of the product. The sludge could also be useful as cover for the adjacent municipal refuse dump.

5.3.3 (c) Wastewater Treatment, Disposal, and Residuals Management Recommendations

The primary focus for immediate work related to wastewater treatment should be on improved sampling and miscellaneous improvements at the treatment facility. Detailed planning for improvements, expansion, and new facilities is beyond the scope of this study, but preliminary phasing and costs have been estimated for the purpose of feasibility analysis. More detailed analyses will be required to clearly define required projects. Recommendations regarding wastewater treatment facilities and estimated costs and phasing are included in the detailed matrices (Appendix 5-2). Note that some wastewater treatment recommendations are included in the 'Management' section of the matrices. Recommended activities include, but are not limited to the following:

- Expand and improve existing **laboratory facilities**.
- **Repair trickling filter arms** by adding electric motors; add **aesthetic buffer**; **replace drying bed covers**; add **algae control baffles**.
- Develop formalized **biosolids sampling and re-use program**, including marketing.
- **Upgrade septage receiving station** including a decanting system.
- Conduct **detailed study for increasing capacity of existing facility** including adding aeration and a new trickling filter.
- **Add aeration to lagoons as pilot program** using solar powered aerators; implement other means of increasing capacity at existing site as determined by aforementioned detailed study.
- **Add digester mixing** and consider adding biogas recovery system.

- Perform **planning for future new wastewater treatment facilities** including permitting and preliminary design.
- **Construct new facilities** as required to treat expected flows through study period.

5.4 Management and Operation and Maintenance (O&M)

5.4.1 Management and O&M Description

Institutional Arrangements

Kericho Town is located in the Kericho District, which occupies a total area of 2,111 km^2 and is one of eighteen districts within the Rift Valley Province.[44] Kericho District is comprised of seven divisions, which are futther divided into locations and sub-locations. Kericho is classified as a Municipality (although is commonly referred to as Kericho Town) and is part of the Ainamoi Divison, of which Kericho Town serves as District Headquarters.[45] The District Commissioner and other Departmental heads including the Kipsigis County Council and the Municipal Council offices are all located within the Kericho Town limits.[46] In 1998, the Kericho Town municipal boundary was expanded from 66 km^2 to its present area of 111 km^2.

The water and wastewater systems in Kericho are under the management of the Kericho Water and Sanitation Company Ltd (KEWASCO). The Kericho Municipal Council wholly owns KEWASCO, which officially began operation on 1st July 2003, taking over for the former Water and Sanitation Department of the Municipal Council of Kericho. KEWASCO currently serves as the sole Water Service Provider (WSP) for Kericho Town as per its Service Provision Agreement (SPA) with the Lake Victoria South Water Services Board, dated 15th April 2005. The Company's Board of Directors is composed of members of the Kericho Municipal Council, local stakeholders, and the Ministries of Local Government and Water. A central corporate management team handles daily operation of the company and includes a Managing Director, Commercial Manager, and an Administration Officer.

Staffing

When KEWACO began operation in 2003, it kept all 184 staff members from the former Water and Sanitation Department of the Municipal Council of Kericho and added three staff to serve as the corporate management team. By the end of the 2004/2005 reporting year, the total number of staff was 171. More recent staffing information from KEWASCO indicates a total of 169 staff with distribution as indicated in Table 5-17.

According to KEWASCO's 2004/2005 Annual Repott, the optimum number of employees for the organization is 126, assuming security functions are outsourced (it should be noted that KEWASCO's August 2006 Tariff Adjustment Proposal notes the optimal number of staff is 115). KEWASCO is continuing to reduce excess workforce via attrition. According to information provided by KEWASCO, it reduced its staff by 9 in 2004/2005. Continuing staff reductions at this rate will result in KEWASCO achieving its stated optimum staff level of 126 within 5 years.

Table 5-17. KEWASCO Present and Proposed Staffing Levels

	Present Number of Staff	Proposed Number of Staff*
Administrative	76	57
Water O&M	66	49
Wastewater O&M	27	20
TOTAL	**169**	**126**

*Total is based on KEWASCO 2004/2005 Annual Report.
Assume same proportions as present staffing levels.

KEWASCO has reported that its personnel expenses (31.5 Million KShs) represent 64% of its total operating expenditures (49 Million KShs). Therefore, reducing staff to 126 (26% reduction) will save the company approximately 8 Million KShs. This savings represents 17% of total operating expenditures for 2004/2005.

A variety of standards exist for calculating appropriate staffing levels. LVSWSB has established Sector Benchmarks as outlined in Schedule E of its standard Water Services Provision Agreement (SPA). These benchmarks are presented in Table 5-18. It is assumed that these figures are for watet O&M staff only and therefore do not include administrative and wastewater staff. LVSWSB's SPAs do not include similar benchmarks for administrative and wastewater staff.

Table 5-18. Staffing Levels Per LVSWSB Service Provision Agreements (Schedule E)

Size of Company	Staff / 1,000 connections		
	Good	acceptable	not acceptable
Large	<5	5-8	>8
Medium and Small (with up to 3 towns)	<5	5-8	>8
Medium and Small (serving more than 3 towns with different systems)	<9	9-14	>14

The 'acceptable' range of 5 – 8 staff per 1,000 connections translates to 27 to 42 water O&M staff for KEWASCO, which has approximately 5,300 active service connections. KEWASCO currently has a water O&M staff of 66 (12 staff / 1,000 connections), but has proposed reducing this to 49 (9 staff / 1,000 connections). Assuming additional connections will be added by the time this staffing level is achieved, the ratio will be less than 9 and therefore probably within the 'acceptable' range for large or medium size companies as defined by LVSWSB.

Appendix G10 of the 2005 Practice Manual for Water Supply Services in Kenya (2005 Design Manual) describes required water staffing levels based on system-specific information. These recommended levels and calculations, based on conditions specific to KEWASCO, are presented in Table 5-19.

Table 5-19. KEWASCO Water O&M Staff Required per 2005 Design Manual Appendix G4

Staff Category	Water supply staff required for full water treatment production > 500 m^3/d, operation 13-24 hrs / d	KEWASCO Water O&M Staffing Requirement
Water Operator Grade I	1	1
Water Operator Grade IIA	1	1
Water Operator Grade IIB	1	1
Water Operator Grade III	1 per 200 water meters	27
Chemical or general attendant Grade I	3	3
Pump attendant Grade I	1 per pumping station	2
Pipe Fitter Grade I	1	1
Pipe Fitter Grade II	1	1
Labourer	4	4
Line Patrollers	1 per 25 km of pipelines	4
TOTAL		**45**

Based on the 2005 Design Manual and LVSWSB SPA, a water O&M staff of 45 or less is probably appropriate.

Requirements for wastewater staffing are presented in Table 4.2.12 of the 1998 Aftercare Study on the National Water Master Plan and reproduced below in Table 5-20. KEWASCO serves an estimated 10,000 people with piped sewer connections, so the guidelines suggest a staff of 10 should be sufficient. However, optimal staffing levels for each town are very site-specific and considering the technical complexity of the Kericho Wastewater Treatment Facility, additional staff may be warranted. KEWASCO plans to reduce wastewater O&M staff to around 20.

Table 5-20. Wastewater O&M Staffing Guidelines, 1998 Aftercare Study on the National Water Master Plan

Function	Position	Population Connected to Sewerage				
		10,000-25,000	25,000-50,000	50,000-100,000	100,000-300,000	>300,000
Management & Process Control	Manager	0	0	1	1	1
Treatment Works Operations & Process Control	Superintendent	0	0	1	1	1
	Trade effluent inspector	1	1	2	2	4
	Technical Assistant	0	0	1	1	1
	Laboratory technicians	0	1	1	2	2
Treatment Works Maintenance	Foreman	1	1	1	2	2
	M/E tradesmen	0	1	2	2	4
	Laborers	2	3	4	6	10
	Drivers	0	1	1	2	4
	Watchmen	1	1	1	3	5
Collection System Maintenance	Superintendent	0	0	0	1	2
	Foreman	1	1	2	4	6
	M/E tradesmen	0	0	1	2	3
	Laborers	4	6	10	20	30
TOTAL		10	16	28	49	75

Operation, Maintenance, and Management Systems

An Operation and Maintenance Manual exists for the Timbilil Water Treatment Works. It is not clear if similar manuals exist for other facilities. Equipment inventories are included in the SPA, but it is not clear if the inventories are up to date and incorporated into an asset management system. KEWASCO is in the process of developing a full asset register, although a tegister of major equipment is reportedly available. KEWASCO has noted that routine maintenance schedules exist and are available for review.

According to the 2004/2005 Annual report, maintenance highlights during this period included:

- Desiltation of Timbilil intake (December)
- Yearly maintenance and repainting of flocculation channels, sedimentation basins, and filters
- Complete renovation of Kimugu water works to give it a new facelift
- Fencing around Kimugu Water Works and Sewerage Treatment Plant
- Weekly maintenance of FRO chemical dozers

In addition, repairs to the water distribution system were noted to have been carried out promptly whenever leakage and pipe bursts occurred.

Consumption of power and chemicals for water treatment facilities is provided in Table 5-7. Power usage from October through December 2006 at the wastewater treatment facility indicate average power use of approximately 1,000 KW-hr/month.

A Management Information System exists as outlined in a September 2002 'Operation, Maintenance and Financial Management Report' that was provided by KEWASCO. The report tracked a variety of parameters including the number of bursts and leakages identified and repaired, the number of new applicants for water connections and connections made, the amount of chemicals used, billing statistics, the number of water meters replaced and tested, monthly expenditures by category, and other information. KEWASCO noted that this system is not being updated and the 2002 report is the most recent available.

Environmental Audits are now carried out annually in compliance with the Environment Management and Co-ordination Act of 1999.

No current mapping exists for Kericho. The most recent available Survey of Kenya topographic maps are 30 years old. Water system maps and development plans are available in hardcopy format from the 1980s.

KEWASCO has a variety of programs for its staff including a pension system, a year end party, management and staff training programs, and performance based salary incentives. Performance appraisals are conducted for KEWASCO employees.

Tariffs

KEWASCO uses a modified version of the national guideline water tariff rates outlined in the Water Act (Table 5-21). The rates presently used in Kericho are lower than the guideline national water tariffs and have been in existence since 1994. The average effective water tariff charged in Kericho is 27 KShs/m^3 (total water sold divided by total tariff revenue). Based on available information, the current average tariff charged in Kenya is estimated to be approximately 38 KShs/m^3.

In August 2006, KEWASCO proposed an increase to its water rates. The proposal is currently under review by the Water Services Regulatory Board (WSRB). The proposal was submitted prior to the issuance of the WSRB's Draft Tariff Guidelines which lay out a structured format for the submission of tariff increase requests. A workshop was scheduled to take place in March 2007 in Nairobi to discuss the draft tariffs analysis document. Representatives from KEWASCO planned to attend to voice their concerns regarding delays in when they expect to be able to change their rates. Present distribution of KEWASCO's water customers by type is presented in Table 5-22. Present and proposed water rates are presented in Table 5-23.

Table 5-21. Kenya Urban Water Tariffs Per Water Act (November 1999)

	Category	Charge		
a)	Unmetered	200	KShs	/ month
b)	(i) Metered use < 10 m^3	200	KShs	/ month
	(ii) Metered use 10-20 m^3	25	KShs	/ m^3
	(iii) Metered use 20-50 m^3	30	KShs	/ m^3
	(iv) Metered use 50-100 m^3	45	KShs	/ m^3
	(v) Metered use 100-300 m^3	75	KShs	/ m^3
	(vi) Metered use 300+ m^3	100	KShs	/ m^3
c)	Kiosk sold by m^3	15	KShs	/ m^3
d)	Kiosk by 20 L jerrycan	2	KShs	/ 20 L
e)	Bulk sale for resale	15	KShs	/ m^3

Table 5-22. Kericho Water Customer Type

Connection Category	Description	Number	Percentage
AI	Domestic Consumers	7,042	96.8%
AII	Commercial and Industrial Consumers	171	2.4%
AIII	Schools and Water Kiosks	41	0.6%
AIV	Car Wash Slabs	19	0.2%
AV	Raw Water Consumers	1	0%
TOTAL		***7,274***	

Source: KEWASCO Annual Report for the Year 2004/2005

Table 5-23. KEWASCO Existing and Proposed Water Tariffs

Billing Block	Current 2006-07 Volume (m^3)	Present Tariff (KShs)	Current Revenue (KShs)	KEWASCO Proposed Tariff (KShs)	Revenue with Proposed Tariff (KShs)
AI					
< 10	183,084	198	6,333,228	230	7,356,780
10 - 19	246,801	22.5	5,553,023	34	7,897,632
20 - 39	197,411	24	4,737,864	37	6,909,385
40 - 59	86,460	26	2,247,960	45	3,890,700
60 - 100	75,336	28	2,109,408	50	3,766,800
>100	242,401	28	6,787,228	55	13,332,055
AII					
< 10	2,254	800	356,800	400	178,400
10 - 19	3,563	28	7,028	40	142,520
20 - 39	9,984	28	279,552	40	399,360
40 - 59	11,650	30	349,500	50	582,500
60 - 100	17,211	30	516,330	50	860,550
>100	107,359	32	3,435,488	55	5,904,745
AIII					
	149,289	20.5	3,060,425	35	5,225,115
AIV					
	7,919	100	791,900	100	791,900
AV					
	416	22	9,152	22	9,152
TOTALS	**1,341,138**		**36,574,885**		**58,136,018**
Effective Avg. Tariff		**27**		**43**	

Source: KEWASCO August 2006 Tariff Adjustment Proposal

The KEWASCO domestic water block for usage less than 10 m^3/month includes a 35% subsidy for the first 6 m^3.

KEWASCO's Tariff Adjustment Proposal does not include detailed projections of future costs as outlined in the WSRB Draft Tariff Guidelines, but does include an analysis to calculate expected costs with projected optimum staffing levels and reduced UfW. The proposal does not recommend changes to the sewer rates which are presently approximately 80% of their water rate counterparts.

Other fees charged by KEWASCO include new and reconnection water and sewer fees, monthly water meter rents, rental fees for urban water kiosks, fines for illegal water connections, testing of water meter fees (when reading within 5%), among others.

Billing and Revenue

According to the August 2006 Tariff Adjustment Proposal, KEWASCO has improved revenue from billing 64% since 2002/2003, most of which occurred during KEWASCO's first year of operation. The 2004/2005 Annual report notes an increase in billing 6.4% compared to the previous year. Despite this increase and due to increasing costs, the company is still not sustainable and costs exceed expenditures. Table 5-24, Table 5-25, , and Table 5-26 are reprinted from the August 2006 Tariff Adjustment Proposal and illustrate recent sources of income, expenditures, and overall deficit. Staff salaries represent the largest expenditure for KEWASCO (64% of total expenditures). KEWASCO attributes the deficits to high staff cost and low tariffs.

Table 5-24. KEWASCO Income

	Financial Year (KShs)		
Income Source	**2003/04**	**2004/05**	**2005/06**
Water & Sewer charges	42,542,251	45,148,503	47,402.990
Exhauster income	3,543,837	3,037,130	2,638,386
Miscellaneous	1,368,840	635,394	1,251,352
TOTAL	**47,454,928**	**48,821,027**	**51,292,728**

Source: August 2006 KEWASCO Tariff Adjustment Proposal

Table 5-25. KEWASCO Expenditures

	Financial Year (KShs)		
Expenditure Item	**2003/04**	**2004/05**	**2005/06**
Salaries, wages & Allowances	30,821,438	31,397,901	31,680,950
Water treatment chemicals	1,908,777	2,217,912	2,272,288
Motor Vehicle expenses	1,451,009	2,983,635	3,346,110
Electricity	924,217	541,955	1,792,628
Lease fee & L VSWSB Charges	3,403,380	3,611,808	6,162,388
Repair of pipelines	1,629,007	1,111,818	1,373,676
Board Allowances	1,541,870	1,452,210	1,703,216
Others	6,866,110	8,477,536	7,194,313
TOTAL	**48,545,808**	**51,794,850**	**55,525,569**

Source: August 2006 KEWASCO Tariff Adjustment Proposal

Table 5-26. KEWASCO Income vs. Expenditures

	Financial Year (Million KShs)		
Item	**2003/04**	**2004/05**	**2005/06**
Income	47.4	48.8	51.6
Expenditure	48.5	51.7	55.5
Deficit	**(1.1)**	**(2.9)**	**(3.9)**

Source: August 2006 KEWASCO Tariff Adjustment Proposal

All water meters are read monthly and bills are sent monthly. According to the most recent KEWASCO annual report, the payment ratio is in excess of 100% due to continued payment of arrears by Town residents. KEWASCO noted they utilize billing software developed in-house by KEWASCO staff. Computerized billing and storage of files began in July of 2004, when five computers and accounting software were procured. [47]

According to KEWASCO, average annual household income is 7,000 KShs. Assuming a household has an unmetered connection or a metered connection using less than 10 m^3 / month, annual household water costs would be 2,400 KShs, or 34% of income. KEWASCO has noted that Town residents are strongly in support of investing in water and sanitation systems and are willing to pay for improved water and sanitation services.

Offices, Lab Facilities, and Transportation

According to the KEWASCO 2004/2005 annual report, the KEWASCO main administrative offices in central Kericho (~1 km from the wastewater treatment facility) are currently not adequate for the needs of the company. Therefore, they are currently considering shifting the offices to the Municipal Council's old Town Hall, which reportedly has sufficient space. KEWASCO has noted that the existing site is capable of being rehabilitated and expanded to serve their needs. The location of the existing offices are well suited for KEWASCO's activities.

Laboratory facilities exist at the Timbilil Water Treatment Facility and at the Kericho Wastewater Treatment Facility. Discussion of existing lab facilities is included in the water and wastewater infrastructure sections.

KEWASCO has noted that available vehicles for staff transportation are lacking and that existing equipment is old and costly to maintain.

5.4.2 Management and O&M Needs

An accurate water and wastewater system inventory is tequired before meaningful planning can be accomplished. An inventory is important for almost all future work including developing O&M plans, infrastructure planning, mapping, tariff analysis, staffing planning, accounting and other activities. An inventory is the first step towards creating an asset management plan.

Once the inventory is created, assets should be valued and prioritized into an asset management plan for future rehabilitation, replacement, or upgrade. A Management Information System formerly existed as outlined an 'Operation, Maintenance and Financial Management' report provided from 2002. However, KEWASCO noted that this system is not being updated and the 2002 report is the most recent available. Information from this system may be able to form the basis for a new asset management system.

In order to maximize equipment lifespan and operating efficiency, KEWASCO should document preventative maintenance plans for water and wastewater facilities, follow the plans closely, and be vigilant about recording maintenance histories for equipment.

Accurate mapping is also crucial for almost all future planning tasks. KEWASCO needs to develop up-to-date electronic mapping of its water and wastewater systems. This mapping should utilize widely available satellite imagery (Figure 5-32) and be created in a Geographic Information System (GIS) environment which enables the viewing of data in a spatial format. Similar mapping efforts are currently being carried out for Migori and Kisii by UN-Habitat and the Regional Center for Mapping and Development. GIS layers should include: existing land use; streets; neighborhoods; population density; water system features including intakes, treatment facilities, piping network, and storage facilities; wastewater collection system piping and treatment facility; water kiosks; public toilets; and bulk water meters. All water and wastewater systems included in system inventory should be included in mapping.

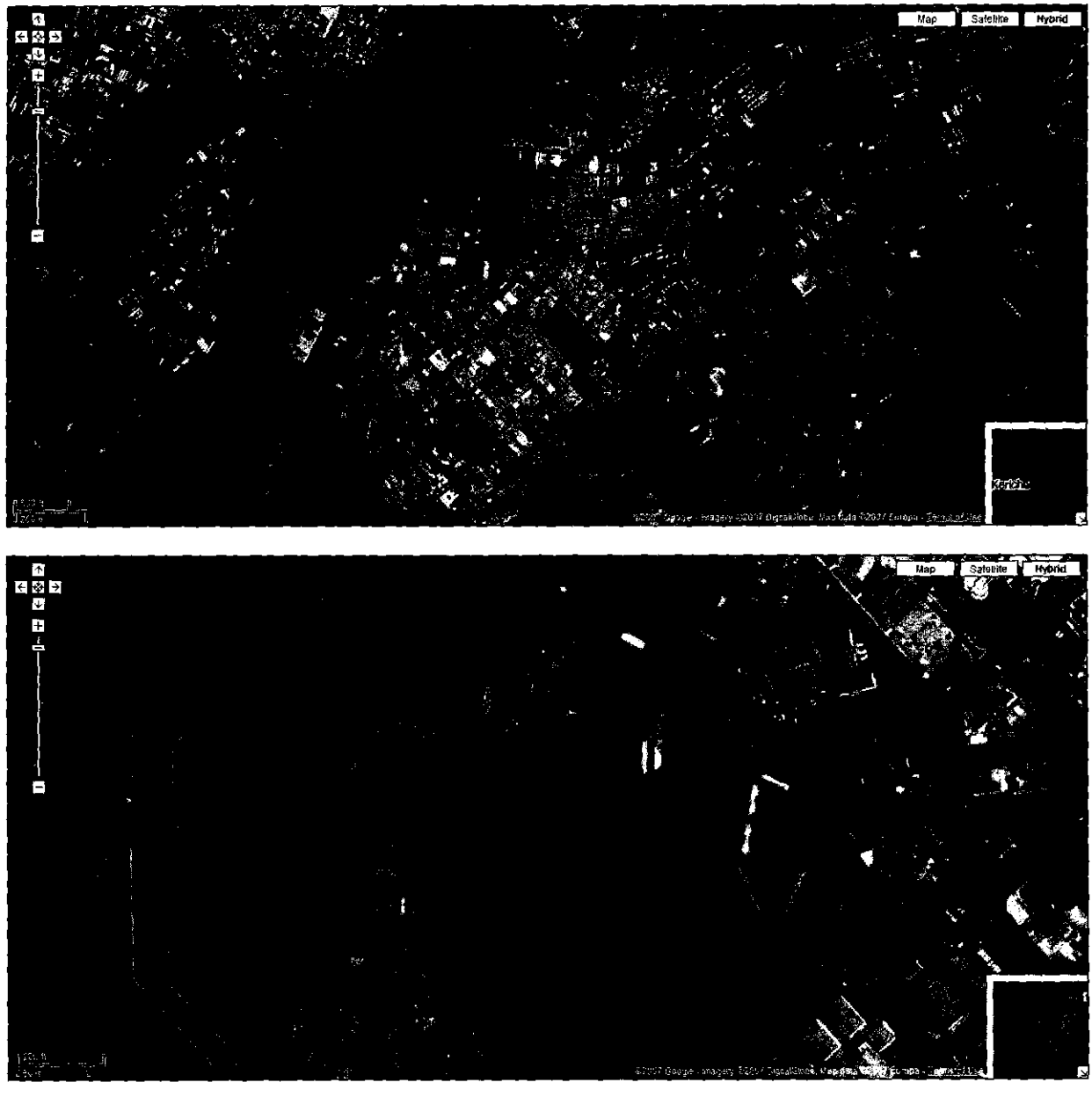


Figure 5-32. Example Satellite Images of Kericho including WWTF and town center
(Source: Google Maps, http://maps.google.com/)

KEWASCO is currently over-staffed, which is partially to blame for the inability of the company to recover its costs and develop reserve funds for future projects. Staff is currently being reduced through attrition. A detailed staffing study is required to fully assess KEWASCO staffing needs.

KEWASCO's current tariff structure and high UfW also causes the company to operate at a loss, despite having no current debt service. Low existing tariffs do not allow the company to pay normal operating costs and develop reserve funds. Available anecdotal information suggests that local residents are willing to pay more to ensure they receive high quality services. KEWASCO should institute tariffs which ensure full cost recovery including O&M as well as capital projects.

The KEWASCO offices are in need of rehabilitation, expansion, and new equipment. Existing offices contain old chairs, small rooms and makeshift work areas. Existing ventilation is inadequate. Offices require immediate equipment upgrades. KEWASCO will eventually require new offices. Specifically, KEWASCO has cited the need for the following:

- Desks and chairs
- Faxes, copiers
- Computers and printers
- Filing cabinets
- Lockable drawers for plumbing tools
- Strong safe for cash revenue

Laboratory facilities are required to take basic daily measurements, including microbiological test kits, chemical test kits, and equipment for TSS, BOD, COD, pH, DO, turbidity. The development of updated laboratory facilities for water and wastewater systems should be coordinated to avoid unnecessary overlap. Quality assurance and quality control checks on sampling programs are required and should be developed in consultation with LVSWSB. Infrequent sampling requiring expensive specialized equipment should be done at LVSWSB.

No public education program currently exists at KEWASCO. An informed customer base is vital in effectively protecting public health, garnering support for local projects, and ensuring successful project implementation. KEWASCO should develop public education programs. The public should be aware of the importance of clean water and sanitation, and especially their associated health impacts. Promotion of water conservation and installation of water-saving devices in homes could save additional water, allowing Kericho to serve additional customers and extending the time before additional supplies are needed. Many homes are expected to have wells and pit latrines co-located and residents should be aware of potential hazards. KEWASCO should begin to make the health-based case for improving public water and wastewater services.

KEWASCO should seek to support and develop entrepreneurship and income-generating activities which will reduce demands on KEWASCO staff. Such activities may include commercialization of water kiosks and public toilets, private exhauster services, biosolids composting and marketing, development of tree nurseries using treatment facility biosolids, algae harvesting from lagoons, and itrigated sugar cane, bamboo, or aquaculture using treated effluent.

Favorable economies of scale may be attained by regionalization of some services including chemical procurement, staff and manager training, equipment repair/rehabilitation, spare parts procurement, bulk purchases including water meters, leak detection, purchasing in-home water saving devices, water bowser, public education, and others. KEWASCO should work with LVSWSB to determine appropriate regionalization programs and pursue them.

Kiosk operators and public toilet operators require training in financial management and operation of the stations to protect public health. Training and certification programs are required for these services.

KEWASCO has noted that available vehicles for staff transportation are lacking and that existing equipment is old and costly to maintain. KEWASCO has noted that it is in need of three four wheel drive trucks, 10 motor cycles, and one executive vehicle.

Other management needs are discussed in other portions of this report Section including a water audit, bulk and consumer meter repair and replacements, an illegal connection removal plan, watershed land purchase for source protection, discussions with large water users not connected to the wastewater system regarding connections, and the development of an on-site wastewater management plan.

5.4.3 Management and O&M Recommendations

Recommendations regarding institutional arrangements, management, and O&M and estimated costs and phasing are included in the detailed matrices (Appendix 5-2). Many activities require more detailed study and costs for such studies have been estimated. Recommended activities include, but are not limited to the following:

- Obtain satellite imagery and prepare **GIS mapping** similar to that being prepared for Migori and Kisii by UN-Habitat and the Regional Center for Mapping and Development. All water and wastewater systems included in the system inventory should be included in mapping.
- Develop **water and wastewater system inventories and asset management plans** utilizing toolkit proposed to be created by LVSWSB. The inventories should include major equipment, piping, tanks, and treatment systems. Available data such as age, expected useful life, condition, service history, and nameplate data should be included. Financial value of assets and list of depreciated assets should be included. Develop or use available standard forms, or purchase and customize available software (recommended) to create inventories and convert to an asset management plan by prioritizing assets and estimating future needs and costs. Priority should be given to critical infrastructure at or past the end of its useful life.
- Develop a **preventative maintenance plan** and maintenance tracking system, including all inventory components, utilizing the toolkit proposed to be created by LVSWSB. The system may incorporate traditional maintenance card techniques, "out-of-the box" software, or customized software. Software packages are readily available to schedule and track all required preventative maintenance and are recommended.
- Review water and wastewater staffing levels and continue staff reductions. Conduct a **staff rationalization study** by an external Human Resources consultant. Study should include organizational chart development, task analysis, determination of staffing requirements, creation of job descriptions, and implementation plan for staffing changes.
- Conduct detailed **analysis of current tariff structure** in conjunction with proposed new projects and costs from asset management plan. Utilize toolkit proposed to be developed by LVSWSB and the Draft Tariff Guidelines created by WSRB. Include consultation and participation of stakeholders. Revise tariff structures so revenues cover all operational expenses and generate additional funds for capital improvements, equipment, meter replacements, planning, etc. Proposed tariffs should not be arbitrary, but rather based on real data, reasonable projections, and a transparent methodology.
- Implement **public education programs** to inform residents about the importance of water conservation, water quality, source protection, sanitation, and potential resultant financial savings. Utilize public education toolkit proposed to be developed at LVSWSB. Couple public toilet and kiosk rehabilitation and commercialization with public education. Work with local environmental and health groups on public education programs. Begin school programs addressing water conservation, health and hygiene. Consider publishing and distributing annual informational reports to customers similar to Consumer Confidence Reporting used in the United States for educating

customers about water sources and watershed protection. Designate staff responsible for public education and public relations including informing customers of any expected service disruptions and handling complaints.

- Consider development of **entrepreneurial opportunities** including commercialization of water kiosks and latrines/public toilets; private operation of KEWASCO-owned exhauster truck(s); compost production and distribution; utilization of biosolids at one of several existing or possible new seedling nurseries; algae harvesting from lagoons; irrigated sugarcane/bamboo/aquaculture. Consider market for biogas from digesters.
- KEWASCO should investigate becoming part of Kisumu-based **regionalization programs** including staff and manager training, equipment repair/rehabilitation, spare parts, chemical procurement, bulk purchases including water meters, leak detection equipment, purchasing in-home water saving devices, water bowser, public education, etc. Work with LVSWSB to develop regional programs.
- Develop and implement **kiosk and public toilet operator training and certification program.**
- Purchase **office equipment** including chairs, desks, faxes, copiers, computers/printers, filing cabinets, lockable drawers for plumbing tools, safe for cash. Begin **planning for new offices** at existing office location or new location. Purchase office space or construct new offices at existing location as recommended by planning study.
- **Purchase vehicles** including trucks, motor cycles, and executive vehicles as required.

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6. KISII **6-1**

6.1 General Information and Projections **6-1**
6.1.1 Location 6-1
6.1.2 Topography, Geology, and Climate 6-1
6.1.3 Land Use and Roadway Infrastructure 6-1
6.1.4 Power Supplies 6-4
6.1.5 Population 6-6
6.1.6 Water Demand and Service Goals 6-8
6.1.7 Wastewater Flow and Service Goals 6-11

6.2 Water **6-13**
6.2.1 Water System Overview 6-13
6.2.2 Water Sources and Intakes 6-15
6.2.2 (a) Water Sources and Intakes Description 6-15
6.2.2 (b) Water Sources and Intakes Needs 6-17
6.2.2 (c) Water Sources and Intakes Improvement Options 6-18
6.2.2 (d) Water Sources and Intakes Recommendations 6-20
6.2.3 Water Treatment 6-21
6.2.3 (a) Kegati Water Treatment Works Description 6-21
6.2.3 (b) Kegati Water Treatment Works Needs 6-25
6.2.3 (c) Kegati Water Treatment Works Recommendations 6-25
6.2.3 (d) Nyakomisaro Water Treatment Works Description 6-26
6.2.3 (e) Nyakomisaro Water Treatment Works Needs 6-28
6.2.3 (f) Nyakomisaro Water Works Recommendations 6-29
6.2.4 Water Distribution 6-29
6.2.4 (a) Water Distribution Description 6-29
6.2.4 (b) Water Distribution Needs 6-36
6.2.4 (c) Water Distribution Recommendations 6-38

6.3 Wastewater **6-39**
6.3.1 Wastewater Overview 6-39
6.3.2 Wastewater Collection 6-39
6.3.2 (a) Wastewater Collection Description 6-39
6.3.2 (b) Wastewater Collection Needs 6-42
6.3.2 (c) Wastewater Collection Recommendations 6-43
6.3.3 Wastewater Treatment, Effluent Disposal, and Residuals Management 6-44
6.3.3 (a) Wastewater Treatment, Disposal, and Residuals Management Description 6-44
6.3.3 (b) Wastewater Treatment, Disposal, and Residuals Management Needs 6-47
6.3.3 (c) Wastewater Treatment, Disposal, and Residuals Management Recommendations 6-48

6.4 Management and Operation and Maintenance (O&M) **6-49**
6.4.1 Management and O&M Description 6-49
6.4.2 Management and O&M Needs 6-56
6.4.3 Management and O&M Recommendations 6-58

6. KISII

6.1 General Information and Projections

6.1.1 Location

Kisii Municipality is the headquarters the Kisii Central District in Nyanza Province, located approximately 115 km south of Kisumu City. Greater Kisii covers 111 km^2, while Kisii Municipality covers an area of 29 km^2. The existing water distribution network extends beyond the Town boundaries and has been estimated by the local water service provider, Gusii Water and Sanitation Company, Ltd. (GWASCO), to cover an area of approximately 79 km^2.[1] The main population centers are situated near the confluence of several major regional roadways including the A1 road (running from Kisumu to Tanzania), the B3 road (heading east from Kisii toward Nairobi), and the smaller C21 and C17 roadways which head northeast and south from Kisii, respectively (Map 6-1).

6.1.2 Topography, Geology, and Climate

Topography

Kisii is located in the lower part of the Kisii highlands and is characterized by rolling terrain. Elevations in Kisii vary from approximately 2,000 m (6,600 feet) to 1,500 m (4,900 feet). The landscape of the region generally slopes from northeast to southwest and streams and rivers therefore generally flow west and southwest toward Lake Victoria.

Streams in Kisii eventually drain into the Gucha River system (also known as the Kuja River system), which generally flows southwest and enters Lake Victoria about 15 km north of the Tanzania border. The major rivers in Kisii Town include the Gucha River and the Riana River. Most of the populated areas of Town are drained by the Riana River and its tributaries, which heads northwest in town, then west and southwest before joining with the Gucha River. The Gucha River serves as a primary water source, but is on the east side of an elevation divide separating the river from major population centers to the west.

Geology

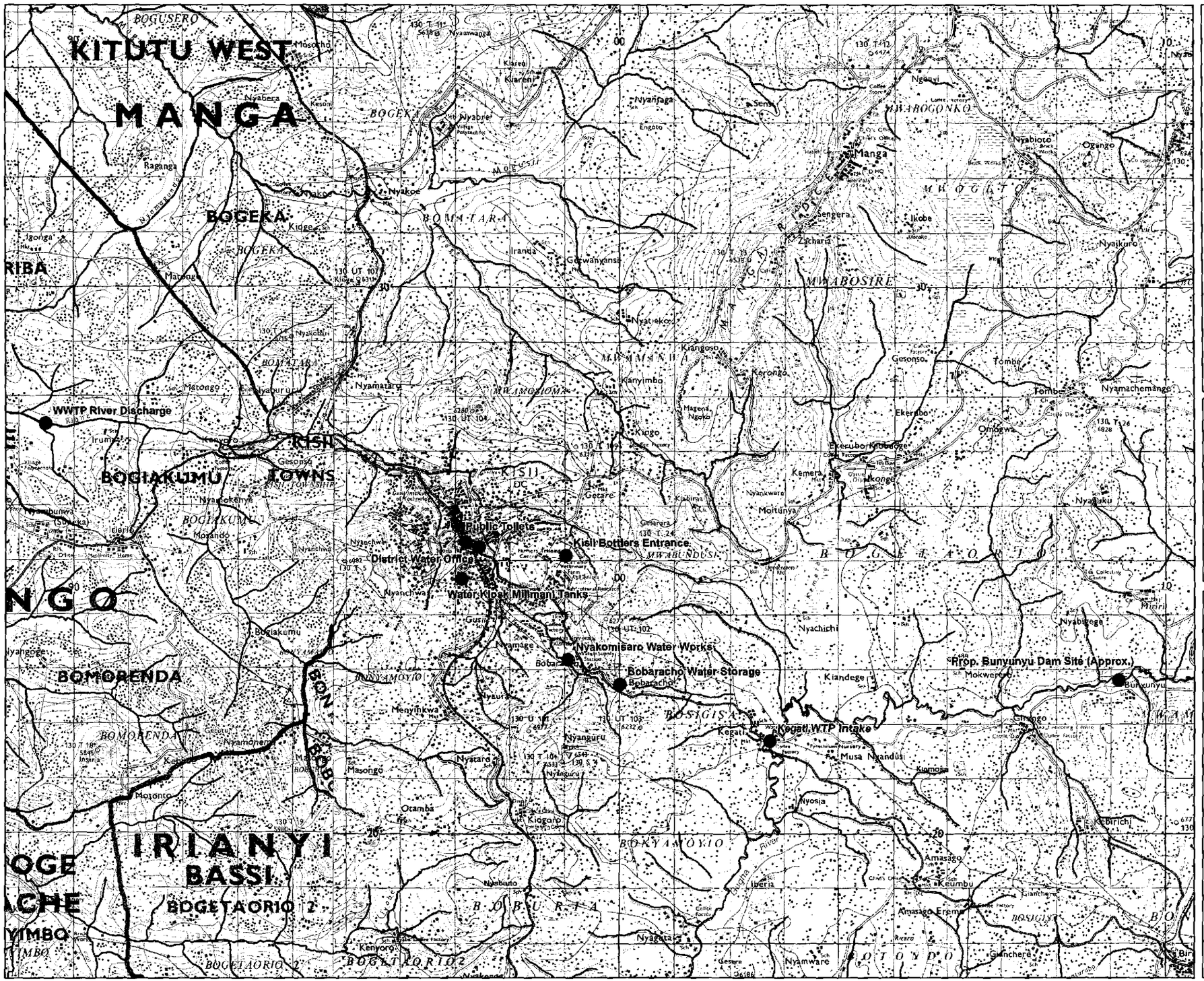
Kisii is located in the Lake Victoria Basin and the geology is characterized by volcanic, igneous, and metamorphic complexes. Little rainfall is reportedly stored as groundwater in the region due to the impervious characteristics of the soils and groundwater yields are therefore generally low.[2] Unregulated and extensive land development including many intensive small farming operations has resulted in soil erosion and increasing turbidity in local surface water bodies.

Climate

Kisii has a highland equatorial climate with moderate temperatures and relatively high and reliable rainfall, averaging over 1,600 mm per year.[3] Although rains may occur throughout the year, rainy seasons occur from March to May and from October to November. Temperatures can range from 10° C to 30° C. The climate can support a variety of crops including coffee, tea, maize, beans, millet, and potatoes.

6.1.3 Land Use and Roadway Infrastructure

Like other towns in the region, Kisii consists of a densely developed town center surrounded by peri-urban areas with less dense housing and some farming, finally giving way to outlying small farms. The densest



Lake Victoria South Water and Wastewater Feasibility Study

Map 6-1
Greater Kisii

COLER & COLANTONIO
ENGINEERS & SCIENTISTS

● Points of Interest

—— Rivers

1:70,000

0 1,000 2,000 4,000 Meters

development is along the major tarmac roads including the A1 road (running from Kisumu to Tanzania), the B3 road (heading east from Kisii toward Nairobi), and the smaller C21 and C17 roadways which head northeast and south from Kisii, respectively. The Town has a closed market in the center of Town, an open market in the lower part of Town, a paved bus station under reconstruction, and a stadium. In addition to primary tarmac roads, a network of unpaved roads also exists and serves the less developed areas. In general, the primary roads mentioned above are in relatively good condition, although some potholes and broken pavement areas were noted, but outlying roads in the peri-urban and rural areas are generally in poor condition.

The densely developed Central Business District (CBD) comprises approximately 2 km^2. The surrounding area consists primarily of peri-urban settlements, where the majority of the population resides. Insufficient data is available to accurately assess land use patterns, but such information is currently being developed as part of a UN-Habitat funded GIS mapping project utilizing satellite imagery. The Regional Center for Mapping of Resources for Development (RCMRD) in Nairobi is carrying out this project and provided some preliminary information including a land use map (Map 6-2) and satellite imagery (Figure 6-1, Figure 6-2). Figure 6-3 and Figure 6-4 depict examples of existing land use in Kisii.

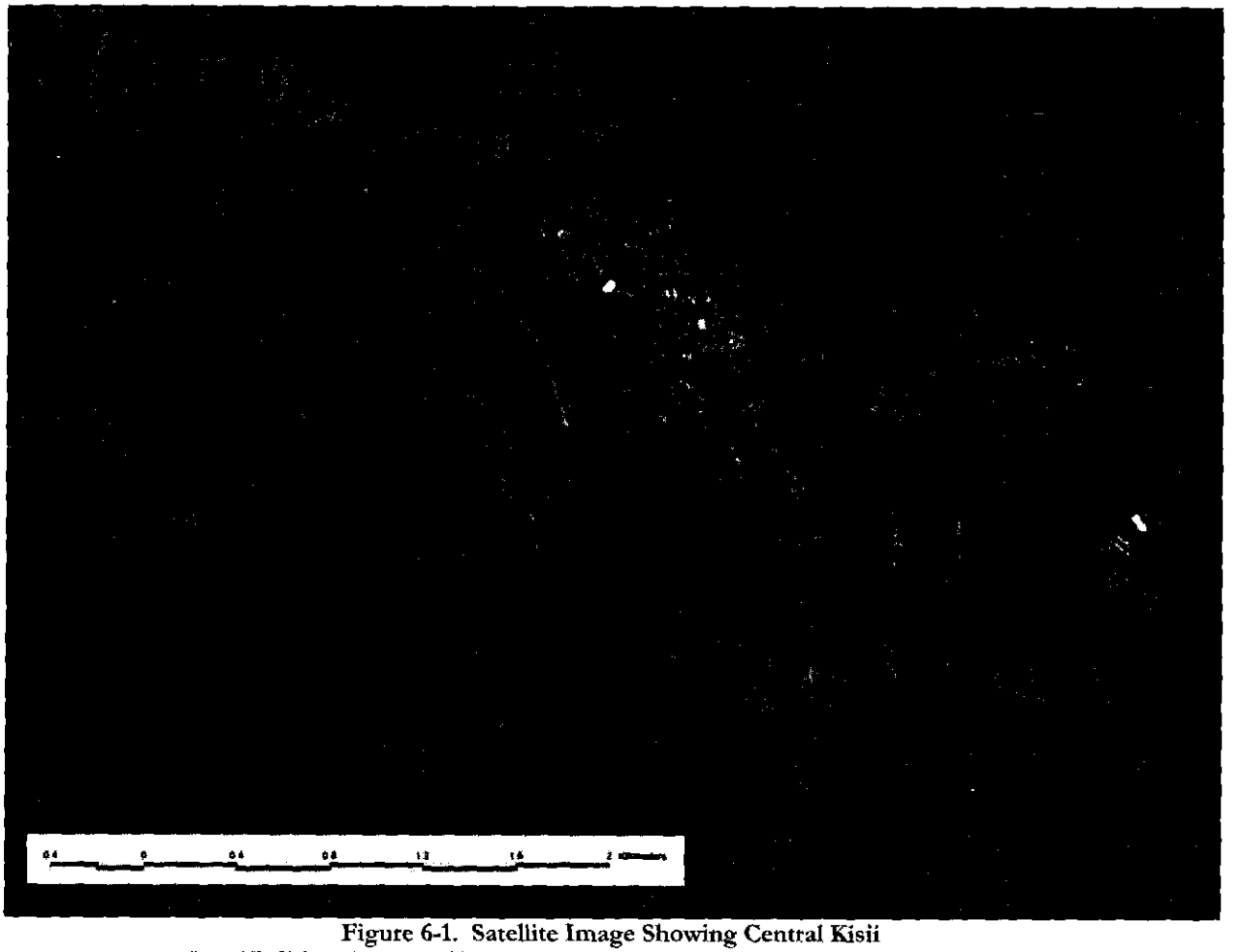
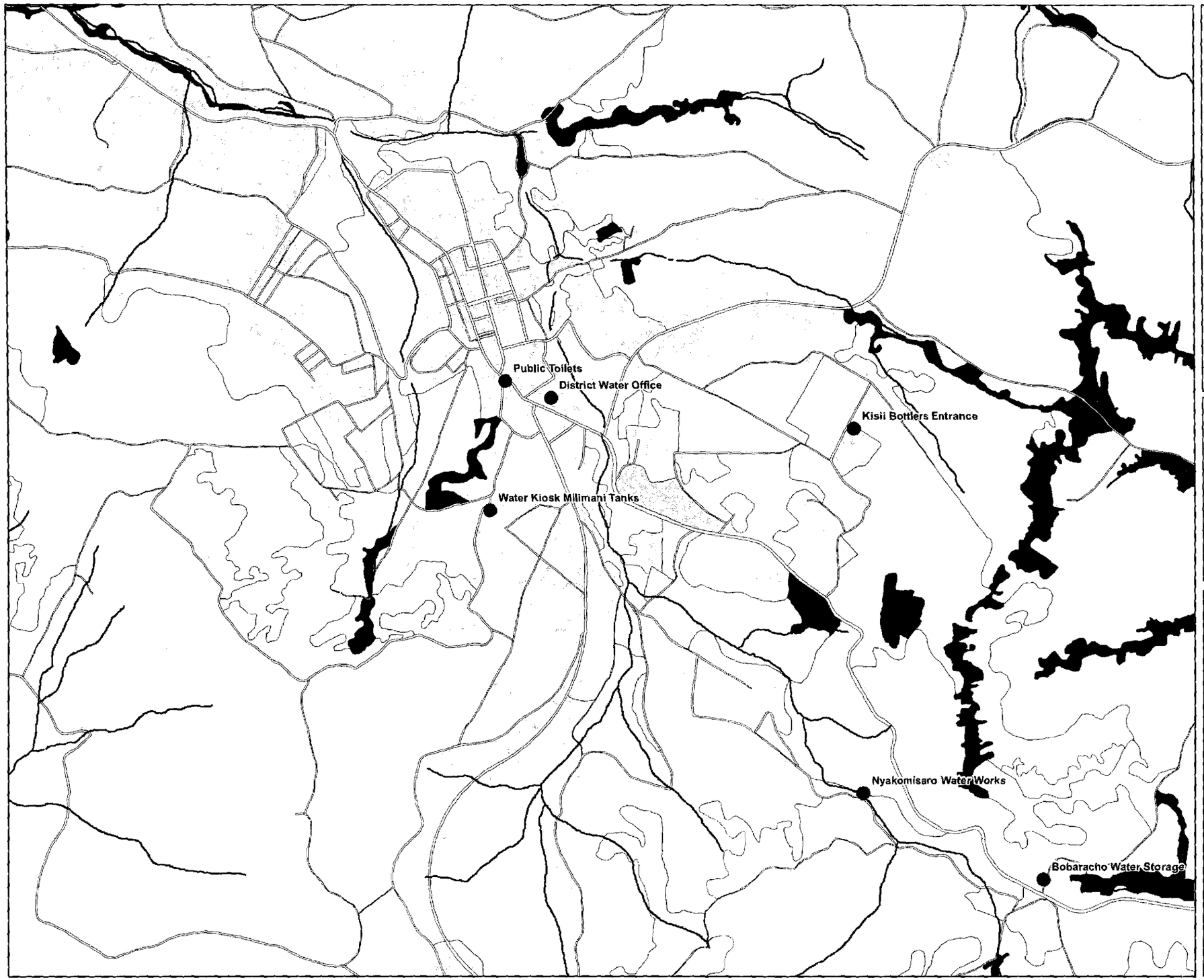


Figure 6-1. Satellite Image Showing Central Kisii
Source: UN-Habitat. Image prepared by Regional Center for Mapping of Resources for Development (RCMRD), Nairobi



Lake Victoria South Water and Wastewater Feasibility Study

Map 6-2

Kisii Town Center Landuse

N
W E
S

Landuse Data Source: UN - Habitat

COLER & COLANTONIO INC
ENGINEERS & SCIENTISTS

Landuse Subclass

- Grassland
- Large Scale Agriculture
- Small Scale Agriculture
- Woodland
- Organized Pattern
- Unorganized Patterns
- Mixed Patterns
- Points of Interest
- Rivers

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0 300 600 1,200 Meters

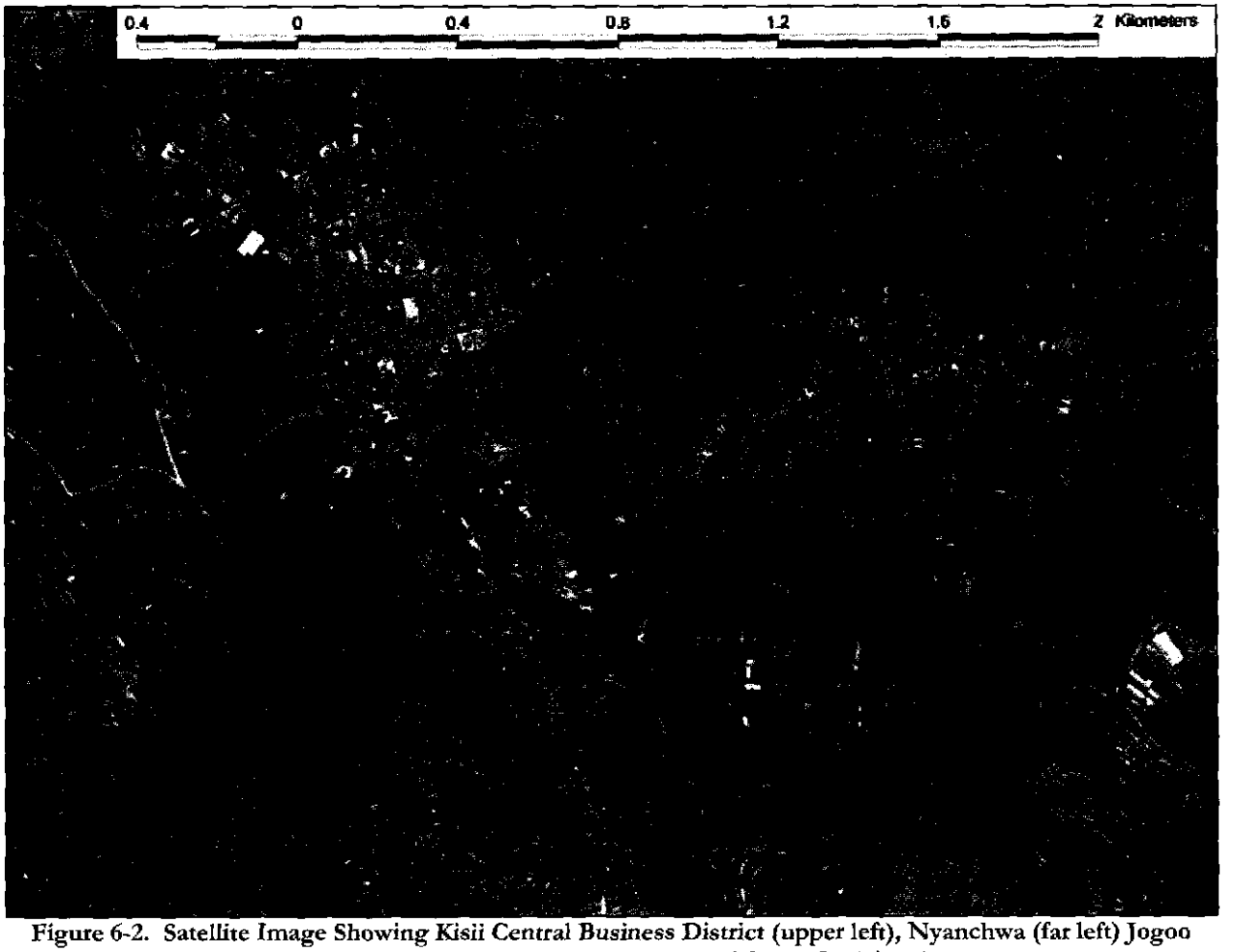


Figure 6-2. Satellite Image Showing Kisii Central Business District (upper left), Nyanchwa (far left) Jogoo (center right), Mwembe (center bottom), and Some Outlying Areas

Source: UN-Habitat. Image prepared by Regional Center for Mapping of Resources for Development (RCMRD), Nairobi

Figure 6-3. Kisii Central Business District

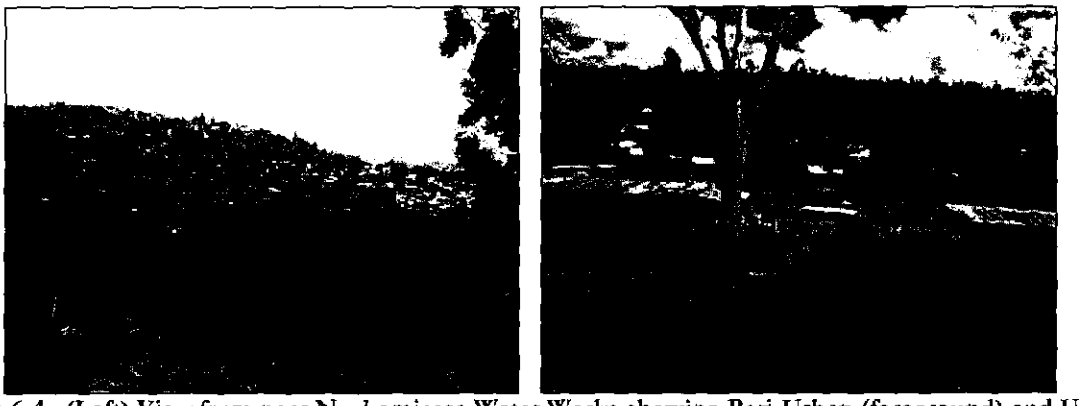


Figure 6-4. (Left) View from near Nyakomisaro Water Works showing Peri-Urban (foreground) and Urban Developments near Mwembe neighborhood. (Right) View from Bobaracho Water Storage Tanks toward Nyanguru peri-urban area

Changes in land use during the study period are expected to be primarily in the form of escalating urbanization via increasing density of residential and commercial development along the major roadways. The majority of this increased density is expected to occur around central Kisii, especially in present peri-urban areas. The development of improved water supply along these main transportation corridors is expected to influence increasing density of development. Residential areas are expected to increase in density as population increases and will likely expand into outlying areas currently occupied by small farms. Farmland is often subdivided in families, resulting in plots becoming smaller and smaller. The Project Team was not made aware of any particular planned developments which would significantly change expected growth patterns in and around existing developed areas.

6.1.4 Power Supplies

Kisii has an electricity distribution network that covers most of the densely populated areas, but reliability problems and frequent blackouts plague the existing system. Power outages occur daily and frequent voltage fluctuations cause problems with pumping equipment. Many residents in the region rely on burning wood and charcoal for domestic energy needs.

The main water treatment and pumping station (Kegati Water Treatment Works) requires reliable electricity for both low and high head pumping. The facility does not have a source of auxiliary power. During a visit to this facility, staff noted that 50% of the time the facility either has no voltage, low voltage, or high voltage. Incoming three-phase power should be at 415 V, the voltage at which all existing pumps in the system are rated to operate. However, incoming voltage fluctuates from 300 to 450 V, causing motors to run hot, contactors to burn out, and forcing operators cease operation of the facility. This is in addition to times when pumping is forced to cease due to power outages. The high lift pumps are typically only used at night when voltage is more consistent.

Unreliable electrical power is the most significant factor limiting the main treatment works from producing at its rated capacity. Schedules for Kenya Power and Lighting Company improvements in electrical power reliability in Kisii are presently unknown. Current electricity rates are 7 KShs/KW-hr. GWASCO staff noted that the power company is aware of the existing problems but has been unresponsive. Therefore, it is recommended that preference be given to gravity systems for future water and wastewater infrastructure improvements whenever feasible to avoid problems associated with power reliability and costs. However, renewable energy sources may be appropriate for some systems and should be explored during more detailed design phase work. Diesel fired generators, although expensive to operate, are expected to be the simplest and most effective way to quickly boost available power supplies and increase water production.

The hilly topography of Kisii is well suited for the development of hydropower supplies. According to records held by GWASCO, flow in the Gucha River at monitoring station 1KB01 varied from 5.8 m^3/s in February to 79.2 m^3/s in May and averaged 24.3 m^3/s.[1] According to GWASCO records, Kegati Treatment Works, which draws from the Gucha River, presently uses approximately 20,000 kW-hours per week, or 80,000 to 90,000 kW-hours per month. Assuming a 1 m drop is available at the existing weir at Kegati Water Treatment Works (Figure 6-5), approximately 23 m^3/s could produce this amount of electricity, conservatively assuming 50% overall hydropower station efficiency. In the data provided by GWASCO, the flow in the Gucha River at Station 1KB01 was greater than or equal to 23 m^3/s four months of the year. The minimum flow of 5.8 m^3/s could produce approximately 20,000 kW-hours per month with the same assumptions.

The Nyakomisaro River is the source of raw water for Kisii's second water treatment facility. This facility is located in a steep ravine adjacent to the river with a drop on the order of 15 meters (rough estimation) (Figure 6-6). Although a staff gauge exists on the Nyakomisaro River, flow data was not available. Assuming a flow of 0.1 m^3/s (ten times the treatment works' design capacity), approximately 6,000 kW-hours could be produced per month.

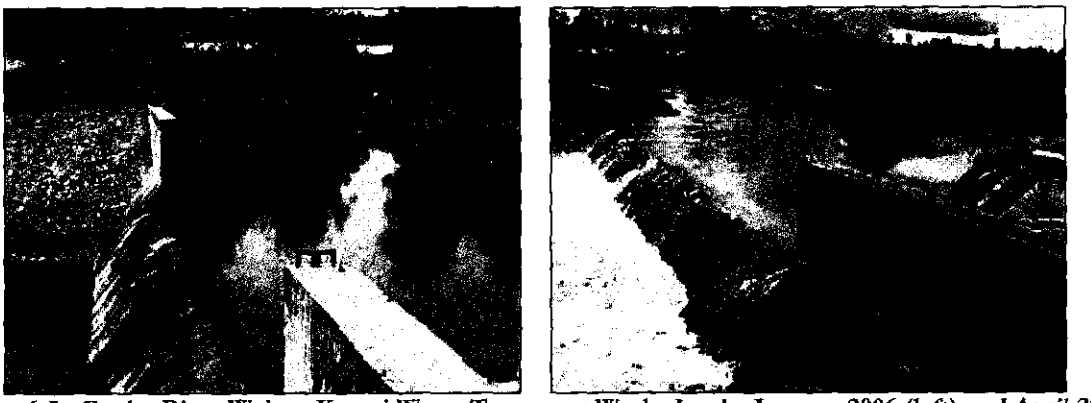


Figure 6-5. Gucha River Weir at Kegati Water Treatment Works Intake January 2006 (left) and April 2006 (right)

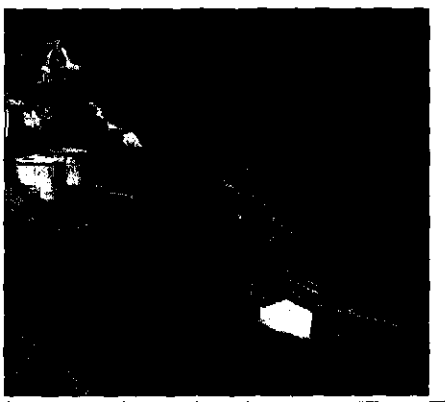


Figure 6-6. Nyakimasaro River at Nyakimasaro Water Treatment Works

In addition to hydropower, other potential renewable power supplies include wind, solar, and biomass. It is unclear if any such projects have been implemented or are in the planning stages in Kisii. In general, it is

[1] The data provided by GWASCO does not indicate the year or years when this data was recorded and it is unclear as to where Station 1KB01 is located. GWASCO noted that 1KB01 is the nearest station. Latitude and longitude locations for this station are included in the 1998 JICA Report, but indicate the station is north of Kisumu, which is impossible because the Gucha River originates southeast of Kisumu and flows southwest. It is assumed that the JICA locations are incorrect. Clarity is required on the location of station 1KB01 and the available streamflow data for the Gucha.

expected that while solar power may be cost effective for small demands such as backup power for offices, it is not yet cost effective for larger demands such as pumping. Drawbacks associated with wind power include variability resulting in the need for large, costly energy storage facilities. Biomass facilities utilizing agricultural waste from sugar and rice farms in the region to create producer gas may have merit and should be explored.

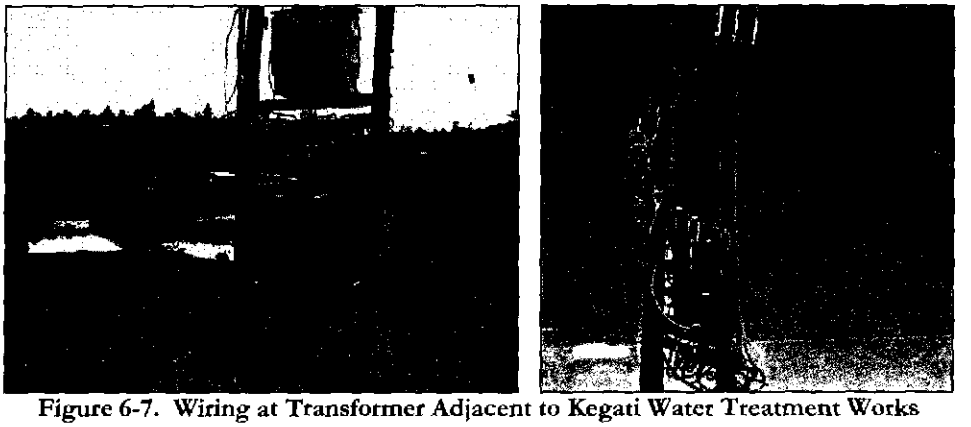


Figure 6-7. Wiring at Transformer Adjacent to Kegati Water Treatment Works

6.1.5 Population

6.1.5 (a) Existing Population

Kisii has a population of approximately 83,000 within in the Town boundaries, and a total population of approximately 200,000 people within the service area of the existing Kisii water supply system. Existing information on population in the Kisii area is imprecise, especially with regard to the population in the greater service area. Kisii experiences a substantial population increase during the day due to the commercial activities within Town attracting large influxes of people from outlying areas, especially on market days.[4] The town serves as the District Headquarters and is the major social, economic, and political center of the region.[5] Despite its vibrant commercial activity, the lack of adequate water and sanitation services hinders economic development.

Table 6-1 provides a summary of estimated existing population within the seven main sub-locations in town as prepared in the UN-Habitat Kisii Report (November 2005).[6] A detailed neighborhood-by-neighborhood study of population and other socio-economic indicators (referred to as a "baseline cluster survey") is currently underway by UN-Habitat. The results of this forthcoming study should be used to improve the accuracy of population, water demand, and wastewater flow projections contained in this report.

Table 6-1. Population of Kisii Town

Zone	Income Category	% of Population	No. of People
Milimani	High income	5%	4,130
CBD	Commercial	33%	27,260
Nyanchwa	Middle income	10%	8,260
Jogoo	Middle/Low income	14%	11,570
Mwembe	Middle/Low income	19%	15,700
Dataja Mbili	Low income	14%	11,570
Nubia	Low income	5%	4,130
	Total	**100%**	**82,600**

Source: Kisii Consolidated Final Report, Interventions in Water and Sanitation, Solid Waste Management and Drainage, UN-Habitat November 2005, Page 16

The daytime population in the center of Town is primarily comprised of public and private sector workers, business people and small-scale traders. High amounts of reliable rainfall allow many residents to grow cash crops in the peri-urban areas.[7] Most of the people in town live in these peri-urban areas and are of middle and low-income.[8] The average annual per capita income of Kisii residents has been estimated to be approximately 2,000 KShs/year. The predominant group in Kisii is the Abagusii, who occupy the Kisii Central, Gucha, and Nyamira districts and are mostly small-scale farmers.

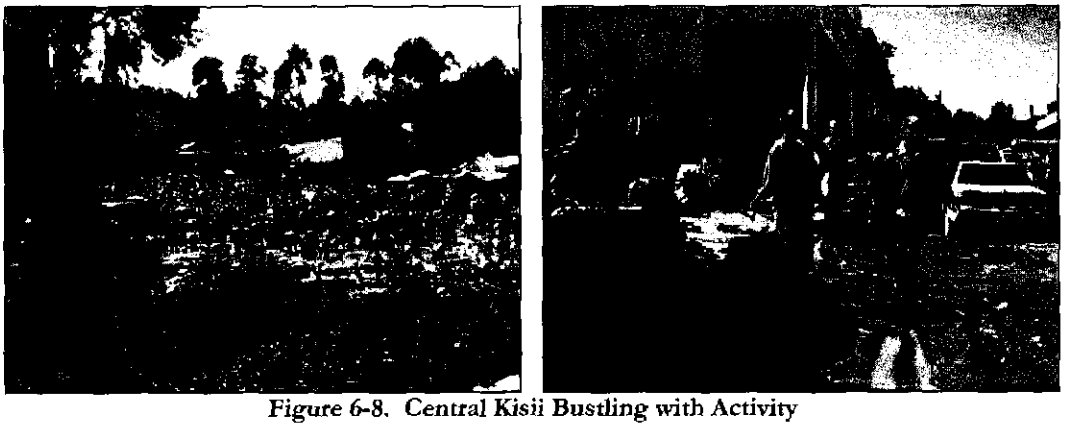


Figure 6-8. Central Kisii Bustling with Activity

6.1.5 (b) Population Projections

Available population projections were reviewed in order to develop projections for the purposes of this study. Estimates prepared by GWASCO assume approximately 3% growth, while Government of Kenya projections assumed over 4.4% growth. A November 2001 document prepared by the National Water Conservation and Pipeline Corporation entitled 'Kisii Water Supply Scheme Project Brief' assumed a growth rate of 4.3% through 2010. The UN-Habitat Kisii Report (November 2005) does not include long-term population projections. Previous studies (H.P. Gauff, 1985) estimated growth of 4% after 1995. Unfortunately, utilizing census figures for estimates of population growth rates is problematic due to overlapping and changing district boundaries over the years. Based on the available data, it was resolved to estimate a growth rate of 3.5% per year. A comparison of population projections by others and the Feasibility Study projections are presented in Table 6-2. Final town population projections used in the study and estimated income categories are presented in Table 6-3.

Table 6-2. Summary of GWASCO Service Area Population Projections

	1	2		3	4
Year	'Kisii Water Supply Scheme Project Brief' (2001)	'U.S. Investments in Water Treatment/Sewer Treatment Sector in Kenya' Document (2003)		GWASCO Water Supply Pre-Visit Survey and Data Request (2006)	Feasibility Study Projection (2006)
2005	110,000	120,000		200,000	200,000
2010	140,000	160,000		230,000	240,000
2015	170,000	200,000		270,000	280,000
2025	260,000	280,000		360,000	400,000

Notes:
Projections rounded to nearest 10,000. Projections 1 and 2 are assumed to be for Town boundaries only. Projections 3 and 4 include entire service area. UN-Habitat assumed 2005 population of approximately 83,000 residents in town and 200,000 within service area.
1 – Based on stated 2000 population and projected 2010 population, implied growth rate of 4.3%
2 – Projections extrapolated through 2025 using implied growth rate of 4.4%.
3 – Implicit growth rate of 3%.
4 – Assumes 3.5% growth rate.

Table 6-3. Projected GWASCO Water Service Area Population and Income Distribution

	Initial (2006)	Future (2015)	Ultimate (2025)
Population	200,000	282,000	400,000
High / Medium Income %	25%	30%	35%
Low Income %	75%	70%	65%

Notes:
- Population projections and income levels based on population within service area as per UN-Habitat Kisii Report (November 2005), assuming 3.5% annual growth rate. Only 82,600 people live in Kisii Town according to census data, but it is estimated that a total of 200,000 live within the water service area. There is significant uncertainty regarding the 200,000 figure, which may be resolved with results of forthcoming UN-Habitat baseline cluster survey.
- Income category breakdown based on UN-Habitat Kisii Report (November 2005) Table 1, and assumes all residents outside Kisii Town boundaries are low income. Assume ~0.5% change in income categories per year.

6.1.6 Water Demand and Service Goals

6.1.6 (a) Overview of Present Water Demand and Service Goals

GWASCO maintains approximately 6,000 registered water service connections, although less than 3,200 are classified as "active". Assuming nine to ten persons are served per active connection, it is estimated that approximately 29,000 residents are served by individual water connections (IWC). The number of residents currently utilizing water kiosks is unknown, but is estimated to be on the order of 100. Therefore, approximately 35% of the estimated service area population and 15% of the estimated town population is served by a piped water connection or water kiosk.

According to GWASCO records for 2005, average day water production is approximately 2,800 m^3/day, while average daily water consumption (based on consumer water meter readings) is less than 1,300 m^3/day. Therefore, unaccounted-for-water (UfW) is approximately 55%. Based on the present estimated service population calculated above, per capita consumption is estimated at 44 liters per capita per day (lpcd) and per capita demand including UfW is estimated at 97 lpcd. These are aggregate values including all demands from all sources (municipal, commercial, industrial, etc.).

Existing town and service area population and service population goals are presented in Figure 6-9. In order to meet the 2015 Millennium Development Goal (MDG) for water service, the existing unserved population in the service area should be reduced from its present value of 85.5% to 42.7% by 2015. This can be accomplished by increasing the number of customers served from approximately 29,100 to 161,500 (includes expected population increase).

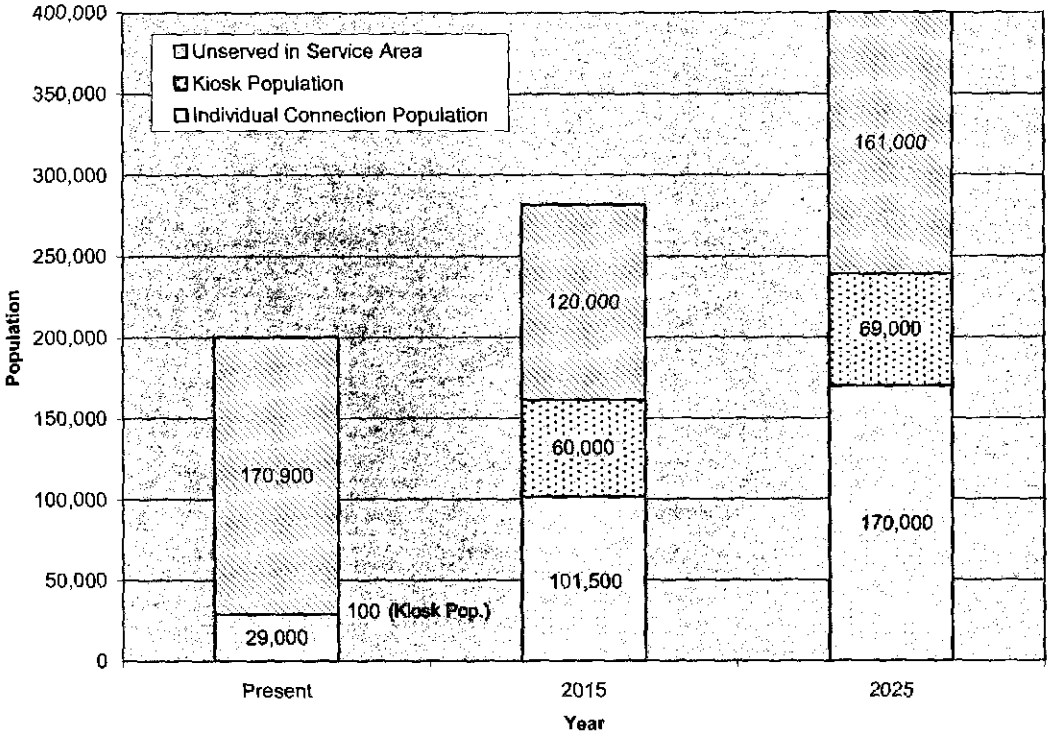


Figure 6-9. Kisii Town Existing Water Service Population and Future Service Goals

6.1.6 (b) Domestic Water Use

Domestic water demand projections were developed based on the methodology described in Section 2. The projections are based on a variety of data and assumptions, including:

- Available consumption, demand, and UfW data
- Expected service area population growth
- Estimated current and future customer income levels
- Estimated per capita water demand growth
- Expected reduction in UfW

Detailed tables of domestic water use demand calculations are presented in Appendix 6-1.

6.1.6 (c) Large Water Users

Water use projections for large users were developed based on the methodology described in Section 2. GWASCO provided water use records for the nine largest water user accounts in Kisii. Large water users in town include a Coca-Cola bottling plant (Kisii Bottlers, Ltd.), schools and universities, commercial / industrial establishments, hotels, and hospitals. The Kisii Bottlers facility (Figure 6-10) currently utilizes its own surface water source (a tributary to the Riana River) and is not connected to the GWASCO water distribution network.

Figure 6-10. Kisii Bottlers Limited – Facility Entrance and Outdoor Storage Area (left); Main Building (right)

GWASCO's largest water customers are the District Hospital (61 m^3/d), Kisii High School (61 m^3/d), Kereri Girls School (24 m^3/d), and GWASCO Institute of Technology (20 m^3/d). Kisii Bottlers, Ltd., a Coca-Cola Bottling Facility, reportedly uses over 350 m^3/d derived from its own private well. It is assumed that this facility will eventually be provided with water from GWASCO, as the company has expressed its interest in abandoning its well. Actual water use records provided by GWASCO may be inaccurate because many existing water meters are old and expected to be under recording flows. Additional allotments for other large water users and market day demands have been assumed. Large water user demands are assumed to grow at the same rate as the Town population. Detailed tables of large user water demands and projections are presented in Appendix 6-1.

6.1.6 (d) Projected Water Demand

Table 6-4 presents a summary of existing and projected water demand and consumption for the study period. Per capita water demand and consumption is expected to rise with an anticipated growth of population in medium and high income categories. UfW is expected to be reduced over time and reach 15% by 2025. It should be noted that these water demand projections are based on a variety of assumptions and should be revisited and revised as appropriate during preliminary design when new data is available. Widely varying projections of water demand exist. The UN-Habitat Kisii Report (November 2005) estimates the current actual water demand in Kisii Town is 11,000 m^3/d, while the current demand for the entire service area is 18,000 m^3/d.[9] The 2001 Kisii Water Supply Scheme Project Brief by the National Water Conservation and Pipeline Corporation projected water demand to reach 24,000 m^3/d by 2010.[10] The Government of Kenya Ministry of Water projected demand would reach 31,995 m^3/d by 2025.[11]

Table 6-4. Kisii Existing and Projected Water Demand and Consumption

	Initial (2006)**	Future (2015)	Ultimate (2025)
Water Production (m^3/d)	2,812	18,000	32,000
Per Capita Water Demand (lpcd)*	97	111	134
Unaccounted for Water (UfW)	55%	25%	15%
Water Sold (m^3/d)	1,264	13,500	27,200
Per Capita Consumption (lpcd)*	44	84	114

**Aggregate value including individual domestic connections, large users, and kiosks.*
***Initial water demand and consumption shown are actual values based on 2005 data provided by GWASCO.*

6.1.7 Wastewater Flow and Service Goals

6.1.7 (a) Overview of Present Wastewater Flow and Service Goals

Based on available information, it is estimated that slightly less than 80,000 residents of Kisii live within the existing wastewater service area as defined by the area covered by existing trunk sewer mains.

GWASCO initially estimated that it maintains approximately 600 sewer connections, slightly less than 400 of which are considered "active". GWASCO subsequently (June 2007) estimated that it maintains 1,070 sewer connections. The wastewater flow received at the existing wastewater treatment facility is presently not metered, but has been estimated at around 500 m^3/d.[12] Assuming approximately 10 persons are served per sewer connection, approximately 6,000 to 10,700 residents are served by a individual sewer connection (ISC), although only 4,000 are estimated to have "active" connections. In June 2007, GWASCO provided revised varying estimates of the actual number of people served (10,070 and 16,000). The number of residents currently utilizing public toilers is unknown, but is estimated to be less than 1,000 for the purposes of this study. Therefore, approximately 9% of the estimated service area population and 3% of the estimated total Town population is served by a piped sewer connection or public toilet (assuming 6,000 sewer connections). The remainder of residents and businesses utilize on-site wastewater systems, usually pit latrines and soak pits, for wastewater management. Some residents directly discharge wastewater into open drainage or local rivers and streams

Assuming average day wastewater flow received at the wastewater treatment facility is 500 m^3/d and 10 persons are served per connection, per capita wastewater flow is therefore 47 to 74 lpcd depending on the actual number of wastewater service connections. This is an aggregate value including all demands (commercial, municipal, industrial etc.). The relatively high range of per capita wastewater flow, larget than average per capita water consumption, may be due to inaccurate flow estimation, infiltration and inflow, and the expectation that residents and business with sewer connections have higher per capita water use than those relying on pit latrines or other forms of wastewater disposal.

Existing town and service area population and service population goals are presented in Figure 6-11. In order to meet the 2015 MDG for wastewater, the existing unserved population in the service area should be reduced from its present value of 91.4% to 45.7% by 2015. This can be accomplished by increasing the number of customers served by either piped sewer connections or public toilets from less than 7,000 to 102,000 (including expected population growth). As detailed in the wastewater section below, all residents currently relying on on-site wastewater systems should be included in the proposed on-site wastewater management program.

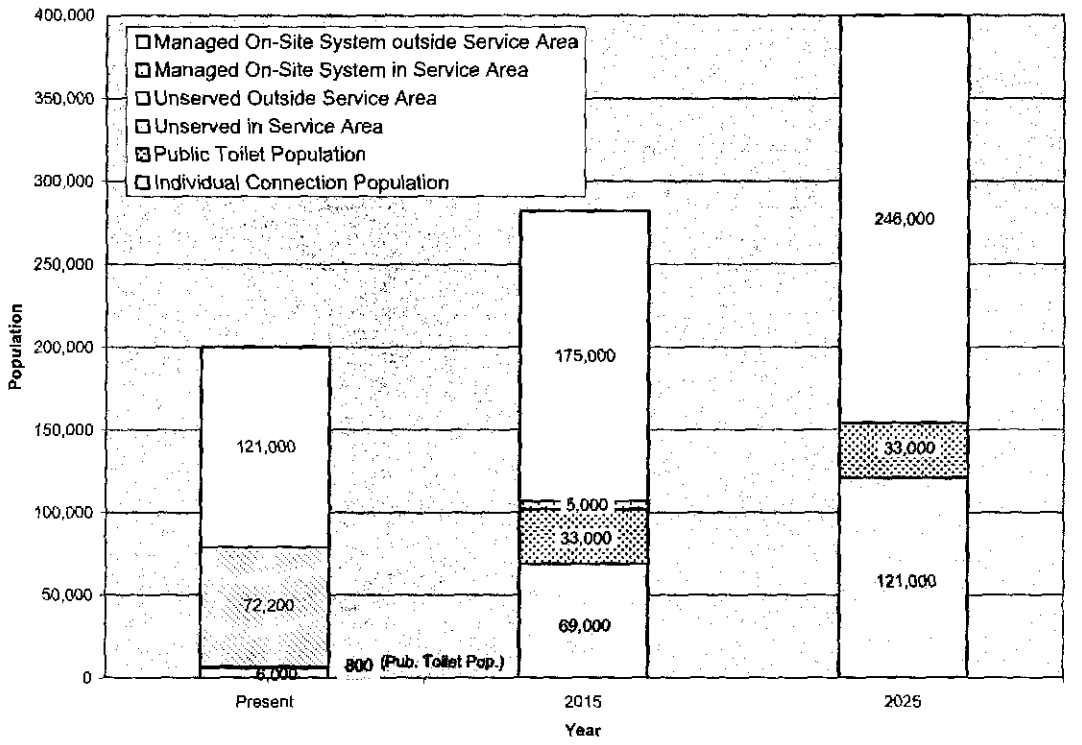


Figure 6-11. Town Existing Wastewater Service Population and Future Service Goals

6.1.7 (b) Domestic Wastewater Flows

Domestic wastewater flow projections were developed based on the methodology described in Section 2. The projections are based on a variety of data and assumptions, including:

- Available flow data and current per capita flow estimates
- Expected service area population growth
- Estimated per capita water demand growth

Detailed tables of domestic wastewater flow calculations are presented in Appendix 6-1.

6.1.7 (c) Wastewater Flows from Large Water Users

Wastewater flow projections for large water users were developed based on the methodology described in Section 2. The calculations assume future wastewater flows are 80% of water usage for connected large users (except Kisii Bottlers for which it was assumed 50%). GWASCO indicated which large water users are currently connected to the existing wastewater system. Kisii Bottlers is connected to the sewer system, but not to the water system. It was assumed that all large water users near the town center and existing trunk sewer mains will eventually be connected to the wastewater system. Wastewater flows from large water users are assumed to grow at the same rate as the Town population. Actual water use records provided by GWASCO, from which wastewater flow estimates were derived, may be inaccurate because many existing water meters are old and expected to be under recording flows. Additional allotments for wastewater flows from other large water users and market day demands have been assumed.

Detailed tables of wastewater flows from large water users are presented in Appendix 6-1.

6.1.7 (d) Projected Wastewater Flow

Table 6-5 presents a summaty of existing and projected wastewater flow fot the study period. Per capita flow is expected to rise with an anticipated growth of population in medium and high income categories. However, per capita wastewater flow is expected to remain stable or decrease slightly during the period 2006 through 2015 due to an assumption that many customers added during that time period will be of lower income and therefore have lower water consumption and wastewater generation. It is also expected that current per-capita wastewater flows may be overestimated due to the factors described above. It should be noted that these wastewater flow projections are based on a variety of assumptions and should be revisited and revised as appropriate during preliminary design when new data is available.

Table 6-5. Kisii Existing and Projected Wastewater Flows

	Initial (2006)**	Future (2015)	Ultimate (2025)
Wastewater Flow (m^3/d)	500	7,250	12,400
Per Capita Wastewater Flow (lpcd)*	74	71	81

** Per person served. Aggregate value including individual domestic connections, large users, and public toilets/ latrines.*
*** Initial flow unknown. Value is based on UN-Habitat estimate.*

6.2 Water

6.2.1 Water System Overview

According to a November 2001 document entitled 'Kisii Water Supply Scheme, Project Brief', the existing water supply system, mostly constructed in the late 1970s, was intended to meet water demands of Kisii Town up to the year 1995. The distribution system was constructed to distribute water from a planned treatment capacity of 18,000 m^3/d. Most of the proposed distribution network covering central Kisii and the rural areas was constructed, but the increase in treatment capacity was not. The installed design treatment capacity of the existing system is 7,000 m^3/d and actual production is less than 3,000 m^3/d. Therefore, a large distribution network exists with insufficient production capacity to provide water to the system.

Approximately 85% of residents in Kisii obtain their water from non-piped sources including springs, streams, water vendors, shallow wells, and rainwater. It is expected that many of these non-piped soutces are contaminated. The primary source of non-piped water in Kisii is springs. UN-Habitat noted that a previous study has indicated that as many as 90% of local sptings and wells may be unsafe for dtinking. It is estimated that more than 50 springs exist in Kisii from which residents draw water, including some which have been improved by local NGOs and government agencies.[13]

GWASCO supplies watet from two water treatment facilities: Kegati Water Treatment Works and Nyakomisaro Water Treatment Works. GWASCO reported average daily water production in 2005 of 2,812 m^3/d, despite having a combined total design treatment capacity of 7,000 m^3/d. Average day production ranged from a maximum of 3,391 m^3/d in February 2005 to a minimum of 2,465 m^3/d in May 2005. Unaccounted for Water (UfW) during this period was 55% based on reported 'water produced' and 'water sold' figures. Due to limitations in treatment and pumping capacity, rationing is employed and most areas do not receive water on a 24-hour basis. Many areas with piped service connections no longer receive water at all due to low production and pumping capacity coupled with increasing demands, leaks, and expected illegal connections. Neighborhoods that formerly received water but currently are unserved include Jogoo, Nyanchwa, Nubia, Milimani, Gekomu, Suneka, Nyambera, Nyamatro, Gesonso, Menyinkwa, Kiogoro, Nyaguta, and Nyanko.[14]

GWASCO maintains approximately 6,000 registered water service connections, although less than 3,200 are classified as "active". The UN-Habitat Kisii Report (November 2005) estimates that more than half of the active service connections only receive water 40 to 60% of the time and that only five percent receive water 100% of the time.[15] GWASCO estimated that there are approximately 4,000 service connections which are currently not served with water.[16]

Assuming future reductions in UfW, water demand is estimated to rise to 18,000 m^3/d by 2015 and 32,000 m^3/d by 2025. Therefore, UfW reduction and significant production capacity increases are required to meet expected demands.

Kegati Water Treatment Works is the primary treatment facility for Kisii Town. It was commissioned in 1977 and upgraded and expanded in 1988. Some limited emergency equipment upgrades were made in 2001. The facility draws raw water from behind a weir on the Gucha (a.k.a. Kuja) River and has a design capacity of 6,000 m^3/d. However, production is limited by failed pumps, unreliable electrical power, and high seasonal source water turbidity, reducing actual production capacity to around 2,500 m^3/d. The treatment works are located approximately 7 km southeast of the Central Business District at an elevation of approximately 1,775 m (5,820 feet) above sea level. Elevations in Kisii vary from approximately 1,980 m (6,500 feet) to 1,520 m (5,000 feet). However, a rise in elevation of apptoximately 70 m exists to the west of treatment works, separating it from the major town population centers. Therefore, pumping to an intermediary storage facility at Bobaracho is required before treated water can flow by gravity to central Kisii.

Nyakomisaro Water Treatment Works was commissioned in 1932 and produces less than 10% of GWASCO's total finished water. The facility draws raw water from the spring-fed Nyakomisaro River (a tributary of the Riana River) and currently produces around 250 m^3/d, despite having a design capacity of 1,000 m^3/d. The present production at the facility is limited by dilapidated equipment and high raw water turbidity. This facility is also situated at approximately 1,760 m (5,770 feet) above sea level, but is on the west side of the elevation divide mentioned above and can therefore distribute water to the major demand areas by gravity.

The extent of the existing distribution network is not known with certainty due to a lack of current mapping. However, based on conversations with GWASCO staff and review of hand-drawn maps (not to scale), it is expected that over 100 km of mains exist, running from Kegati Water Treatment Works in the southeast to Suneka Market in the northwest. Smaller mains extend as far south as Nyosia and Nyaguta, and as far west as Kiogoro, Otamba, and Motonto. Pipe sizes vary from 350 mm to 50 mm. The oldest pipes dating back to 1932 are made of galvanized iron or asbestos cement, while most newer pipes, mostly constructed in the 1970s, are made of uPVC.[17] At least 12 storage tanks are in use ranging from 50 to 500 m^3, although ten or more additional tanks exist but are not in use due to damage or lack of water.[18] With the exception of pumping from Kegati Water Treatment Works, the entire system is operated by gravity. A booster pumping station exists at Bobaracho but has not been used since its installation in 1992. GWASCO notes that the facility was operational in 1992.

Laboratory facilities and chemicals are not adequate for carrying out basic water quality tests. Dosing is generally done by estimation or rule of thumb and sampling is reportedly limited to pH and residual chlorine. Sampling data was not provided (although data reportedly exists for finished product water) and it is unclear if finished water quality meets National and World Health Organization standards.

6.2.2 Water Sources and Intakes

6.2.2 (a) Water Sources and Intakes Description

Present water sources for the GWASCO water supply system include the Gucha River (primary source), which provides raw water to the Kegati Water Treatment Works, and the Nyakomisaro River (secondary source), which provides water to the Nyakomisaro Water Works. Most residents in Kisii do not have access to a piped water source and therefore draw water from a variety of sources, typically springs.

The **Gucha River intake** (Figure 6-13, Figure 6-13) is adjacent to the Kegati Water Treatment Works, approximately 7 km southeast of central Kisii, just upstream of the B3 road bridge over the Gucha River.

The intake is situated behind a concrete weir and consists of five 6" intake pipes, three of which utilize low-lift suction pumps, and two of which have been retrofitted with submersible pumps because the low lift pumps are not functioning (in June 2007, GWASCO noted that none of the low-lift suction pumps are currently operational and that the entire supply depends on the submersible pumps). The weir allows flow to pass downstream throughout the year, although during the Project Team visit in the midst of a drought in January 2006, very little flow was passing downstream (Figure 6-11). A large wetland exists behind the weir, which is expected to be partially natural and partially created by extensive silt deposition resulting from erosion in the watershed.[19] The intake sump reportedly requires regular dredging due to heavy silt loading in the river, apparent in the April 2006 photo in Figure 6-12. Fencing at the site is bteached and potential safety hazards exist in the vicinity of the weir and intake.

Development and encroachment in the watershed upstream of the intake is apparently unregulated and as a result, turbidity levels in the raw water have reportedly increased since the facility was constructed in 1976. Upstream land uses include extensive small scale agriculture and some small industrial activities including coffee processing. Development has been allowed to take place within several hundred meters of the intake. A detailed assessment of upstream land use has not been conducted. Raw water quality data is not available.

Flow in the Gucha River at the intake weir is not measured by GWASCO. According to the 1998 JICA Aftercare Study, six gauging stations have existed on Gucha River, at least three of which have ceased operation. According to records provided by GWASCO, the closest gauging station is 1KB01, where flow varies from 5.8 m^3/s in February to 79.2 m^3/s in May and averages 24.3 m^3/s.[2] Information on when the data provided by GWASCO was taken was not provided, but the JICA Aftercare Study notes that flow at this station averages 24.3 m^3/s, so it is assumed to be an average for the period of record, listed in the JICA Aftercare Study as 1950 through 1964.[20] Water production at Kegati Water Treatment Works is approximately 2,500 m^3/d, or around 0.03 m^3/s. Assuming the provided flow data for station 1KB01 is similar to actual flows at the intake, extracted volumes are less than 1% of the lowest monthly low flow (5.8 m^3/s). Permitted withdrawal information was not provided for the intake at Kegati Water Treatment Works. It is assumed that a permit exists for the design capacity of 6,000 m^3/d, although no documentation was available. Potential for increasing withdrawal is unknown.

[2] According to latitude and longitude locations provided in the 1998 JICA Aftercare Study (pg IV-T-8), all the Gucha River gauging stations, including 1KB01, are north of Kisumu. The Gucha River originates southeast of Kisumu and flows south and southwest to Lake Victoria. It is assumed for the purposes of this study that the JICA locations are incorrect. Clarification on these locations will obviously be required during preliminary design.

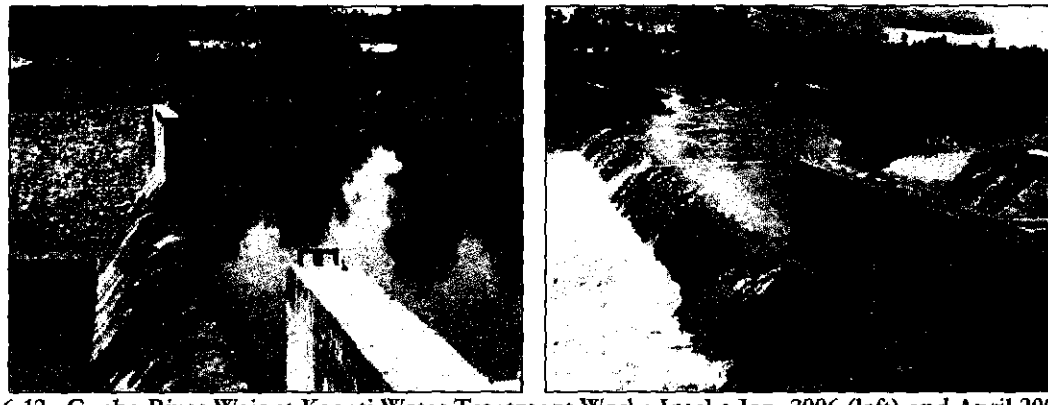


Figure 6-12. Gucha River Weir at Kegati Water Treatment Works Intake Jan. 2006 (left) and April 2006 (right)

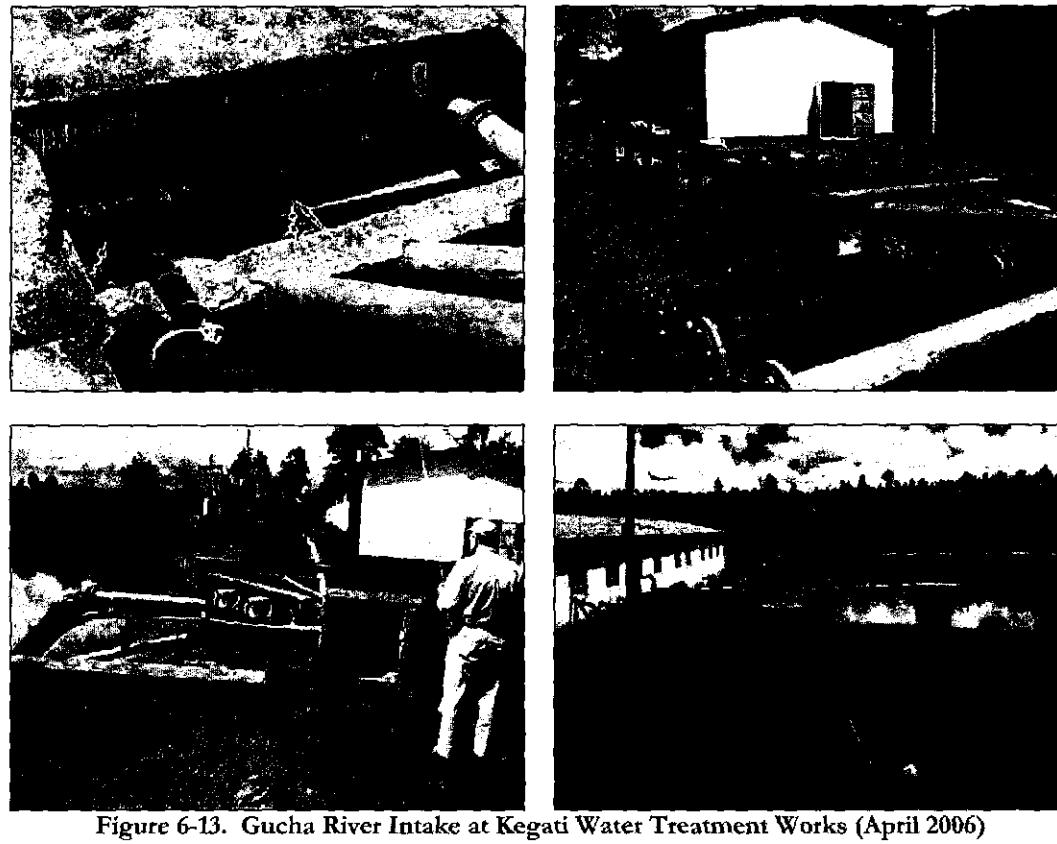


Figure 6-13. Gucha River Intake at Kegati Water Treatment Works (April 2006)

The **Nyakomisaro River intake** is located approximately 3.5 km southeast of the town center, in a peri-urban area adjacent to the Nyakomisaro Water Treatment Works near Bobaracho. The Nyakomisaro River (a tributary of the Riana River) is primarily spring fed and runs through a steep ravine adjacent to the treatment works, which was commissioned in 1932. The intake itself consists of a small dam and gravity intake adjacent to a small waterfall on the river (Figure 6-6).

According to the UN-Habitat Kisii Report (November 2005), most of the stream flow is generated from springs located on private land within 3 km of the intake. Unchecked encroachment of homes and small farms within the Nyakomisaro watershed has lead to increasing levels of turbidity in the raw water. A foot path runs immediately adjacent and upstream of the intake, increasing potential for contamination. The intake does not include a means for trapping silt and floating substances before the primary clarifiers, causing

high levels of settled solids to accumulate in the treatment works and requiring very high dosage of coagulant. The facility operators reported being unable to remove the turbidity even with very high alum dosing levels.

Flow and water quality data was not available for the Nyakomisaro River. The design capacity of the treatment works is 1,000 m^3/d, so it is assumed that a permit exists for this amount and that sufficient flow exists to accommodate this withdrawal. Downstream of the intake, the river and its tributaries serve as a source of water for Kisii Bottlers (Coca-Cola bottling company) and car wash facilities, among other uses.

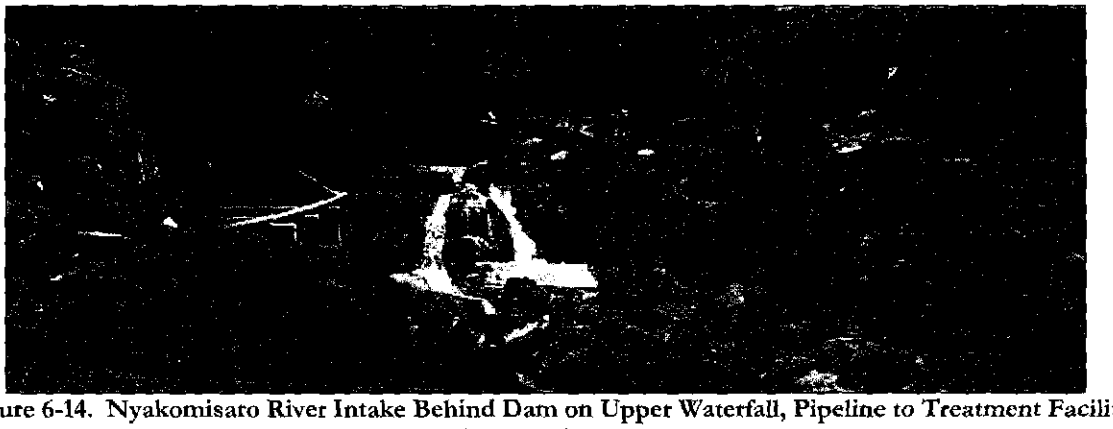


Figure 6-14. Nyakomisaro River Intake Behind Dam on Upper Waterfall, Pipeline to Treatment Facility visible left of waterfall

Other Water Sources

Detailed information is not available on other water supply sources in Kisii, such as springs, streams, water vendors, shallow wells, and rainwater. The majority of Kisii residents obtain water from such sources, most of which are expected to be contaminated and contributing to high levels of waterborne diseases. Although some residents may use point-of-use treatment, it is expected that most residents consume the water without treatment. Poor sanitation practices and illegal dumping are likely causes of contamination. The UN-Habitat Kisii Report (November 2005) notes that "the state of environment report (2005) has associated untreated drinking water with typhoid, cholera, poliomyelitis, amoebiasis and hepatitis-A in Kisii Central District, whilst lack/insufficient water has caused skin diseases (including scabies), eye diseases (including Trachoma), diarrhea and dysentery."

6.2.2 (b) Water Sources and Intakes Needs

Insufficient flow and raw water quality data is available to effectively evaluate the existing water sources and intakes. However, available information suggests that sufficient flow may be available in the Gucha River to provide sufficient water supply for the design period. Assuming an average flow of 24.3 m^3/s (2.1 million m^3/d) based on reported flow data for gauging station 1KB01, this would be sufficient to meet projected 2025 demand of 32,000 m^3/d, although a dam would eventually be required to equalize flows during the dry season. The lowest average monthly flow reported in the information provided by GWASCO for station 1KB01 was 5.8 m^3/s (500,000 m^3/d). Current total water abstraction and production is less than 3,000 m^3/d, so a more than tenfold increase is expected to be required in the design period. Flow available in the Nyakomisaro River is unknown but assumed to be sufficient to support the existing treatment facility design capacity of 1,000 m^3/d. Low flow problems resulting in reduced abstraction were not reported by the operators at either facility.

Current Gucha and Nyakomisaro River streamflow and raw water quality data are required for an accurate assessment of potential water abstraction increases from the two existing sources. A sampling program

should be established and data should be collected in accordance with Government of Kenya requirements for assessing new water supply abstractions. In addition, clarity is required regarding existing permit status and potential for increased abstraction. Flow in the Kegati River may be approximated at the existing weir by measuring the depth of flow over the weir and the width of the weir. In January 2007, GWASCO noted that they had been in discussion with WRMA regarding setting up a flow and water quality sampling station on the Gucha River, which would be paid for by WRMA and installed by GWASCO.

Source water protection is required in both the Gucha and Nyakomisato River watersheds. Due to high population density, a large percentage of land in Kisii is used for agriculture, including the hilly peri-urban areas in both current water supply watersheds. Land is often subdivided within families, resulting in increasingly smaller areas being used for intensive farming. This farming often extends to the banks of streams and results in soil erosion and water pollution from the application of fertilizers and chemicals. Watershed management programs are needed to reduce erosion and pollution which have adverse effects on raw water quality. Land purchase should be considered for permanent protection of water sources. No public education programs are currently in place regarding source water protection and water conservation.

Quantitative data on increasing coagulant dosage requirements and anecdotal information GWASCO staff indicate increasing levels of turbidity and development pressure within the watersheds. The intakes are not equipped with appropriate silt traps, thus suspended solids loads overwhelm primary sedimentation tanks and result in coagulant and chlorine dosing being ineffective. According to GWASCO staff, finished water often still has significant levels of turbidity when it reaches the consumer, particularly during the wet season when turbidity is highest. Improvements to intakes to reduce silt loads are required.

Safety hazards exist at both intake sites, most notably the ease of public access to the intakes and a lack of guard rails and lighting. Fencing and other safety precautions should be added.

6.2.2 (c) Water Sources and Intakes Improvement Options

A major increase in water abstraction is required to meet projected demand. Available data suggests that only the Gucha River is located within an acceptable distance and has sufficient capacity and to meet expected long term demand. It is expected that a dam will be eventually required to provide sufficient supply during low flows. Other potential sources such as springs and groundwater wells would require excessively numerous installations (more than one hundred) and are therefore not cost effective.[21] The 1998 JICA Aftercare Study estimates the groundwater resources development potential of GWASCO District to be 4,100 m^3/d, compared with new surface water development potential of 77,127 m^3/d. The study also notes the following:

> *"The surface water resources are planned to bear 96% of the total development* [in Kenya]. *The unregulated run off of rivers or groundwater or combination of both of them are not sufficient enough to meet future water demand in a number of the urban centers. For these, a large dam or inter-basin transfer or combination of them are proposed."*[22]

A dam on the Gucha River at Bunyunyu (~7 km east of Kegati Water Treatment Works) is one of fourteen dams proposed in the 1992 National Water Master Plan and is referenced in the 1998 JICA Aftercare Study.[23] GWASCO staff noted that even during low flow conditions such as those existing during the January 2006 visit, the Gucha River has sufficient capacity to provide 18,000 m^3/d, which is equivalent to the expected 2015 demand. Assuming this information is accurate, sufficient run-of-river flow may be available to meet all projected demand through 2015, after which time a dam would be required.

Unreliable electrical power is the most significant factor limiting the main water treatment works (Kegati) from producing at its rated capacity. Electrical power also represents one of the largest operating expenses for the existing system. Therefore, it is recommended that preference for future water supply systems be

given to those that function entirely or primarily by gravity. It has been noted by UN-Habitat that the location of the existing Kegati Water Treatment Works was initially decided based on considerations other than engineering judgment. The UN-Habitat Kisii Report (November 2005) notes that:

> *"Use of surface water has been very limited. At the time that Kegati water works were developed in 1977, it seems that little effort was made to study this option more widely. Generalised topographical maps indicate that this option is viable as a longer-term option." "Rehabilitation of the Kegati pumping system is expedient in view of the current poor state of the water system and suffering. Further expansions, however, should seek to utilise gravity flow and minimise or eliminate pumping altogether".*[24]

The location of the existing facility necessitates pumping water approximately 3 km to a tank facility at Bobaracho before it can flow by gravity to the main population centers of Kisii. Therefore, a potentially more suitable location for a treatment facility would be at Bobaracho with an intake on the Gucha River located sufficiently upstream to allow gravity flow to Bobaracho. Such an arrangement would allow the most densely populated areas (highest demands) to be served without the need for pumping.

Previous studies have suggested that an intake and dam located at Bunyunyu may provide sufficient head for gravity flow to Bobaracho. Bunyunyu is located approximately 7 km east of Kegati Water Treatment Works at elevation of approximately 6,000 ft. Kegati Water Treatment Works are at 5,800 feet. Bobaracho is located at an elevation of approximately 6,000 feet and is approximately 9 km west of Bunyunyu. According to GWASCO staff and UN-Habitat, gravity flow to Bobaracho is feasible, although further study is required to verify this. GWASCO is supportive of a plan to create a nearly all-gravity system with a new treatment facility at Bobaracho.

This 'Kisii Water Supply Scheme Project Brief' (2001) by the National Water Conservation and Pipeline Corporation estimated that water demand would reach 24,000 m^3/d by 2010. The document recommends that an intake and subsequently, a dam, be constructed to meet this demand:

> *"Available stream flow records show that only the Gucha River has adequate flow for exploitation to cover a project of this magnitude. The Gucha River is recommended to continue to serve as the source of water within the supply area. Studies carried out in the past show that while total annual flow is adequate to meet the demand into the foreseeable future, the flow during dry seasons will be inadequate with time as the demand increases. Specifically, during the National Water Master Plan (NWMP) studies completed in 1992, this fact was recognized and a dam site was identified at Bunyunyu, 10 km upstream of the present intake. Construction of a dam will ensure storage of excess runoff during high flows to be used when low flows are experienced."*[25]

The Kisii Water Supply Scheme Project Btief proposed two alternate schemes, one using all gravity flow for raw water abstraction, and a second requiring raw water pumping. The document states, "It is highly recommended that the gravity option be adopted".[26] It recommends that the project be implemented in phases, with an intake and raw water main constructed first and a dam constructed subsequently at the intake location as demand dictates. Both options include treatment located at the present Kegati water works with high lift pumping to Bobaracho. The document does not discuss the possibility of gravity flow to Bobaracho for a completely gravity system. This option of continuing to utilize the Kegati Water Treatment Works site even after a new intake and dam are established near Bunyunyu should also be considered, especially if gravity flow to Bobaracho is not feasible. Hydropower facilities installed at or near Kegati may be feasible for reducing electrical power needs from the existing grid.

The 1998 JICA Aftercare Study proposes a dam on the Gucha River to meet the Aftercare Study's projected urban water demand for GWASCO District of 16,960 m^3/d in 2010.[27] The expected amount of demand to be provided by the proposed Bunyunyu Dam in that year is 8,960 m^3/d.[28] The report does not clearly state the maximum amount of water expected to eventually be supplied by the proposed dam at Bunyunyu. Similarly, the Government of Kenya Document entitled 'US Investments in the Water Treatment/Sewer Treatment Sector In Kenya', notes that a new intake and dam at Bunyunyu could be expected to produce 9,000 m^3/d.[29] Detailed plans or reports describing the proposed dam were not made available during the

study and should be obtained and reviewed. Detailed flow data for the proposed location at Bunyunyu is required to confirm availability of flows.

A Government of Kenya document has suggested that a dam on the River Twach[3] could provide 17,000 m^3/d.[30] UN-Habitat has suggested that a gravity diversion of water from the Nyamira Highlands to Bobaracho could provide sufficient water supply.[31] Both of these sources are located far to the north (20+ km from Bobaracho), although actual proposed locations are not provided in the aforementioned documents so the distances are uncertain. All options require detailed investigations to determine feasibility.

All options water sources and intakes must include major increased abstractions over the study period. The only viable source of sufficient supply appears to be the Gucha River and abstraction of water from this source will eventually require a dam to allow sufficient abstraction during low flow periods. However, improvements to existing intakes will be required in the interim to maintain and boost current production. Upgrades at existing intakes at Kegati and Nyakomisaro must be implemented to reduce turbidity entering the treatment facilities. A variety of options have been suggested for both intakes including withdrawal of water through riverbed via infiltration galleries, sedimentation basins, and infiltration trenches. Also, the low lift pumps at Kegati should be replaced as recommended in the UN-Habitat Kisii Report (November 2005). Replacement of these pumps may already be underway as part of their 'immediate interventions'. As noted previously, source water protection measures are also urgently needed in both watersheds to reduce silt and pollution loads and curb further degradation to the watershed.

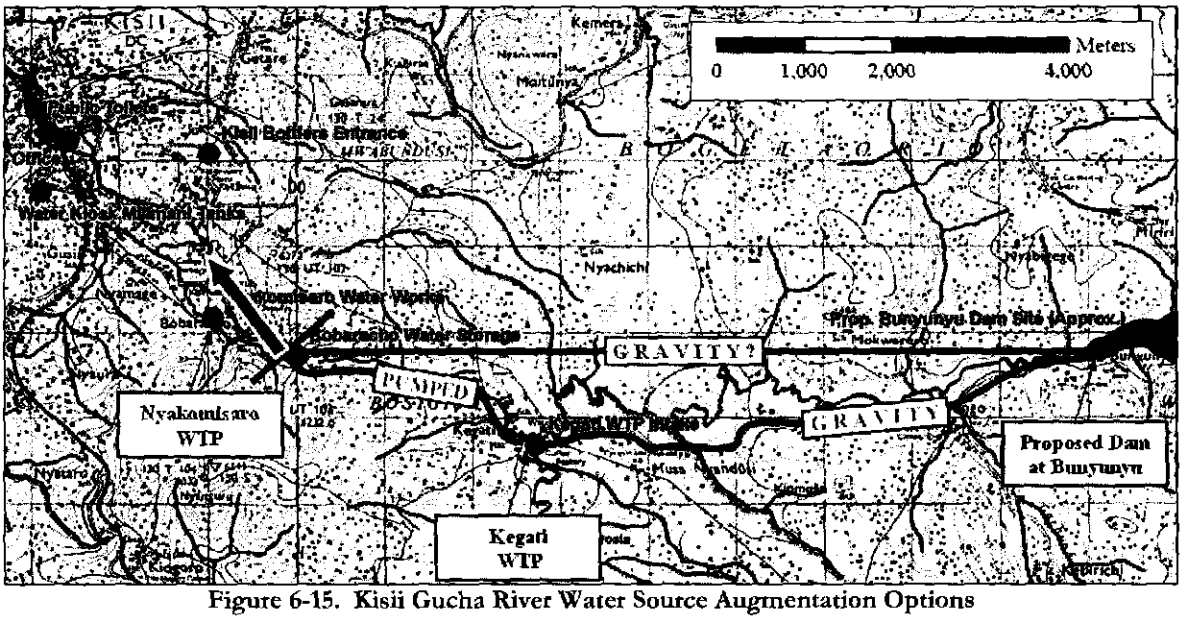


Figure 6-15. Kisii Gucha River Water Source Augmentation Options

6.2.2 (d) Water Sources and Intakes Recommendations

A gravity intake on the Gucha River near Bobaracho, if shown to be feasible in subsequent studies, and subsequently a dam at the same location, is the recommended option for augmenting water supplies for Kisii based on available information. Until these improvements are made, upgrades to the existing intakes should be undertaken to increase supplies and reduce silt loads. Although up-front costs associated with the recommended gravity intake and dam option will be higher than other options, it is the only option that can reliably produce a large supply of water during all seasons without the need for pumping.

[3] It is assumed that this refers to the River labeled on the Survey of Kenya Kisii map as Awach Kasipu, also known as the Ober.

At least until the proposed new intake is constructed, GWASCO will need to continue to rely on the existing intakes and treatment facilities. Activities required for moving the intake and raw water main project forward should begin immediately. Recommendations for sources and intakes and estimated costs and phasing are included in the detailed matrices (Appendix 6-2). Recommended activities include, but are not limited to the following:

- Perform **detailed study and cost estimation for source augmentation options**. Include consideration of dam at either Bunyunyu or Bonyama (Nyamataro Bridge further upstream) with gravity raw water main to Bobaracho Tanks with new treatment facility at Bobaracho, or to Kegati WTP with hydropower facilities installed. Also consider River Awach and diversion from Nyamira highlands. Investigation should consider initial phase for construction of upstream intake, then adding dam as second phase as dictated by demand and available flows. All previous reports on proposed Bunyunyu Dam and other options should be obtained and reviewed. In light of current poor power reliability, the gravity flow option is recommended based on current available information. Detailed ground survey or accurate leveling measurements are required as part of this task to evaluate feasibility. Treatment and distribution studies are included as separate tasks, but expected service areas and elevations must be considered simultaneously.
- Obtain all available **historic flow data** for the Gucha and Nyakomisaro Rivers from the Water Resources Management Authority (WRMA).
- Establish **flow and water quality monitoring station** on the Gucha River to gather data required for application for increased abstraction and dam per Government of Kenya regulations. Immediately begin approximating flow at the existing weir at Kegati.
- Clarify Gucha and Nyakomisaro River **permitted abstraction volumes, ownership of permits, and present status**; clarify potential for increased abstraction. Begin permitting process for increased abstraction from Gucha River.
- Undertake **source protection measures** including watershed delineation, watet quality threat assessment, development of a watershed management program including farming best management practices, and consideration of land purchase for watershed protection. Protections should be implemented as soon as possible, especially in the Gucha watershed to limit siltation behind proposed dam at Bunyunyu. Develop public education programs regarding source water protection and conservation.
- Investigate **hydropower feasibility** at or near both existing treatment works. Also consider a biomass gasification plant using sugar cane waste or other locally available organic materials.
- Perform detailed analysis and implement **upgrades to intake structures** at both water treatment facilities, including possible underground spring intake at Nyakomisaro Water Treatment Works.
- Construct **new intake at Bunyunyu and raw water main to new treatment facility at Bobaracho**, if recommended in subsequent detailed analysis.
- Construct **dam at Bobaracho** and **additional raw water main capacity** as required.

6.2.3 Water Treatment

6.2.3 (a) Kegati Water Treatment Works Description

The Kegati Water Treatment Works are located 7 km southeast of the Central Business District, just north of the B3 road btidge over the Gucha River. The works are at an elevation of approximately 1,775 m (5,820 feet) above sea level. The facility draws raw water from the Gucha River and provides 92% of the treated water produced by GWASCO.

The facility was commissioned in 1977 and was upgraded and expanded in 1988. Some limited emergency equipment upgrades were made in 2001. The facility draws raw water from behind a weir on the Gucha

(a.k.a. Kuja) River and has a design capacity of 6,000 m^3/d. Average water production is currently approximately 2,500 m^3/d. The facility employs a conventional treatment process consisting of coagulation, flocculation, sedimentation, filtration, and disinfection. The facility appears to be in fair condition and some equipment (notably pumps) and facilities are in need of repair or replacement. Layout drawings of the treatment facility are not available, although GWASCO staff provided a hand-drawn sketch of the facility.

Water is drawn from the Gucha River through a series of five intake pipes utilizing low lift suction pumps (20 hP) and submersible pumps installed to replace two broken low lift pumps (Figure 6-13). Raw water flows to a pump house adjacent to the intake where two low lift pumps (30 hP), only one of which is working, pump water to the headworks via a 12" diameter steel main (Figure 6-16, Figure 6-17). From the headworks, where alum and soda ash are added, water flows by gravity through the entire treatment works (Figure 6-18). After chemical addition, water flows through mixing chambers, then to horizontal flow sedimentation tanks and over a weir to the sand filters (Figure 6-19, Figure 6-20). Two filter backwash blowers, one of which is working, are housed in a building adjacent to the main treatment plant tankage (Figure 6-21). This building also houses offices for the water works. After filtration, the water flows by gravity to two clear water tanks where disinfection takes place with 65% sodium hypochlorite (Figure 6-22). From the clear water tanks, water flows back to the pump house where five high lift pumps (60 hP), only two of which are working, pump the finished water into the distribution system (Figure 6-23).

No laboratory facilities exist at Kegati and therefore chemical dosing is done by estimation. The only sampling performed is for pH (raw and finished) and residual chlorine. The amount of chemicals required varies widely depending on the season. Dosage of alum and soda ash reportedly double during the wet season when turbidity levels rise. According to the UN-Habitat Kisii Report (November 2005), seasonal alum dosage varies from 100 to 200 kg/d, soda ash dosage varies from 10 to 25 kg/d, and chlorine dosage varies from 8 to 10 kg/d.

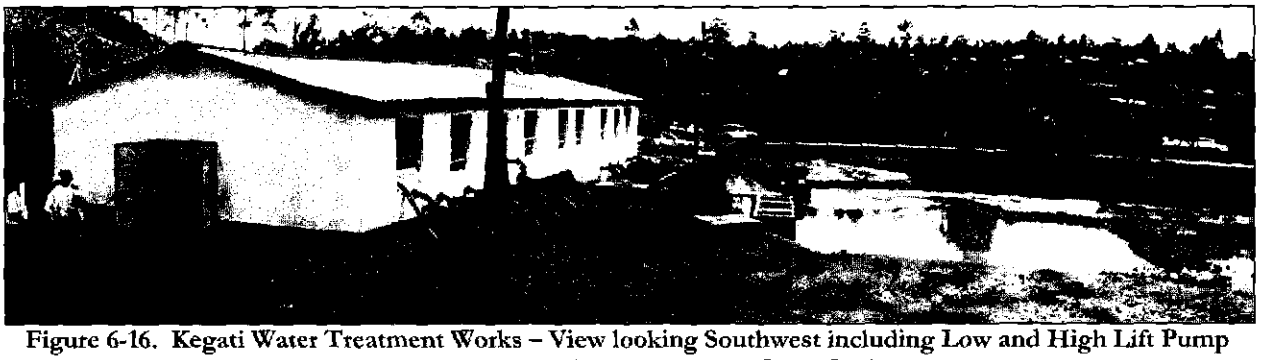


Figure 6-16. Kegati Water Treatment Works – View looking Southwest including Low and High Lift Pump Building (left), Gucha River and B3 Road Bridge

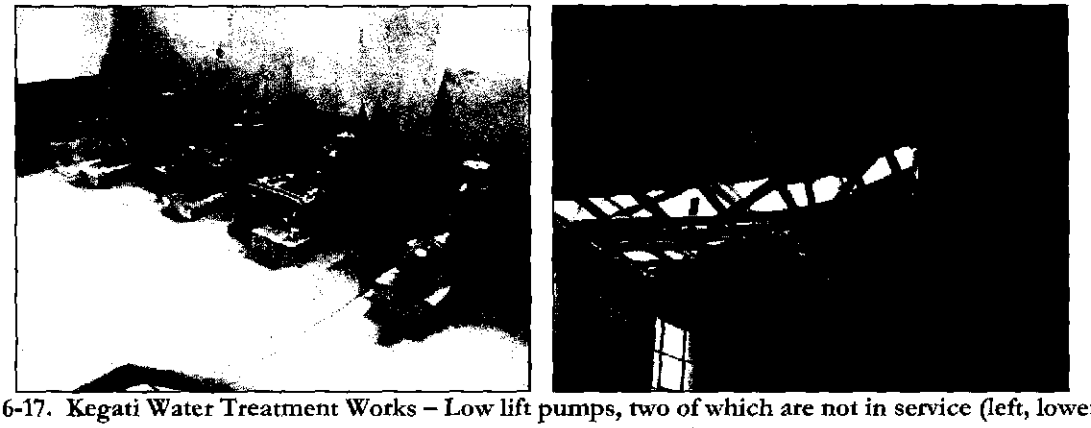


Figure 6-17. Kegati Water Treatment Works – Low lift pumps, two of which are not in service (left, lower room of pump house); Hole in ceiling of pump building (right)

Figure 6-18. Kegati Water Treatment Works - Chemical Feed Equipment and Mixing at Headworks

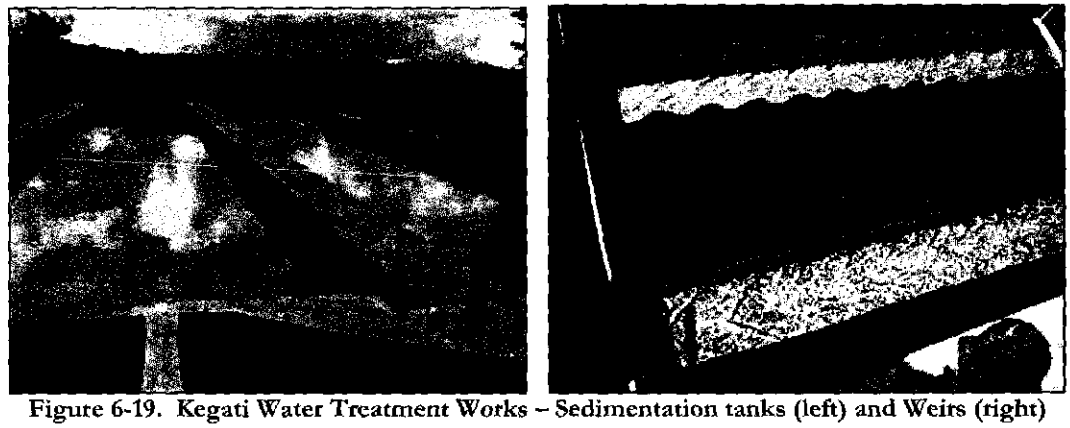


Figure 6-19. Kegati Water Treatment Works – Sedimentation tanks (left) and Weirs (right)

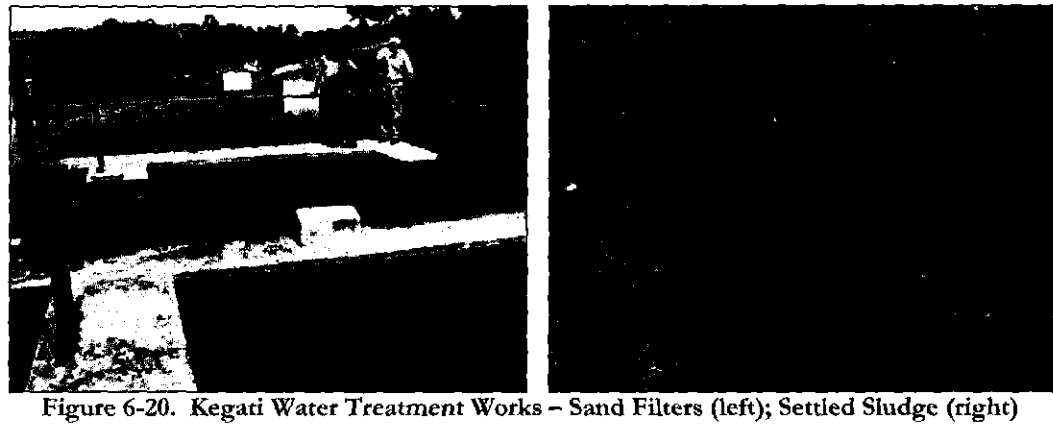


Figure 6-20. Kegati Water Treatment Works – Sand Filters (left); Settled Sludge (right)

Figure 6-21. Kegati Water Treatment Works - Blowers for Filter Backwash (left); Bee's Nest in Ceiling of Blower Room (right)

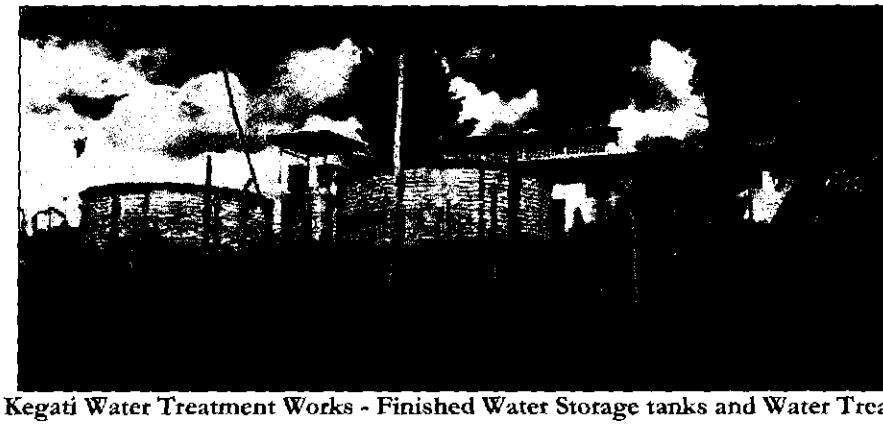


Figure 6-22. Kegati Water Treatment Works - Finished Water Storage tanks and Water Treatment Works Buildings

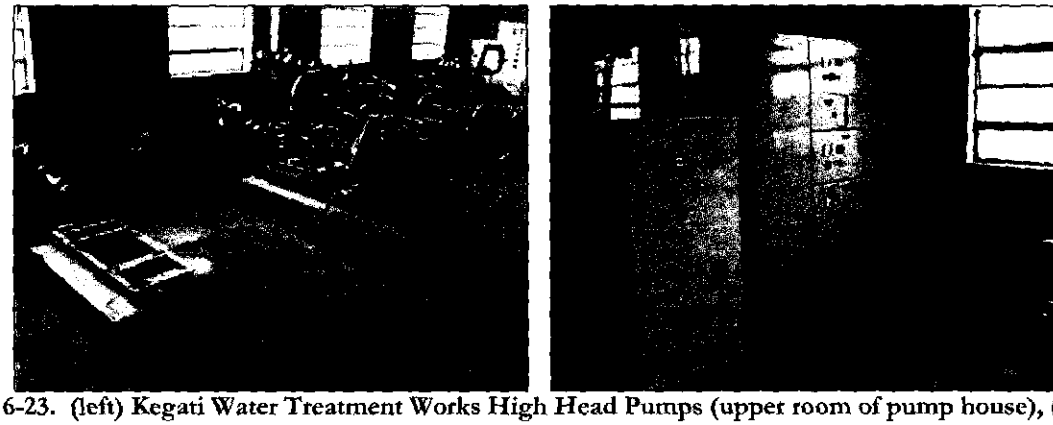


Figure 6-23. (left) Kegati Water Treatment Works High Head Pumps (upper room of pump house), (right) Control Panels (including new soft starter for high lift pumps)

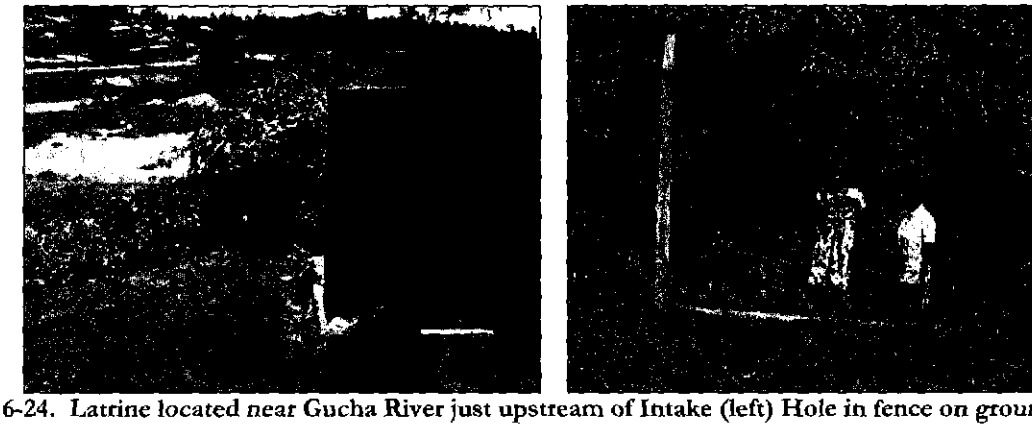


Figure 6-24. Latrine located near Gucha River just upstream of Intake (left) Hole in fence on grounds (right)

6.2.3 (b) Kegati Water Treatment Works Needs

Production at Kegati is limited by unreliable electrical power, failed pumps, high seasonal source water turbidity, and assorted other deficiencies. These factors combine to reducing facility production to around 2,500 m^3/d, despite having an original design capacity of 6,000 m^3/d.

Power outages and low and high voltage events occur frequently at Kegati Treatment Works. Unreliable electrical power is the most significant factor limiting production capacity. The failure of pumping systems is partly attributable to voltage fluctuations. GWASCO staff noted that 50% of the time the facility either has no voltage or low voltage. Voltage should be 415 V, but fluctuates from 300 V to 450 V, causing motors to run hot and contactors to burn out. The high lift pumps are typically only used at night when voltage is higher. Power outages frequently cause all pumping to cease because the facility does not have an auxiliary electrical power source. Although average production at Kegati is around 2,500 m^3/d, the facility is able to produce well over 3,000 m^3/d when reliable power is available. Weekly records were provided by GWASCO as examples for three non-consecutive weeks in April, May, and June 2006. The data indicate water production of as much as 3,800 m^3/d when voltage remained relatively consistently near 415 V for a 24-hour period. The data also indicate that on some days there was no production due to blackouts. Installation of an auxiliary generator, while expensive to install and maintain, would immediately boost production dramatically.

The capacity of the works is also impaired by a lack of functioning low lift and high lift pumping equipment. UN-Habitat carried out a detailed analysis of pumping equipment needs as part of its November 2005 Kisii study. This study noted that the current pumping regime can supply 3,220 m^3/d maximum and that replacement of failed and existing pumps with larger pumps will increase capacity to 6,000 m^3/d. The pumps should be synchronized to ensure that required storage capacity is minimized. Therefore, UN-Habitat recommended replacing all five raw lift and clear water pumps with new ones all having a capacity of 125 m^3/hr.[32] Other needed upgrades include repairs to the existing control panel, replacement of backwash blowers, repair of leaking valves, fencing, and repairs to the roof of the pump building.

The lack of laboratory facilities limits the ability of the facility to optimize chemical usage and ensure quality control. Basic laboratory facilities are needed. In addition, alum dosing requirements could be reduced by the installation of additional baffles in the existing mixing chambers to enhance mixing efficiency.[33]

6.2.3 (c) Kegati Water Treatment Works Recommendations

Detailed recommendations for the Kegati Water Treatment Works and estimated costs and phasing are included in the detailed matrices (Appendix 6-2). Most detailed recommendations are based on those recommended in the UN-Habitat Kisii Report (November 2005), although phasing has been altered for most

projects. Some UN-Habitat recommended upgrades may already be underway as part of their 'immediate interventions' project. Recommendations include, but are not limited to, the following:

- Conduct **detailed study for upgrade and expansion work.** Estimate detailed costs, determine permitting requirements, and develop preliminary design. Include recommendations for laboratory upgrade and new equipment. The extent of upgrades will be dependent on the results of the source augmentation study (e.g. significant upgrade and/or future expansion may not be warranted if new water treatment facility will be constructed at Bobaracho).
- Install **standby diesel generator.** Expected size required is approximately 500 kW, 750 kVa. Also consider installing a system to stabilize voltage and minimize reliance on the proposed generator such as a Sag Fighter® or Tap Changer Controller.
- Replace all five **low lift pumps**, all five **high lift pumps**, and both **backwash blowers.**
- Repair **control panel**, add additional **baffles** to mixing chambers, replace leaking **valves.**
- Upgrade **laboratory facilities** to allow for all frequently required testing to be performed locally.

6.2.3 (d) Nyakomisaro Water Treatment Works Description

The Nyakomisaro Water Treatment Works (Figure 6-25), commissioned in 1932, are located approximately 3.5 km southeast of the town center in a peri-urban area less than a kilometer west of the B3 roadway near Bobaracho. The works are at an elevation of approximately 1,760 m (5,770 feet) above sea level and draw raw water from the Nyakomisaro River (a tributary of the Riana River) as it passes through a steep ravine adjacent to the treatment works.

The treatment works, which operate entirely by gravity, have a design capacity of 1,000 m^3/day, but currently only produce around 250 m^3/day. The facility employs a conventional process consisting of coagulation, flocculation, sedimentation, filtration, and disinfection. The facility is in poor condition. Layout drawings of the treatment facility are not available, although GWASCO staff provided a hand-drawn sketch of the facility.

Water is drawn from the Nyakomisaro River through a 6" gravity intake pipe located behind a small dam. Water flows from the intake through a 6" sluice valve into chemical dosing and mixing chambers where alum and soda ash are added. Water then flows to one of three circular sedimentation tanks installed in parallel (Figure 6-26) and then to one of four circular sand filters in parallel (Figure 6-27). A pipeline from the Bobaracho water tanks to Nyakomisaro exists to provide water for gravity backwashing filters when available at Bobaracho. Finally, the water is disinfected with 65% sodium hypochlorite and discharged to finished water tanks and distribution piping (Figure 6-28, Figure 6-29).

No laboratory facilities exist at Nyakomisaro Water Treatment Works and therefore chemical dosing is done by estimation and seems to be arbitrary. The only sampling performed is for pH and residual chlorine.

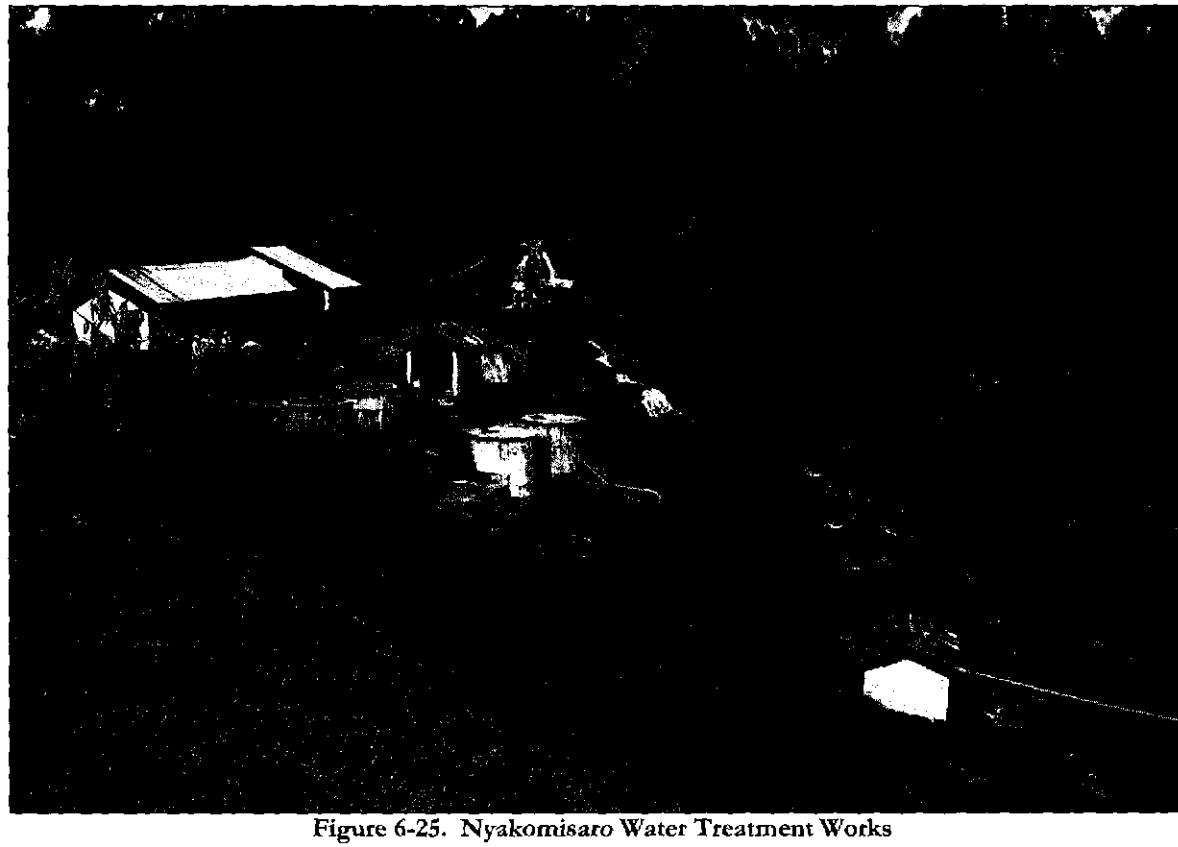
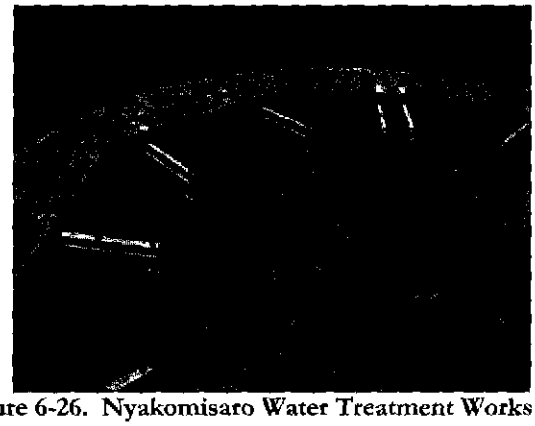


Figure 6-25. Nyakomisaro Water Treatment Works



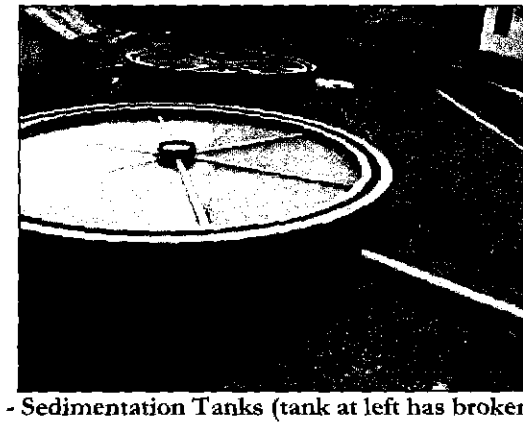


Figure 6-26. Nyakomisaro Water Treatment Works - Sedimentation Tanks (tank at left has broken weir)

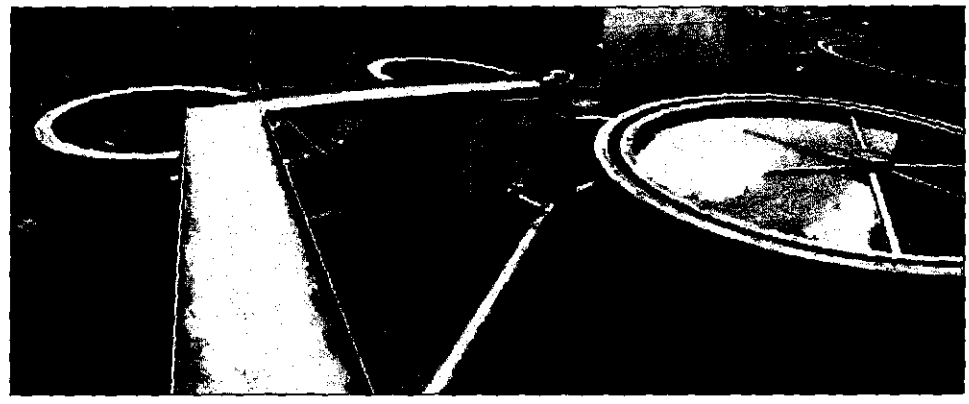


Figure 6-27. Nyakomisaro Water Treatment Works – Sand Filters (left, background right), Sedimentation tanks and chlorine dosing chambers also visible at right

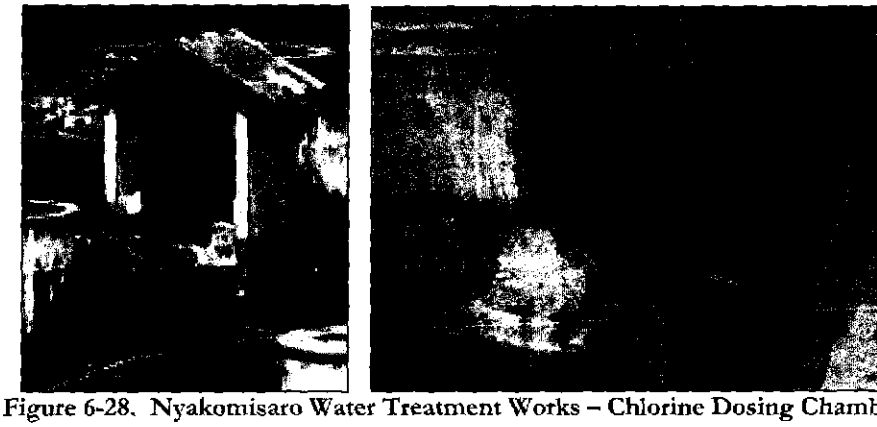


Figure 6-28. Nyakomisaro Water Treatment Works – Chlorine Dosing Chamber

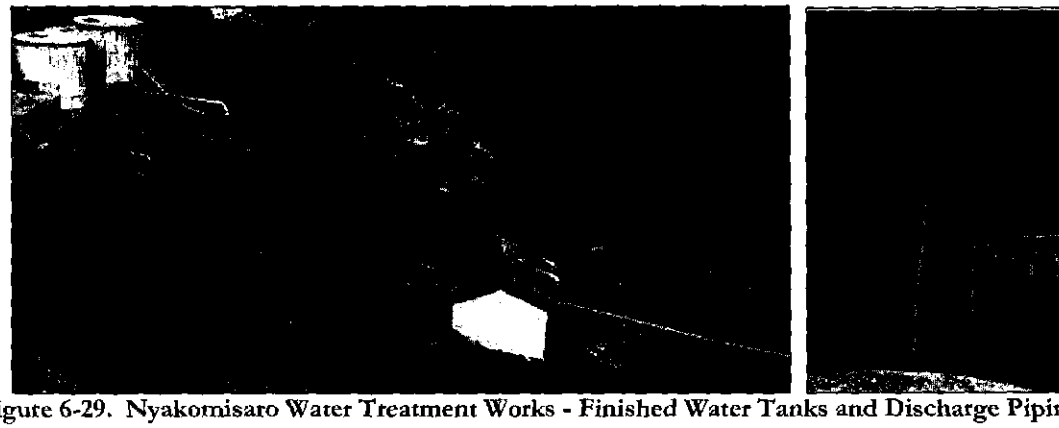


Figure 6-29. Nyakomisaro Water Treatment Works - Finished Water Tanks and Discharge Piping

6.2.3 (e) Nyakomisaro Water Treatment Works Needs

Water production at Nyakomisaro is limited by inoperable equipment, inability to backwash filters, and high source water turbidity. These factors have combined to reduce production to 25% of the facility's design capacity.

High raw water silt loads exist in the raw water, caused by unchecked development and farming in the watershed. A lack of silt removal at the intake allows high silt loads to enter the treatment works. Even with large dosing of alum (20 kg/day) and soda ash (8 kg/day), the silt cannot be adequately removed due to overwhelming suspended solid loads and ineffective clarification. The chemical dosing chamber is in need of

repair and is undersized. The finished water still has levels of turbidity when it reaches customers, especially when turbidity is high during the rainy season.[34] The clarifiers do not operate effectively due to broken troughs and piping. Much of the existing yard piping is rusted and tuberculated, resulting in expected high head loss and reduced capacity.[35] The entire system is reportedly always clogged with silt, particularly the sedimentation tanks and filters. The filter media requires replacement. Due to high silt loads and insufficient backwashing, the high head loss in the filters often causes overflows resulting in water losses.[36] The operator noted that high turbidity levels during heavy rains cause them to shut the facility down.

The lack of laboratory facilities limits the ability of the facility to optimize chemical dosage and ensure quality control. Basic laboratory facilities are needed.

Safety and security issues exist at the facility including a lack of fencing resulting in easy access to the facility from the surrounding areas, a lack of adequate guard rail systems near open tanks, and a lack of electricity and lighting.

6.2.3 (f) Nyakomisaro Water Works Recommendations

Detailed recommendations for the Nyakomisaro Water Treatment Works and estimated costs and phasing are included in the detailed matrices (Appendix 6-2). Most detailed recommendations are based on those recommended in the UN-Habitat Kisii Report (November 2005), although phasing has been altered for most projects. Some UN-Habitat recommended upgrades may already be underway as part of their 'immediate interventions' project. Recommendations include, but are not limited to, the following:

- Conduct **detailed study for upgrade and expansion work**. Estimate detailed costs, determine permitting requirements, and develop preliminary design. Include recommendations fot laboratory upgrade and new equipment. Extent of upgrades will be dependent on results of source augmentation study (e.g. significant upgrade and/or future expansion may not be warranted if new water treatment facility will be constructed at Bobaracho).
- Perform a **variety of upgrades**, including: replace filter media, upgrade and expand chemical dosing chamber, replace clarifier troughs and deteriorated yard piping and valves.
- Install **laboratory facilities** to allow for all frequently required testing to be performed locally. Ensure staff is trained properly in sampling techniques and interpretation of results for chemical dosage optimization.

6.2.4 Water Distribution

6.2.4 (a) Water Distribution Description

6.2.4 (a) 1. Service Area

The extent of the existing distribution system is not known with certainty due to the lack of current mapping. However, based on conversations with GWASCO staff and review of hand-drawn maps, it is expected that over 100 km of mains exist, running from Kegati Water Treatment Works in the southeast to Suneka Market in the northwest. According to a brief prepared by the Ministry of Water, the distribution system consists of 138.5 km of lines from 100 mm (4") to 350 mm (14") diameter.[37] Small mains extend as far south as Nyosia and Nyaguta, and as far west as Kiogoro, Otamba, and Motono. Pipe sizes vary from 350 mm to 50 mm according to GWASCO. The oldest pipes dating back to 1932 are made of galvanized iron or asbestos cement, while most newer pipes, mostly constructed in the 1970s, are made of uPVC.[38] With the exception of pumping from Kegati Water Treatment Works, the entire system is operated by gravity. A booster pumping station exists at Bobaracho but has not been used since its installation less than ten years ago.

An approximation of the existing area covered by a distribution network and the area currently provided with water is provided in Figure 6-30. The layout of the existing system is complex and seemingly haphazard. According to the hand-drawn map provided by GWASCO, almost all neighborhoods not adjacent to the main B3 road between Kegati Water Treatment Works and the GWASCO Institute of Technology just north of the CBD are currently not served with water despite having piped networks due to lack of supply. Some areas along the C17 road heading south from the CBD are served, including the Milimani area and portions of Mwembe. UN-Habitat developed a very useful layout sketch of the Kisii Water Supply System in its November 2005 report ('Layout Sketch Plan of Kisii Water Supply System'), although not to scale.

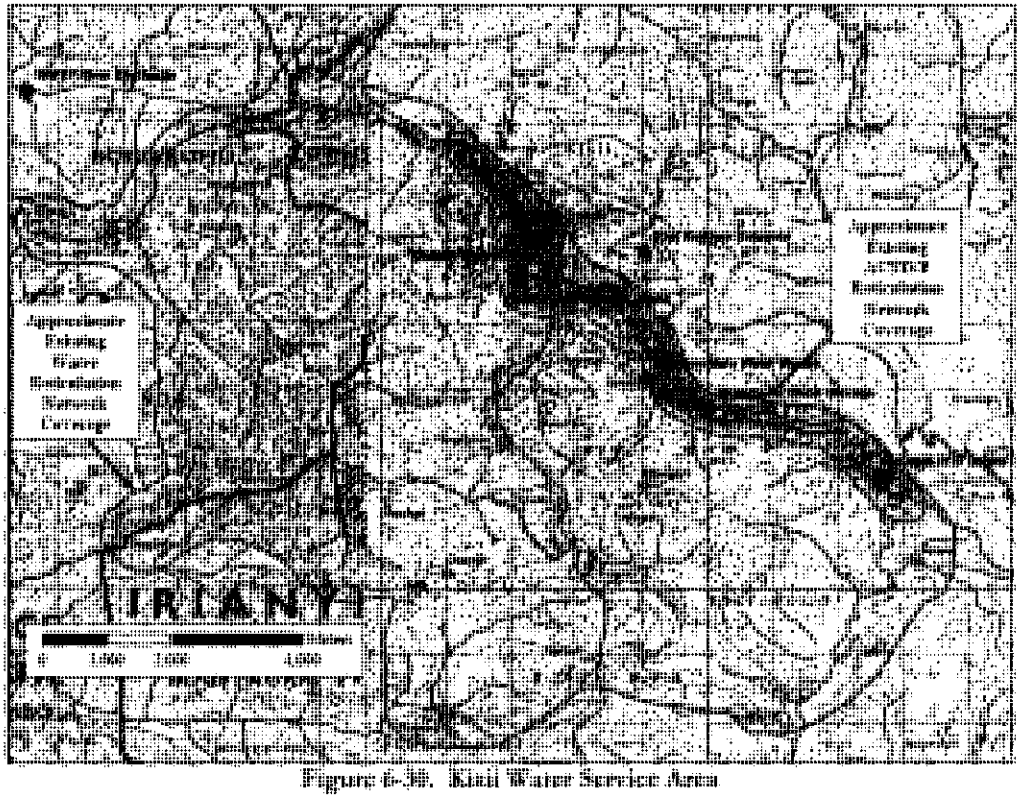


Figure 6-30. Kisii Water Service Area

Water is supplied by Kegati Water Treatment Works and Nyakomisaro Water Treatment Works. When finished water leaves the Kegati Water Treatment Works it is pumped in three directions. The first is southeast along the B3 road 2.5 km toward Nyosia via a 50 mm (2 in) uPVC pipe. The second is south towards Nyanko and Naguta via 10 km of 150 mm (6 in) uPVC water main which reduces to 100 mm (4 in) in the vicinity of Nyanko and eventually reduces again to 50 mm (2 in).[39] The third and primary distribution is to the northwest approximately 3 km horizontally and up 70 m vertically to the storage tanks in Bobaracho via a 350 mm (14 in) GI water main.

From Bobaracho, water mains extend northwest toward the central business district as well as southwest to Menyinkwa and south through Nyanguru and Kiogoro to Otamba, Ogembo, Itumbe, Matanwa, and Nyakogogi. Mains from Menyinikwa and Ogembe reportedly travel west as far as Motono and Itibo before heading north to Riamasagara near Suneka.

Neighborhoods west of the Town center with distribution piping include Daraja Mbili, Nubia, Nyanchwa, Milimani, Gekomu, Mwembe, Menyinkwa, and Itibo. Neighborhoods east of the Town center with pipe networks include Jogoo and Nyambera. Mains loop around the west of the central business district through Nyanchwa up to Daraja Mbili where they meet the mains on the B3 road then head west and southwest along the B3 road via Gesonso to Suneka. Prior to reaching Sunkea, the main connects in Riamasagara with a main

heading north from the western rural areas (Itibo, Motono). GWASCO has noted that it used to serve an estimated 79 km², but now has reduced service to the main Municipal area covering 29 km².[40] According to mapping provided by GWASCO, the following densely populated neighborhoods were once served with water but are now not provided with water:

Nyaguta	Mwembe	Nyanchwa	Suneka
Nyanko	Gekomu	Nubia	Gesonso
Kiogoro	Milimani	Daraja Mbili	Nyamataro
Menyinkwa	Jogoo	Nyambera	

Table 6-6, reptoduced from the UN-Habitat Kisii Report (November 2005), is a listing of tbe main water supply mains in Kisii.

Table 6-6. Main Water Supply Lines in Kisii

Diameter (mm)	Type	From – To	Category	Zone Served
350	GI	Kegati – Bobaracho	Pressure	Rising main
150	GI	Kegati – Nyanko	Pressure	Nyanko line
50	uPVC	Kegati – Eastwards	Pressure	Nyosia line
200	GI	Bobaracho – Nyanguru tank	Pressure	Kiogoro and Sameta areas
300	uPVC	Bobaracho – Break pressure tank	Gravity	Kisii town
300	uPVC	Bobaracho – Menyinkwa line	Gravity	Menyinkwa and Suneka areas
150	uPVC	Menyinkwa line – Nyakomisaro	Gravity	Milimani tanks
150	uPVC	Booster tank – Nyakomisaro line	Gravity	Milimani tanks
150	GI	Nyakomisaro – Milimani tanks	Gravity	Milimani tanks
100	AC	Nyakomisaro – Milimani tanks	Gravity	Milimani tanks/Old town

Source: Kisii Consolidated Final Report, Interventions in Water and Sanitation, Solid Waste Management and Drainage. UN-Habitat November 2005, page 28, Table 6

6.2.4 (a) 2. Pressure Zones and Pumping

Due to high amounts of leakage, small pipe diameters, and insufficient pumping capacity, providing sufficient water pressure is a major problem in Kisii. Many residents' connections are dry or provide water at very low pressure. The only functional pumping systems exist at Kegati Water Treatment Works. The booster pumping station at Bobaracho, intended to provide water to areas to the south (Nyanguru and beyond), has not been used since 1992 (Figure 6-31, Figure 6-32).

Elevations in Kisii vary from approximately 1,980 m (6,500 feet) to 1,520 m (5,000 feet). Kegati Water Treatment Works are located at an elevation of approximately 1,775 m (5,820 feet) and Nyakomisaro Water Treatment Works are located at an elevation of approximately 1,760 m (5,770 feet). A rise in elevation of approximately 70 m exists between the Kegati treatment works and the major town population centers. The high point of this rise is approximately located at the Bobaracho water storage tank facility. Distribution from Nyakomisaro Water Treatment Works is by gravity due to its location on the opposite (west) side of the elevation divide.

According to the UN-Habitat Kisii Report (Novembet 2005), the distribution network can be effectively divided into three pressure zones: upper, middle, and lower.[41] The upper zone, at higher elevation, includes Milimani, Mwembe, upper CBD, Jogoo, Nyanchwa, Nubia, Gesonso, and Suneka. The middle zone includes the main CBD and upper Daraja Mbili, and the lower zone includes lower Dataja Mbili and parts of Nyabururu. Although this definition may be generally correct and the higher zones generally have lower pressure, some inconsistencies exist, such as the fact that Milimani, part of the upper zone, is reportedly one of the most well served areas. Interconnections between the zones exist.

It has been recommended to install five high lift pumps at Kegati Water Treatment Works, each with a capacity of 125 m^3/hr at 80 meters of head. The booster station at Bobaracho consists of two 60 hP pumps with a capacity of 70 m^3/hr. A generator also exists at the site, presumably sized appropriately to power the Bobaracho pumps.

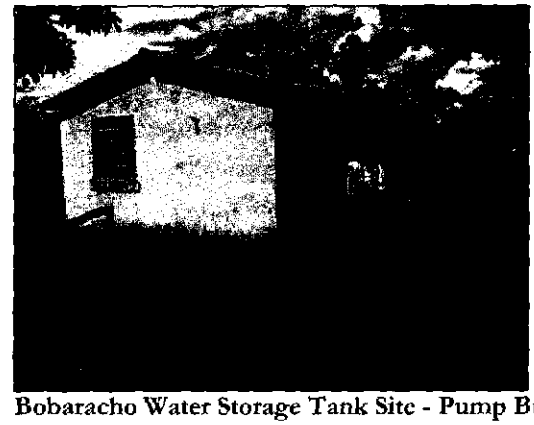
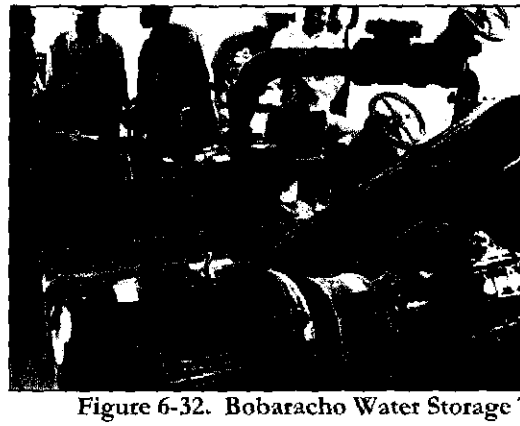


Figure 6-31. Bobaracho Water Storage Tank Site - Pump Building (left)



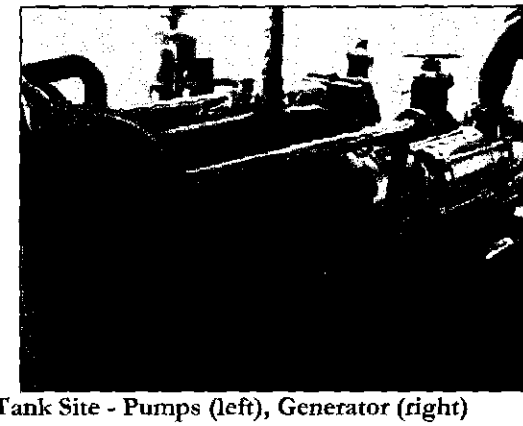


Figure 6-32. Bobaracho Water Storage Tank Site - Pumps (left), Generator (right)

6.2.4 (a) 3. Storage

At least 12 storage tanks are in use ranging from 50 to 500 m³, although ten or more additional tanks exist but are not in use due to damage or lack of water.[42] The UN-Habitat Kisii Report (November 2005) contains a table describing 13 storage tanks in Kisii. This table is reproduced below as Table 6-7. Additional smaller tanks are indicated on the UN-Habitat 'Layout Sketch Plan of Kisii Water Supply System', most of which ate presumably dry and not in service.

Table 6-7. Water Storage Tanks in Kisii

Location	Capacity (m³)	Number	Volume (m³)	Type of Walling	Condition
Bobaracho	250	2	500	Masonry	Good
Kisii High School/FTC	250	2	500	Masonry	Good
Break pressure tank	137	1	137	Masonry	Good
Menyinkwa	150	1	150	Masonry	Good
Milimani	500	1	500	Masonry	Good
Milimani	90	3	270	Masonry	Poor
Milimani	50	1	50	Masonry	Poor
Menyinkwa/Milimani line	250	1	250	Masonry	Good
TOTAL		**13**	**2,357**		

Source: Kisii Consolidated Final Report, Interventions in Water and Sanitation, Solid Waste Management and Drainage, UN-Habitat November 2005, page 28

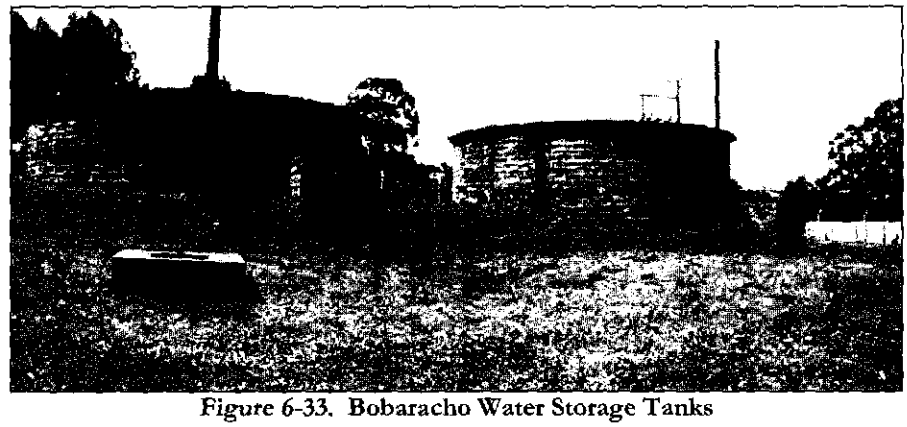


Figure 6-33. Bobaracho Water Storage Tanks

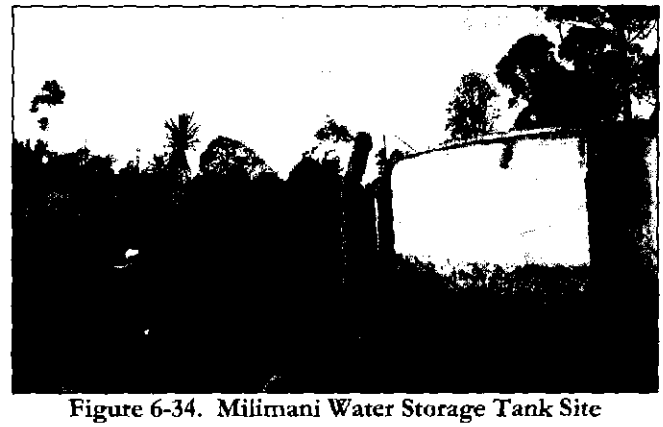


Figure 6-34. Milimani Water Storage Tank Site

6.2.4 (a) 4. Hydrants and Fire Protection

Available mapping does not show any fire hydrants in town. Also, many existing pipe sizes are too small to produce significant fire flows. The Project Team did not observe any hydrants during town visits and it is therefore assumed that hydrants are not installed. References to utilizing the existing water distribution network for fire protection were not found in documents obtained by the Project Team for Kisii.

6.2.4 (a) 5. Unaccounted For Water and Metering

Unaccounted for Water

Current UfW is estimated to be at least 55%, or over 1,550 m^3/d. It is expected that that the principal sources of this loss are leakage, illegal connections, and excess water use at flat rate (unmetered) connections. If UfW were immediately reduced to 15%, the number of people GWASCO could serve would rise from approximately 29,000 to over 54,000. Clearly, nearly doubling the number of customers served without increasing water production would have a huge impact on the health and economic well being of the town as well as GWASCO's revenues.

Unaccounted-for-water can be more clearly identified and isolated through the collection and analysis of bulk and consumer water meter data.

Bulk Water Meters

Bulk meters are required to quantify UfW, assess system integrity, and isolate problem areas. No bulk meters are known to exist in Kisii.

Consumer Water Meters

Although 6,000 registered water service connections exist in Kisii, 3,200 of which are classified as "active", GWASCO estimated there are approximately 1,200 meters in town. If so, about one fifth of the existing registered customers are metered, or about one third of "active" customers. Water usage at unmetered (flat rate) water connections is expected to be a significant source of UfW. Most existing meters expected to be over 10 years old, although GWASCO reported recently installing 200 new meters. The actual number of working meters is unclear.

6.2.4 (a) 6. Other Water Sources: Water Kiosks, Water Vendors, Community and Private Systems

Water Kiosks

The actual number of water kiosks in Kisii is unknown, but expected to be very small. Only one water kiosk, adjacent to the Milimani tank site, was identified and visited (Figure 6-35). It was operated by a local women's group and appeared to be functioning well. The rate charged at the kiosk is 2 KShs/20 liter jerrycan (100 KShs/m^3). The operator has an agreement with the LVSWSB to operate the kiosks and receives a bill each month based on meter readings. The UN-Habitat Kisii Report (November 2005) notes that several water kiosks installed since 1999 are not used due to lack of water.[43]

Figure 6-35. Water Kiosk Adjacent to Milimani Tank Site

Water Vendors

Many residents living in informal settlements such as Jogoo are expected to obtain water from water vendors, typically at high rates varying from 250 KShs/m^3 to as much as 1,000 KShs/m^3 during water crises, compared to piped water rates of approximately 30 KShs/m^3.[44] UN-Habitat noted vendor prices in Kisii vary from 100 to 500 KShs/m^3. The quality of water sold by vendors is unregulated and therefore potentially unsafe due to uncertainty regarding source water quality, the cleanliness of containers, and other factors.

Community and Private Water Supply Systems

The primary source of water for Kisii residents is numerous protected and unprotected springs in Kisii. Some springs have been developed and maintained by local community groups (Figure 6-36). Other public community water sources include dug wells and boreholes.

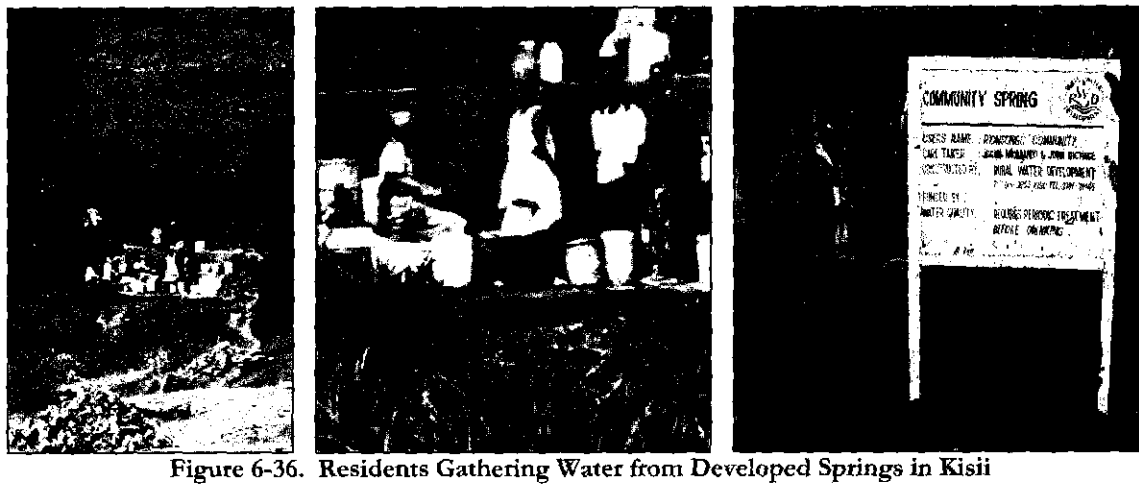


Figure 6-36. Residents Gathering Water from Developed Springs in Kisii

At least one major private water supply exists in Kisii at the Kisii Bottlers Coca-Cola facility. The facility employs approximately 200 employees and is located approximately 1.5 kilometers east of the central business district near the Farmers Training Centre (Figure 6-10). Due to insufficient supplies available from the municipal water supply system, the company constructed its own water supply system, which is reportedly adequate for its needs, except during droughts such as the one in early 2006. The facility pumps water from a tributary to the Nyakomisaro River and operates its own conventional treatment facility located at the bottling facility site (Figure 6-37). Standby piping connects the facility to the GWASCO water supply system for use during droughts. Kisii Bottlers management indicated that the facility initially used 200 m^3/d, but has

increased production and now uses 350 m^3/d. They expect to expand the facility and use 700 m^3/d or more eventually. The facility maintains a public water supply access point where local residents may take water for free for one hour each day (Figure 6-38).

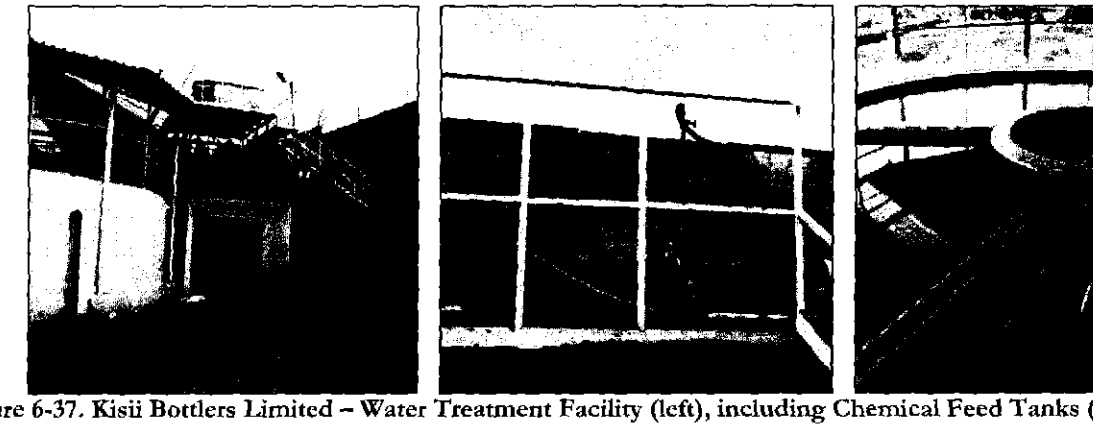


Figure 6-37. Kisii Bottlers Limited – Water Treatment Facility (left), including Chemical Feed Tanks (center), and Clarifier (right)

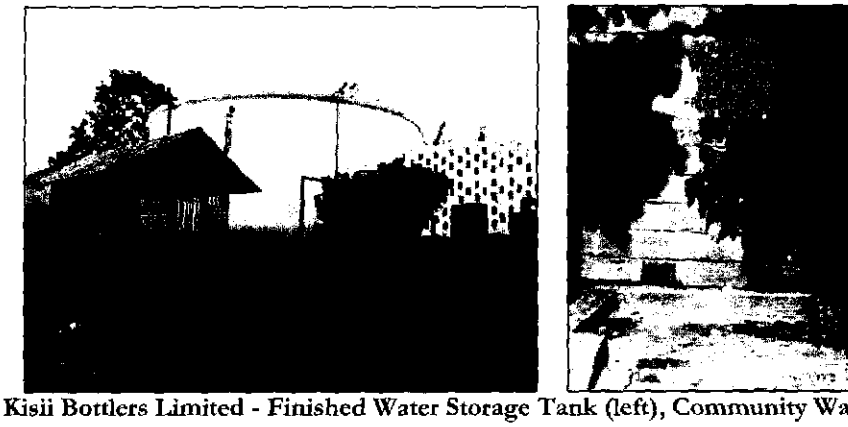


Figure 6-38. Kisii Bottlers Limited - Finished Water Storage Tank (left), Community Water Point (right)

6.2.4 (b) Water Distribution Needs

As noted above, current UfW in the distribution network is estimated at approximately 55%. If this percentage were immediately reduced to 15%, the number of people GWASCO could serve would rise from approximately 29,000 to over 54,000 and revenues would increase dramatically. Reduction of UfW should be a main priority for GWASCO. Expected sources of UfW are leaks, illegal connections, and high water use at unmetered connections.

Clarity is required regarding the extent of the existing distribution system, which portions are active, sizes of mains and storage facilities, etc. A system inventory and current mapping is needed.

Portions of the existing distribution network were constructed many years ago (as old as 1932), especially in the central business district, and consist of asbestos cement and galvanized iron pipe. Much of this older piping, especially the asbestos cement portions, have been cited by GWASCO as being very problematic due to their brittle nature resulting in breaks and leaks. Many kilometers of uPVC pipe were installed in outlying areas during the late 1970s. Unfortunately, much of this piping has been dry for years and therefore it is possible that the piping cannot cost-effectively be brought back online due to excessive biofilm development and bacterial growth. The condition of specific portions of pipe is unknown and will need to be evaluated in detail subsequently. For the purposes of cost estimation for this study, it has been assumed that all piping in

the distribution network will eventually require replacement. However, a variety of key water mains are in need of immediate repair and replacement to serve additional customers. The UN-Habitat Kisii Report (November 2005) details the most important immediate repairs and replacements that are required in the distribution.

Illegal connections to the distribution network are expected to be a major problem in Kisii and a significant source of UfW. GWASCO staff have indicated that they have been threatened by residents when entering some neighborhoods to investigate illegal connections or shut off connections due to nonpayment. In addition, GWASCO noted that it suspects some of their staff have accepted bribes from residents in order to assure that their water supplies are not disconnected. It is likely that some of the registered but reportedly non-active connections are actually still receiving water via a meter bypass connection or other means. Most active connections do not have water meters installed and therefore have no incentive to curb excessive water use. Flat rate connections may be being used to supply water to a number of households. All illegal connections should be eliminated or registered and metered. Meters should be installed at all presently flat rate (unmetered) connections.

There are no bulk water meters and relatively few consumer water meters installed in Kisii. Bulk metering is important for identification of UfW sources and consumer meters act at the "cash register of the water system". Bulk meters are needed throughout the distribution system and data should be recorded and analyzed regularly. Consumer meters older than 10 years are generally expected to be under recording flows, thereby reducing GWASCO revenue. Most existing meters in Town are expected to be in need of replacement and many new consumer meters are needed. Many new service connections are required within the existing distribution system to keep pace with population growth and also to extend service to additional areas.

According to the 2005 Practice Manual for Water Supply Services in Kenya (pg A 28), it is recommended that "capacity for fire fighting should not be less than 10 lps for 2 hours". It also notes that providing for piping not less than 100 mm or 150 mm in very high value commercialized areas normally ensures adequate water supply at the hydrant (pg A 116). Consideration should be given to increasing capacity/diameter of water mains and installation of hydrants to allow for fire fighting capacity.

The booster pump station at Bobaracho has never been operated due to broken rising mains from Kegati Water Treatment Works and high demand in the system, which prevents the existing water storage tanks from being filled. It is also presumed that the same power unreliability problems exist at Bobaracho as exist at Kegati. It is assumed that the pumps and generator are in functioning condition, although this requires confirmation. The existing control panel is reportedly in need of repair/upgrade. The tanks at the site require some upgrades including new valving. Upgrades to the piping heading south to Kiogoro and Sameta must be undertaken before this facility is put back on-line.

According to the 2005 Practice Manual for Water Supply Services in Kenya, water storage volume should include balancing storage to reduce peak flows and emergency storage to safeguard against interruption of supply. Balancing storage should be 50% of the daily water demand of the area served by the tank, while emergency storage should provide water sufficient for a 12 hour supply breakdown. Therefore, assuming any 12 hour supply breakdown will require approximately 50% of daily water demand, total required storage is approximately one day's demand. Present useable storage capacity of approximately 2,400 m^3 is close to Kisii's average day demand (approximately 2,800 m^3) and is therefore adequate for present conditions assuming they are effectively located and maintained. Additional storage will need to be added as the service area expands and production increases. Existing and new storage facilities will require regular maintenance.

The condition of the water kiosk visited in Milimani was relatively poor, although it seemed to be functioning fairly well from a business perspective. Existing kiosks should be upgraded, standardized, and commercialized. Hundreds of additional kiosks will be required in order to cost-effectively meet the

Millennium Development Goal and long-term service targets. Pilot programs, kiosk standardization programs, and training for operators will be required. It is expected that kiosks will be particularly useful in informal settlements such as those in Jogoo, Daraja Mbili, and Nubia, but many mixed income areas will also likely benefit from well-operated water kiosks. Water vendors are currently fulfilling a very important need that is being unmet by GWASCO. This should be recognized and water vendors should be considered as part of the existing water supply infrastructure. However, vendors should be regulated and licensed. It is expected that many water vendors may successfully transition to kiosk operators.

6.2.4 (c) Water Distribution Recommendations

The primary focus for immediate work related to the distribution system should be focused on reducing UfW and improving metering. Detailed planning for distribution system improvements and expansion is beyond the scope of this study, but preliminary phasing and costs have been estimated for the purpose of feasibility analysis. Detailed recommendations regarding the distribution system and estimated costs and phasing are included in the detailed matrices (Appendix 6-2). Note that some distribution system-related recommendations are included in the 'Management' section of the matrices and are not listed here. Immediate distribution system needs are based primarily on those recommendations in the UN-Habitat Kisii Report (November 2005), although phasing has been altered for most projects. Some UN-Habitat recommended upgrades may already be underway as part of their 'immediate interventions' project. Recommended activities include, but are not limited to the following:

- Develop an **inventory of the existing water distribution system** including pipes, valves, tanks, pumps, kiosks, etc. including **mapping** and identification of dry areas.
- Determine optimal locations for **bulk water meters** and install them. Calibrate/replace meters at treatment facilities. Install raw water meters.
- Institute program of **consumer meter installation and replacement**, starting with a pilot water meter program to evaluate technologies. Over 3,000 consumer meters are currently needed for existing active customers and thousands more are required for **illegal connections** and re-activated customers. Implement a comprehensive program to investigate and register or remove illegal connections. Utilize the proposed LVSWSB toolkit and model by-law. A structured program should be developed to quantify and address the issue including public education and bylaw enforcement. Develop and implement an incentive program to encourage all flat rate customers to install water meters.
- Perform a system-wide **water audit** to clarify water balance, UfW sources, and identify problem areas.
- Make **immediate repairs to distribution system** as outlined in UN-Habitat Kisii Report (November 2005).
- **Activate Bobaracho tanks and pump station** after making required repairs to pump station and pressure mains. Any programs to increase water pressure in the system may exacerbate existing leaks or create new leaks and should be considered.
- Create **hydraulic computer model** of system if sufficient data is available.
- Review water audit results, mapping, system inventory, and computer model to develop a **prioritized plan for distribution system improvements.**
- Develop and perform a System-Wide **Leak Detection and Repair** program. Program should initially focus on known leaks, then utilize remote leak detection equipment on key water mains, utilizing proposed LVSWSB-owned leak detection equipment and "circuit-rider" operator. Monitoring for leaks should be conducted after pressure and flow increases to ensure new leaks are not created.
- Implement a **water conservation education and assistance** program to inform residents about the importance of conservation and potential monetary savings. Include bulk purchase of water saving

devices including sink aeratots, low flow showerheads, and similar devices for free or reduced rate distribution.

- Utilize Kiosk and Public Toilet Toolkit (proposed to be created by LVSWSB) to create a **plan for building, managing, and maintaining water kiosks.** Include training for kiosk operatots. Utilize mapping for optimal location of kiosks within 400 meters of users. Immediately install two kiosks as pilot program, including one kiosk for vendors as recommended by UN-Habitat. More than 100 kiosks are expected to be required during the study period.
- **Repair and replace water mains** in accordance with system improvement plan. **Expand service area and install new and infill water service connections.** Over 15,000 new service connections are expected to be required during the study period. New required facilities will include water mains and service connections, valves, hydrants (to be determined), bulk and consumer water meters, storage tanks, and pumping systems for remote high elevation areas.

6.3 Wastewater

6.3.1 Wastewater Overview

Kisii's wastewater system includes a piped gravity collection system and centralized wastewater treatment facility. The collection system covers most of the central business district and surrounding neighborhoods including portions of Milimani, Nyanchwa, Jogoo, Mwembe, Dataja Mbili, and Nubia. The wastewater treatment facility is located in Suneka and reportedly has a capacity of 8,000 m^3/d. The lagoon treatment facility discharges treated effluent to the Riana River. Design plans by East African Engineering Consultants and Otieno, Odongo, and Partners from 1991-1992 are available for the sewer system and treatment facility.

The wastewater system serves an estimated 6,000 people via approximately 600 to 1,070 piped sewer connections (varying estimates exist), less than 400 of which are labeled "active", and 4 public toilet installations. In June 2007, GWASCO estimated that 16,000 people may be served by the existing sewer system. The number of illegal connections is unknown, but assumed to be low based on estimated flow at the treatment plant of around 500 m^3/d. Based on available information, it is estimated that slightly less than 80,000 residents of Kisii live within the existing wastewater service area. Sufficient capacity exists at the treatment facility to accommodate the entire estimated existing population in the wastewater service area. Effective utilization of the existing wastewater infrastructure has been limited by a lack of sewer connections caused by high up-front costs and a lack of piped water in some sewered areas.

The over 92% of residents without wastewater connections utilize on-site wastewater systems, usually pit latrines and soak pits, for wastewater management. Some residents directly discharge wastewater into open drainage or local rivers and streams.

6.3.2 Wastewater Collection

6.3.2 (a) Wastewater Collection Description

An extensive network of trunk sewer mains were constructed in 1998-1999 to extend a previously existing smaller collection system (installed in 1978) covering the central business district. According to available design plans (as-built drawings were not available), the expanded network covers most of the densely populated portions of central Kisii. It extends from the treatment facility north of Suneka Market along the B3 road to the northeast and then southeast to approximately one kilometer past the Kenya Farmers Training Center, ending near Bobaracho. Sewers also extend radially outward on both sides of the B3 road, reaching

east to Jogoo and Kisii Bottlers, and south and west to Mwembe, Milimani and Nyanchwa. An approximation of the current extent of the collection system is provided in Figure 6-39.

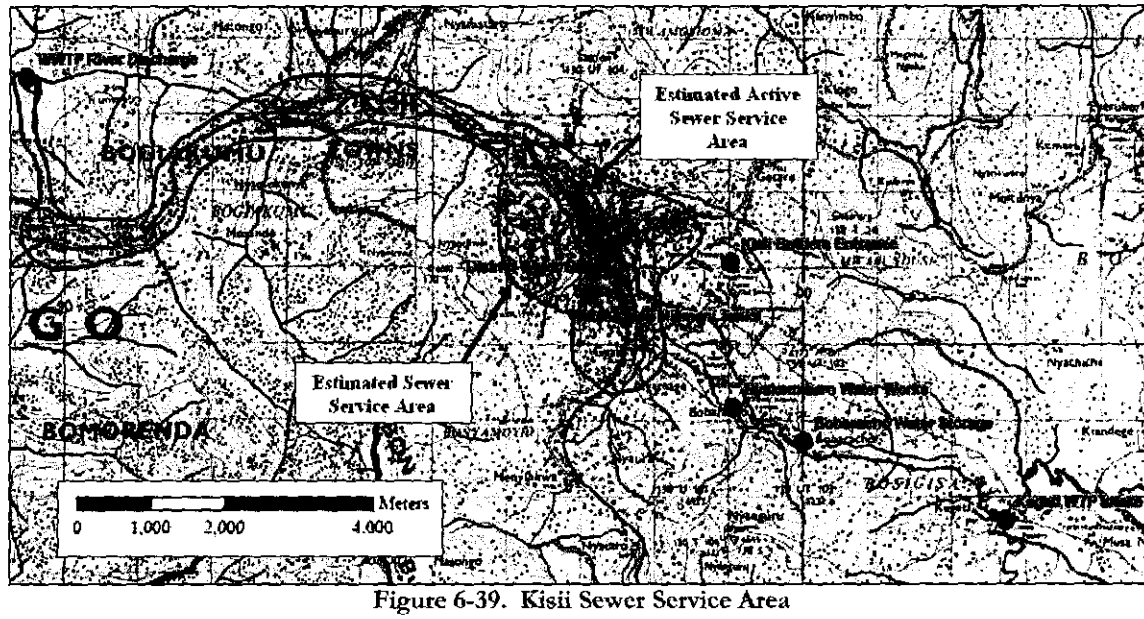


Figure 6-39. Kisii Sewer Service Area

The collection system consists of pipes ranging in diameter from 600 mm (24") near the wastewater treatment works to 160 mm (6") in the upper reaches of the system. Some of the pipes in the old collection system are reportedly also of small diameter. The entire system functions by gravity and there are no pumping stations.

As noted above, only 600 to 1,070 registered sewer connections exist and less than 400 of those are active. The GWASCO fee for connecting to the wastewater system was 10,000 KShs in 2006, which very few Kisii residents and business could afford. Based on recommendations of the Project Team, GWASCO has subsequently (as of June 2007) amended its connection fees as listed in Table 6-8. The number of large water users within the central business district that are not connected to the sewer was not provided, but is expected to be significant.

Table 6-8. GWASCO Revised Sewer Connection Fees as of June 2007

Sewer Connection Type	Sewer Connection Fee as of June 2007 (KShs)
Individual	5,000
Commercial	10,000
High Rise Buildings	20,000
Institutions	50,000
Industries	100,000

Public Toilets

Four public toilet units reportedly exist in Kisii, all of which were built by the Kisii Municipal Council (KMC).[45] Each unit has several stalls and sinks for men and women. One unit is located near the post office (Figure 6-40), two at the open air market in Daraja Mbili, and one at Kisii Stadium. Three of the installations are managed by the Kisii Green Town Environmental Initiative, a local citizens group, while the stadium

toilet is managed by KMC. The Green Town Environmental Initiative staffs toilets to collect user fees of 5 KShs. Although the toilets are connected to the sewer system, they do not currently have water due to nonpayment of bills resulting from financial management difficulties.[46]

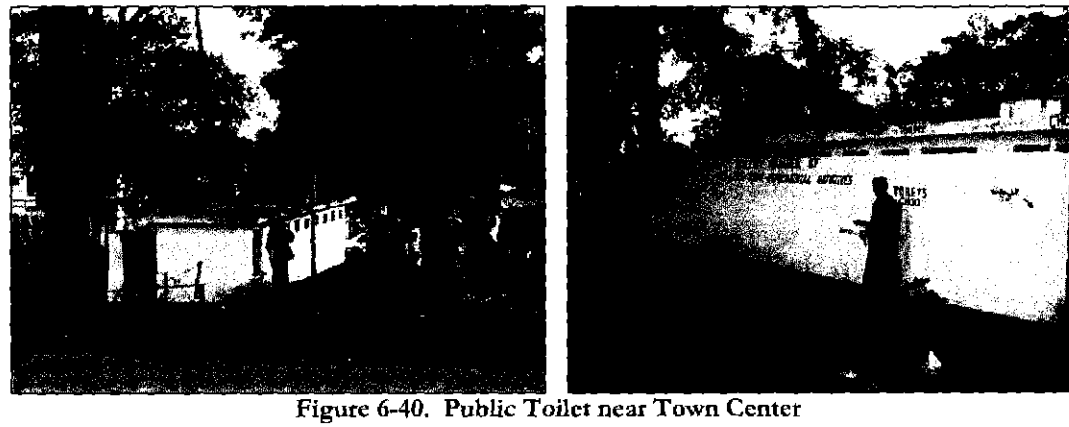


Figure 6-40. Public Toilet near Town Center

On-Site and Other Wastewater Systems

The use of pit latrines and septic tanks are predominantly used in the densely populated lower income neighborhoods including Nubia, Daraja Mbili, Jogoo, Mwembe, Gesonso, and Nyabururu. It is expected that some tight tanks may also exist. Some higher income residents have septic tanks. Most residents rent their homes and the wastewater disposal systems, typically latrines, are overseen by the landlords. It is expected that thousands of pit latrines exist in Kisii. Assuming one pit latrine or septic system exists for every 10 to 20 persons not connected to the sewer, there may be 10,000 to 20,000 on-site wastewater disposal systems in Kisii.[4]

Latrines, septic systems, and tight tanks require periodic pumping to remove accumulated solids or liquids and solids (septage). However, it is expected that solids are not removed from many household pit latrines and that they are simply abandoned when full. Most latrines in the informal settlements are not accessible by standard exhauster equipment. This situation results in potential health effects, especially considering that in most of these areas sufficient supplies of water are not available for washing. Failing latrines and other on-site wastewater systems discharge organic pollution to the ground in densely populated areas, sometimes near wells and springs. In some cases, wastewater is discharged directly to local surface water bodies.

When septage removal does occur from on-site wastewater systems, it is typically accomplished by one trailer mounted exhauster truck operated by the Kisii Municipal Council, which reportedly breaks down frequently. GWASCO noted that as of June 2007 the exhauster has been officially handed over to GWASCO. The equipment is operated by a hired tractor and charges 3,500 Kshs/trip within the Municipality (additional 100 KShs/km outside Municipality). The exhauster discharges directly to sewer manholes. Access to the existing wastewater treatment facility is difficult due to the condition of the access roadway and the facility is also far from the point of wastewater generation. Information regarding exhauster charges was not available. For comparison, KEWASCO, the WSP for Kericho, noted that its haulers typically obtain a minimum of 3,000 KShs per exhauster load in Kericho, which reportedly varies from 5 to 7 m^3 and covers operating expenses, fees charged at the treatment facility, and profit.

No pretreatment program currently exists in Kisii. A former wastewater tteatment facility existed at the Kisii Bottlers facility, but wastewater from the facility has since been connected to the existing collection system

[4] Assumes approximately 194,000 people not connected to sewer. Design standards used in the 1991 Kericho Sanitation Project Draft Criteria Report by GKW Consult note that one latrine would serve 16 people and one septic tank would serve 10 people.

without treatment (Figure 6-41). The discharge has a high pH caused by NaOH used in the bottling process. Sampling is performed quarterly by a local laboratory certified by the Kenya Bureau of Standards. Kisii Bottlers staff noted that they had tried adding acid to neutralize the strong base, but this did not work well. Kisii Bottlers plans to install a pretreatment facility similar to one at a Coca-Cola facility in Tanzania. The facility currently pays 37,500 KShs/month to GWASCO as a sewer fee. In June 2007, GWASCO noted that it has advanced negotiations with Kisii Bottlers to develop a pretreatment program.

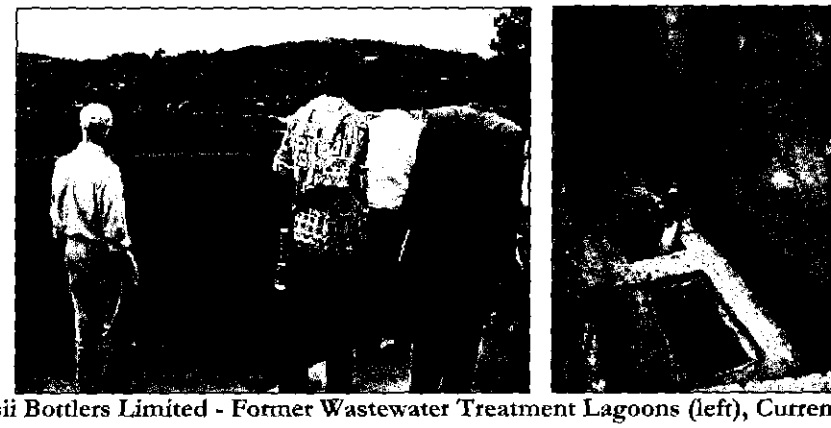


Figure 6-41. Kisii Bottlers Limited - Former Wastewater Treatment Lagoons (left), Current Sewer Discharge Point (right)

6.3.2 (b) Wastewater Collection Needs

The most pressing need for the wastewater collection system is to drastically increase the number of sewer connections. The previously existing (2006) sewer connection fee of 10,000 KShs was prohibitive and a primary reason for the low connection rate. In June 2007, GWASCO noted that it had reduced the fees to those listed in Table 6-8. The lack of water service provision in many sewered neighborhoods also results in low connectivity. Sewers in several neighborhoods including Nubia, Nyanchwa, Daraja Mbili, Mwembe, and Jogoo are not used due to low numbers of connections and insufficient or no piped water supplies. Additional clarity is required on the actual number of active sewer connections and population served to resolve discrepancies. Creating a full list of sewer connections is reportedly underway as of June 2007.

The existing treatment facility has excess capacity and thousands of new sewer connections are needed in the existing service area. Therefore, there is clearly a need to increase sewer connections by "infill". A prioritized list of targeted new sewer connections is required, starting with large water users located within the existing sewer service area. All schools (including GWASCO Institute of Technology and Egerton University), hospitals, the CBD, slaughterhouses, municipal buildings, public toilets/latrines, markets, sports stadiums, and public buildings in the existing service area should be connected. After the most cost-effective infill connections are made, the existing collection system should be expanded to include additional densely developed areas where the use of on-site systems is expected to be problematic. The connection fee should be reduced, financial assistance and incentive programs should be developed, and media campaigns should be organized to encourage and publicize sewer connections. Reduction in the connection fee has been enacted as of June 2007 as listed in Table 6-8, although subsequent revisions could be required.

Dozens of manhole covers have reportedly been stolen, resulting in foreign materials entering the sewer and causing blockages. Locking manhole covers should be installed. The lack of sufficient scouring flow also contributes to frequent blockages. Blocked sewers have occasionally overflowed into street drains and surface water bodies. Blockages have also been noted in portions of the old collection system which is damaged and has smaller diameter. GWASCO does not have adequate vehicles and equipment to effectively remove blockages.

Existing public toilets are inadequate and poorly maintained and managed. Public latrines and toilets are an important piece of wastewater management infrastructure and should be appropriately commercialized, regulated, and maintained, and new facilities should be constructed. These facilities will be very important in achieving the Millennium Development Goals and long term service targets. A plan should be developed for GWASCO to takeover oversight of existing facilities, construct new facilities, and ensure this infrastructure is safe, sustainable, and a source of local income generation.

Many on-site wastewater systems (latrines, soak pits, septic systems, tight tanks, etc.) are expected to be failing and represent an acute public health hazard and a public nuisance. Failing on-site systems contaminate local public and private groundwater and surface water supplies. These systems can adequately protect public health and are often more cost effective than public sewers in low density areas. However, these systems must be appropriately designed and maintained in order to protect public health. Kisii should institute management systems to inventory and oversee operation of these facilities and ensure they are properly maintained, including periodic pumping of accumulated solids.

GWASCO does not currently have any means of exhausting the thousands of on-site wastewater systems that exist in town. Equipment for removing accumulated septage is urgently needed, including equipment for removing septage from difficult locations in informal settlements. An analysis should be performed to detail the exact number of additional equipment required.

6.3.2 (c) Wastewater Collection Recommendations

The primary focus for immediate work related to the wastewater collection system should be focused on increasing infill connections within the existing service area. Detailed planning for collection system improvements and expansion is beyond the scope of this study, but preliminary phasing and costs have been estimated for the purpose of feasibility analysis. More detailed analyses will be required to clearly define required projects and expansion areas. Recommendations regarding the collection system and estimated costs and phasing are included in the detailed matrices (Appendix 6-2). Note that some collection system-related recommendations are included in the 'Management' section of the matrices. Some immediate distribution system needs are based on recommendations in the UN-Habitat Kisii Report (November 2005), although phasing has been altered for most projects. Some UN-Habitat recommended upgrades may already be underway as part of their 'immediate interventions' project. Recommended activities include, but are not limited to the following:

- Develop an **incentive program for encouraging / requiring sewer connections**. Program elements may include: Reduction in 10,000 KShs fee (completed, may require revisions); provisions for payment over time with increase in volumetric tariff; an "early-connecr" discount; public outreach media campaign including well-publicized connection awards for local stewardship; require all new developments to connect before a building permit is issued in the sewer service area; and enforce existing bylaws.
- Conduct **detailed planning study to create multi-tiered infill connection priority list** based on present water use and proximity to existing collection system. Begin to make infill connections utilizing the priority list. Clarify existing number of wastewater service connections, active/inactive status, and population served (underway as of June 2007).
- Identify and conduct **discussions / negotiations with large water users** not connected to sewer system to encourage them to connect to the sewer.
- **Replace manhole covers** with heavy-duty lockable manhole covers.
- Evaluate need fot **exhauster equipment** and purchase. Consider viability of purchasing a Vacutug for informal settlements. Consider encouraging private haulers to operate in Kisii; possibly lease Kisii-owned exhauster to private individuals.

- **Create designated septage discharge stations** for exhausters within the collection system and establish fee system for discharges. Stations should be staffed and include restricted entry and flushing equipment.
- Purchase **sewer cleaning equipment** including rodding, winching, jetting, and swabbing equipment. Develop and implement regular **sewer flushing program**. As of June 2007, GWASCO reported that it had acquired some sewer unblocking rods and jetting equipment.
- **Rehabilitate and commercialize existing public toilets** in accordance with toolkit proposed to be created by LVSWSB (including signage, lighting, security, certified operator, lease agreements, etc.). **Develop a plan for constructing new public toilets/latrines**, including provisions for future conversion to water flush systems in areas where water is not currently available. **Construct new public toilets/latrines, starting with a pilot program.** It is expected that dozens of public toilet installations will be required during the study period.
- Develop an **on-site wastewater system inventory, tracking system, and program for mandatory periodic inspections and pump-outs**. Utilize toolkit proposed to be developed at LVSWSB. The system should include provisions for management of private septage haulers including a manifest system and requiring discharge only at approved locations.
- Establish **pretreatment program** for commercial and industrial users. Start by requiring upgrades to the Kisii Bottlers sampling station and required periodic sampling (underway as of June 2007).
- **Install new wastewater service connections and expand service area**. As many as 15,000 new sewer service connections are expected to be required during the study period as part of the infill program and expansion.

6.3.3 Wastewater Treatment, Effluent Disposal, and Residuals Management

6.3.3 (a) Wastewater Treatment, Disposal, and Residuals Management Description

The existing wastewater treatment facility (Figure 6-42) was commissioned in 1999 and is located approximately two kilometers north of Suneka market, adjacent to the Riana River. The facility is at approximately 1,500 m (4,900 feet) above sea level and can therefore receive wastewater from the entire existing sewer network by gravity. A former treatment facility existed in Daraja Mbili but was decommissioned in 1999 when the new sewer mains and treatment facility was completed. The facility was constructed with funds from the African Development Bank and Government of Kenya.[47]

The large lagoon-based wastewater treatment facility is located on a 17.9 hectare (44.2 acre) parcel and has an estimated capacity of 8,000 m^3/d.[48] The influent flow meter is currently not functioning and influent flow is not measured. However, the flow currently received at the facility has been estimated at approximately 500 m^3/d.[49] Both the capacity of the facility and the influent flow require confirmation. Although design drawings were available, a design report was not available.

Raw wastewater enters the plant through headworks containing coarse screens and a grit chamber (Figure 6-43). Screenings are buried on-site. A flow constriction and equipment housing exists where flow measuring equipment was intended to be installed, presumably an ultrasonic water level transmitter. The equipment reportedly exists in storage somewhere in Kisii. From the headworks, wastewater flows into a series of primary settling ponds (Figure 6-44). The ponds are outfitted with sludge drains which can be opened and closed via manual valves controlled from the surface (Figure 6-45) to allow sludge to be transported to two drying beds (Figure 6-46). During the project team visit to the facility in April 2006, the first primary pond was empty and sludge was being removed from Pond 1 manually with shovels. It was not clear how removed sludge would be handled / disposed. It is not clear if the sludge drain valves are operable. The sludge drying beds are overgrown with hyacinth and weeds and were completely filled with rainwater in April 2006. It appeared that the sludge beds were not being utilized. Supernatant from the primary ponds

flows into a facultative pond and then to a maturation pond (Figure 6-47). A recirculation system exists (Figure 6-48, not functioning) intended to reticulate flow from the maturation pond back to the primary ponds. Treated effluent from the maturation pond is discharged to the Riana River (Figure 6-49).

A laboratory / staff building also exists on site, which was never completed and does not contain laboratory equipment. During the project team visit in April 2006, there was no operator on-site, only a security guard. An operator has not been assigned to the facility, reportedly due to a lack of sufficient funds.

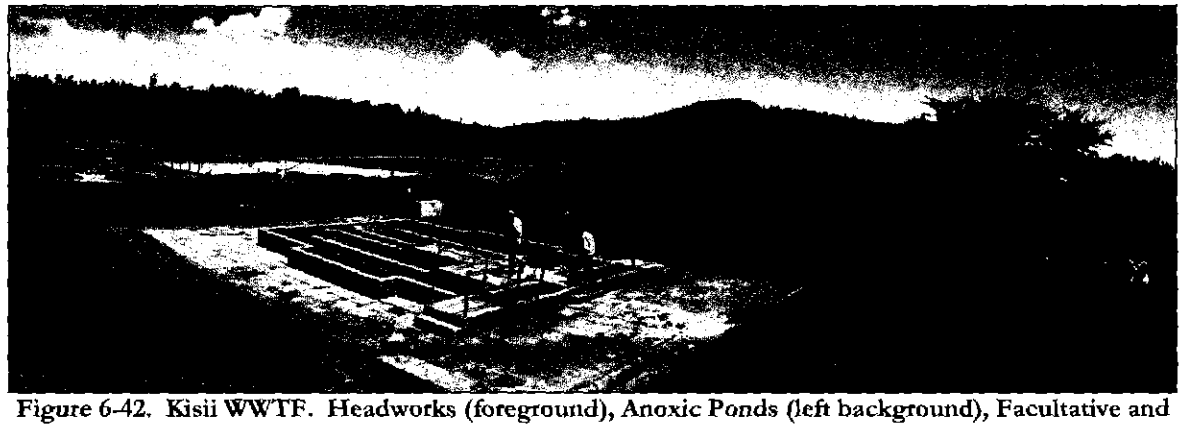


Figure 6-42. Kisii WWTF. Headworks (foreground), Anoxic Ponds (left background), Facultative and Maturation Ponds (center background), Sludge Drying Beds (right background)

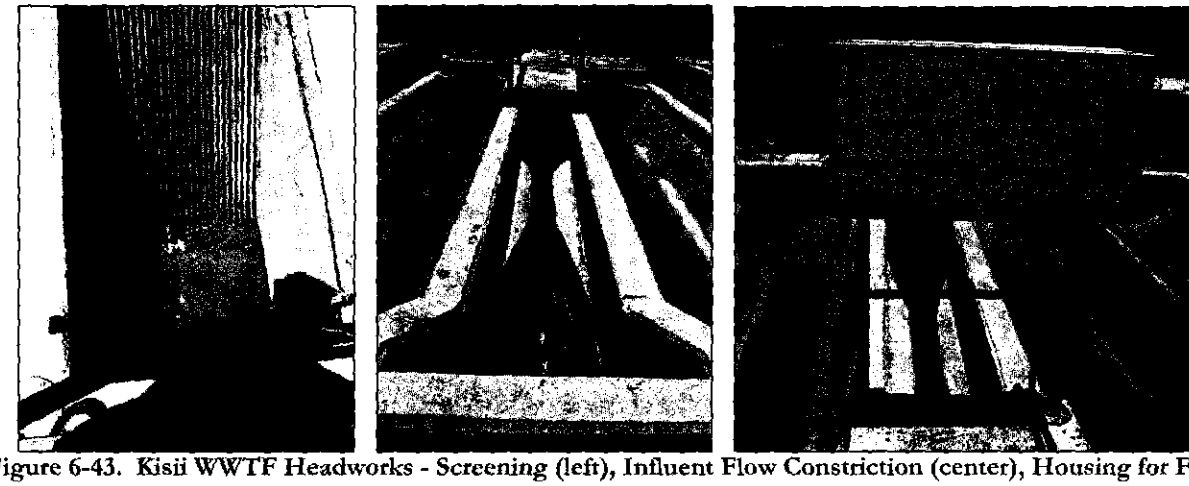


Figure 6-43. Kisii WWTF Headworks - Screening (left), Influent Flow Constriction (center), Housing for Flow Meter Equipment (right)

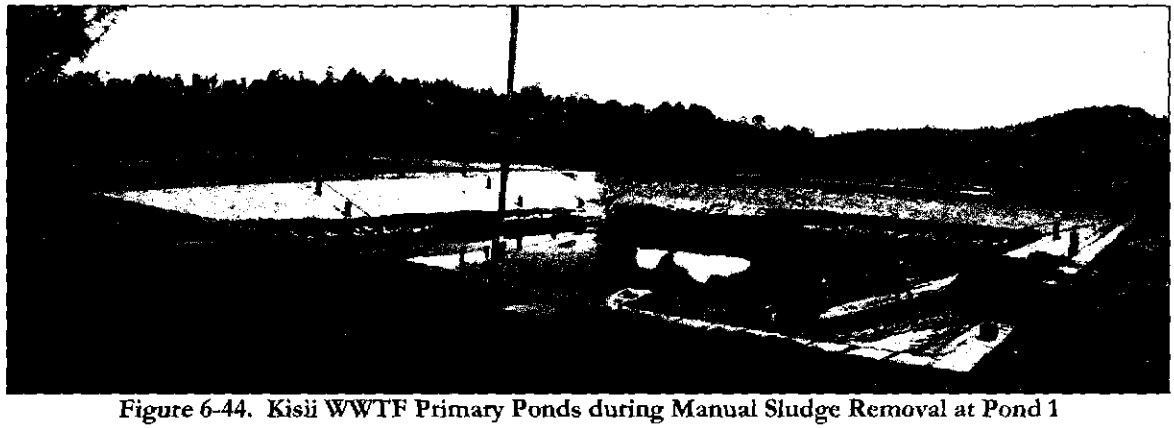


Figure 6-44. Kisii WWTF Primary Ponds during Manual Sludge Removal at Pond 1

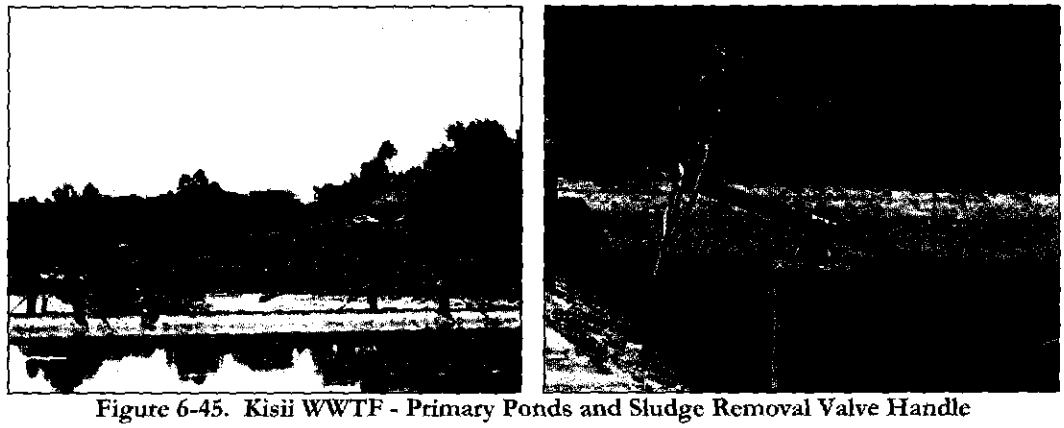


Figure 6-45. Kisii WWTF - Primary Ponds and Sludge Removal Valve Handle

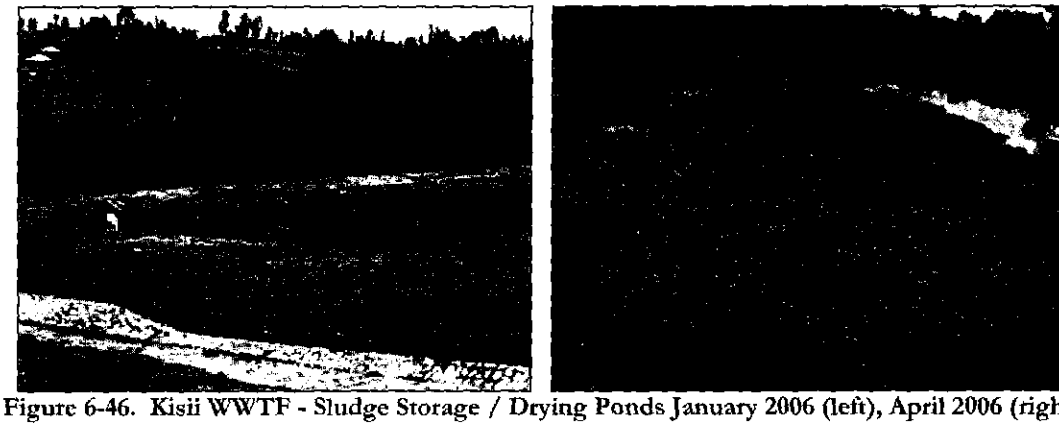


Figure 6-46. Kisii WWTF - Sludge Storage / Drying Ponds January 2006 (left), April 2006 (right)

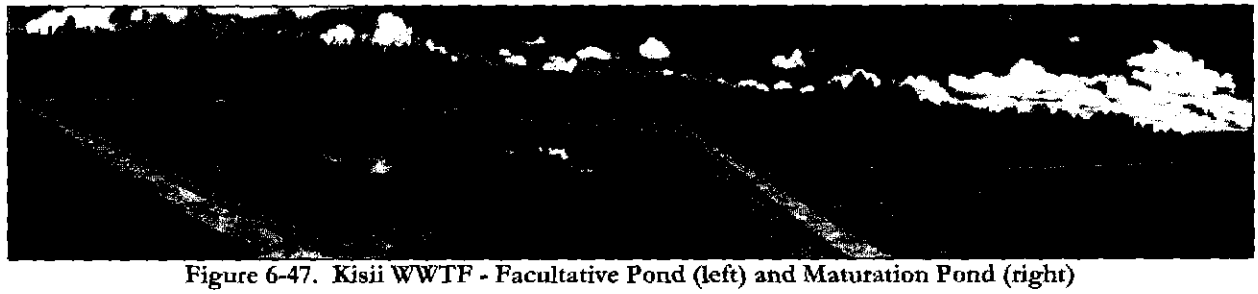


Figure 6-47. Kisii WWTF - Facultative Pond (left) and Maturation Pond (right)

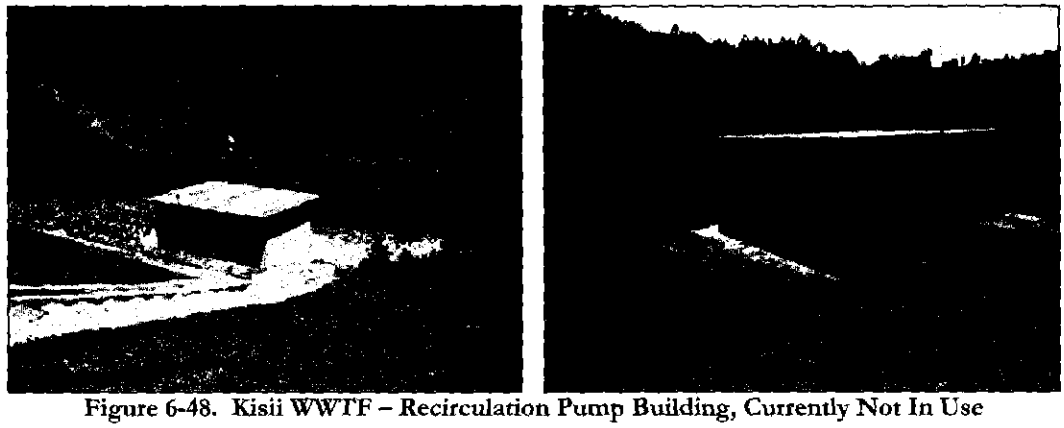


Figure 6-48. Kisii WWTF – Recirculation Pump Building, Currently Not In Use

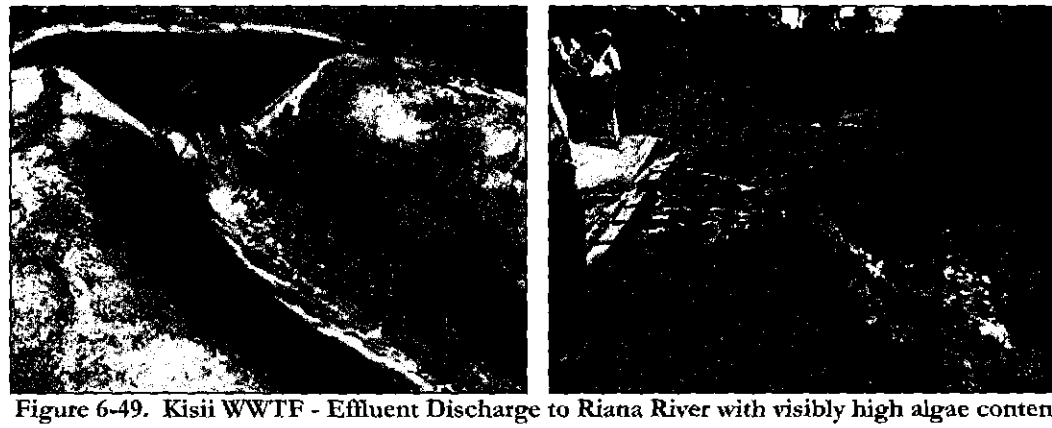


Figure 6-49. Kisii WWTF - Effluent Discharge to Riana River with visibly high algae content

6.3.3 (b) Wastewater Treatment, Disposal, and Residuals Management Needs

The existing wastewater treatment facility, constructed less than 10 years ago, represents a highly valuable asset for GWASCO that is currently being used ineffectively and is in a state of disrepair. The facility apparently has sufficient capacity to accept flow from the entire existing service area. Immediate operational and physical upgrades are needed and planning for future upgrades and capacity expansion should be conducted.

The incoming flow rate is not measured. Installation of the flow measuring equipment should be considered, but in the meantime the flow may be measured manually by gauging the incoming flow height with a measuring stick and converting the measurement to a flow rate. Similarly, no influent and effluent sampling is performed. A sampling program should be instituted immediately. Without flow and water quality sampling information, the performance of the facility cannot be evaluated. Laboratory equipment is required for taking basic daily measurements and the staff building should be upgraded and outfitted with standard office equipment. Clarification is required regarding permitted effluent requirements. At least one operator should be on-site in addition to security personnel. Additional information regarding operators is included in paragraph 6.4.

Problems associated with influent screening have reportedly resulted in polyethylene bags and other materials passing into the primary ponds. Fine screening should be installed. Missing manhole covers and broken and missing fencing around the site are in need of replacement.[50]

The sludge removal valves may be operational but are apparently not used. This system requires evaluation and to be brought back on-line. According to UN-Habitat, the sludge valves were operational at the time of their evaluation (2005). However, UN-Habitat noted that the primary ponds were overloaded and excess sludge and floating material has reduced the effective retention time of the whole system and the overall treatment efficiency.[51] The primary ponds may require dredging and should be sampled with a core sampler. Consideration should be given to purchasing a gas-driven pump for sludge removal without draining.

The sludge drying beds are apparently not used as intended and now require dredging to remove solids and weeds. The beds should be covered to prevent rainwater from filling them. Sludge should be removed regularly and composted on-site as part of a new program to re-use biosolids. Harvested algae from the effluent should also be composted. According to GWASCO, there is potential in Town for utilizing treated wastewater sludge in local agriculture. Composted sludge should be analyzed to ensure it meets applicable regulations, including limits for metals, and instructions should be provided regarding safe use of the material. Marketing efforts should be undertaken to enhance the attractiveness of the product for use in local agriculture. Such marketing efforts could entail utilizing the product for decorative plantings at the treatment

facility and at public toilets with signs indicating the source of the product. Consideration should also be given to planting bougainvillea at the site (using compost) to reduce odors.

The recirculation system is not functional and is in need of repair. According to UN-Habitat, the re-circulation system may not have been used since its installation. The system is intended to seed microorganisms back to the front of the facility, thereby improving treatment.

The effluent visually appears to have a high algae content (Figure 6-49). Floats present in the maturation pond seem to indicate that effluent screening may have once existed. Effluent screening should be installed (or re-installed) to reduce BOD in the effluent or consideration should be given to installing a riverbank infiltration system with algae harvesting.

It is expected that the existing facility, with some upgrades, will be able to meet Kisii's needs through the study period. The timing of the need for additional capacity will depend on the pace of adding sewer connections and on the determined actual capacity of the facility. Once the capacity of the existing treatment facility site is reached, additional capacity may be added at the existing site. Supplemental aeration (possibly with solar aerators) may eventually be used to increase the facility capacity without increasing tankage or to improve effluent quality. Consideration should be given to constructing a polishing wetland on-site for improved treatment (Figure 6-50) and downstream effluent re-use for agriculture. GWASCO has noted that potential exists for downstream re-use.

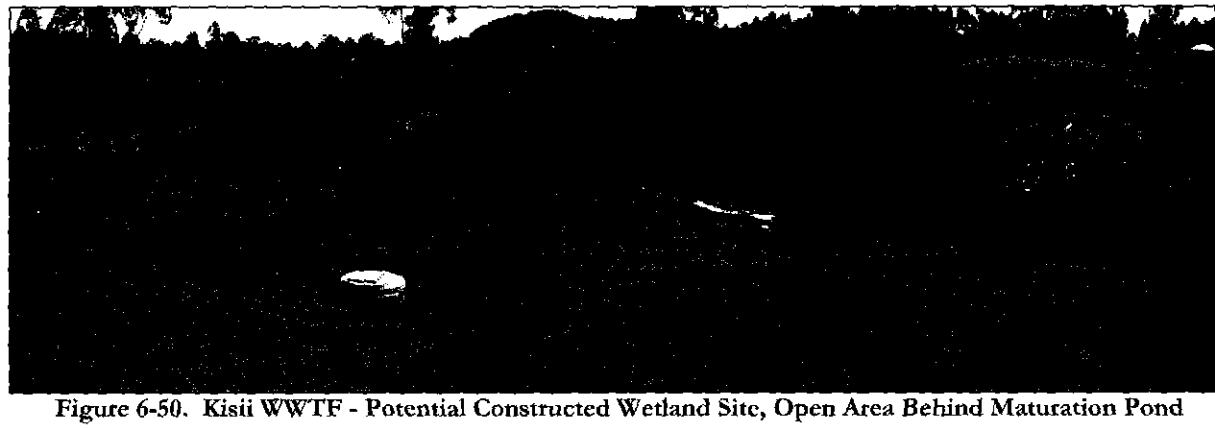


Figure 6-50. Kisii WWTF - Potential Constructed Wetland Site, Open Area Behind Maturation Pond

6.3.3 (c) Wastewater Treatment, Disposal, and Residuals Management Recommendations

The primary focus for immediate work related to wastewater treatment should be on establishing regular operational improvements including staffing the facility, establishing a flow measurement and water quality sampling program, and making miscellaneous immediate upgrades. Detailed planning for improvements, expansion, and new facilities is beyond the scope of this study, but preliminary phasing and costs have been estimated for the purpose of feasibility analysis. More detailed analyses will be required to clearly define required projects. Recommendations regarding wastewater treatment facilities and estimated costs and phasing are included in the detailed matrices (Appendix 6-2). Note that some wastewater treatment recommendations are included in the 'Management' section of the matrices. Some immediate distribution system needs are based on recommendations in the UN-Habitat Kisii Report (November 2005), although phasing has been altered for most projects. Some UN-Habitat recommended upgrades may already be underway as part of their 'immediate interventions' project. Recommended activities include, but are not limited to the following:

- Add **treatment facility staff** and establish **flow monitoring and influent and effluent sampling program.** Initial program may simply include flow measurement with a measuring stick and sending samples to LVSWSB laboratory for analysis.
- Obtain **original design reports and manuals** to determine capacity and design operating requirements.
- Equip existing **laboratory facilities**, including basic sampling equipment
- **Upgrade existing staff office.**
- Install finer **influent screens** and **algae control baffles**
- **Repair sludge valves** (if required), **dredge primary ponds** (if required), **dredge sludge drying beds, install drying bed covers, begin using drying beds as originally intended.**
- Establish **sludge and algae composting** program; Develop **biosolids re-use program** including marketing; Add **aesthetic buffer** by planting bougainvillea
- **Repair recirculation system.**
- Conduct **detailed study for future increased capacity of existing facility** and improved treatment efficiency including adding solar powered aeration.
- Evaluate feasibility of **downstream re-use of treated effluent**. Obtain information on predominant crops, water and nutrient needs, and proximity (down gradient preferred). Explore options for effluent reuse / polishing including constructed wetlands, aquaculture, sugar cane, bamboo, or other crops grown downstream of treatment facilities.

6.4 Management and Operation and Maintenance (O&M)

6.4.1 Management and O&M Description

Institutional Arrangements

Kisii Municipality is the headquarters of the Kisii Central District and lies within the Nyanza Province. Greater Kisii covers an area of 111 km^2, while the Municipality covers 29 km^2. The District Commissioner and other District departmental heads are located in Kisii.

As of June 2006, operation of water and wastewater systems in Kisii was transferred under the management of the newly-established Gusii Water and Sanitation Company Ltd. (GWASCO), which runs water systems in Kisii, Nyamira and Gucha Districts. The company, which is based in Kisii, is owned by the Kisii Municipal Council, GWASCO County Council, and the Town councils of seven towns in the area.

The former water service provider in Kisii was the National Water Conservation and Pipeline Corporation (NWCPC) and the former wastewater service provider was the Kisii Municipal Council. Some wastewater-related tasks such as management of public toilets, septic system pumping, and security at the wastewater treatment facility are still undertaken by the Kisii Municipal Council and overseen by the Kisii Town Engineer. GWASCO serves as the sole Water Service Provider (WSP) for Kisii Town per its Service Provision Agreement (SPA) with the Lake Victoria South Water Services Board, dated 27th June 2006. The Company's Board of Directors is composed of members of the Kisii Municipal Council, other Town and County Councils, and the Ministries of Local Government and Water. A central corporate management team handles daily operation of the company and includes a Managing Director, Technical Manager, and Commercial Manager.

Staffing

According to the LVSWSB Service Provision Agreement (SPA), GWASCO staff includes 39 water system employees and 12 wastewater system employees[5], not including the Commercial Manager and Managing Director, which make an overall total of 53. Of the 39 water system staff listed, it appears that 8 are administrative staff (Technical Manager and billing and revenue clerks) while the remainder are field staff. Of the wastewater staff, it appears that 2 are administrative staff (administrative and accounts assistants) and the remainder are field staff. GWASCO noted that wastewater billing is presently done by the water staff. For the purposes of this analysis, it is assumed that there are a total of 12 administrative personnel (8 water, 2 wastewater, and the Commercial and Managing Directors). A breakdown of this understanding of GWASCO Staffing is provided in Table 6-9.

As noted above, there was no operator at the wastewater treatment facility although laborers were removing sludge from the primary ponds on orders from the Town Engineer. It is expected that few or no wastewater staff actually exist, but the following analysis is based on staffing levels from the SPA assuming staff will eventually be added.

Table 6-9. GWASCO Present Staffing Levels

	Present Number of Staff
Administrative	12
Water	31
Wastewater	10
TOTAL	**53**

GWASCO expenditures on personnel were and electrical costs are expected to represent the majority of overall operational expenses. In Kericho, personnel expenses represent 64% of its total operating expenditures (49 Million KShs), but Kericho's systems operate almost entirely by gravity.

A variety of standards exist for calculating appropriate staffing levels. LVSWSB has established Sector Benchmarks as outlined in Schedule E of its standard Water Services Provision Agreement (SPA). These benchmarks are presented in Table 6-10. It is assumed that this figure is for water O&M staff only and therefore doesn't include administrative and wastewater staff. LVSWSB's SPAs do not include similar benchmarks for administrative and wastewater staff.

Table 6-10. Staffing Levels Per LVSWSB Service Provision Agreements (Schedule E)

Size of Company	Staff / 1,000 connections		
	Good	acceptable	not acceptable
Large	<5	5-8	>8
Medium and Small (with up to 3 towns)	<5	5-8	>8
Medium and Small (serving more than 3 towns with different systems)	<9	9-14	>14

The 'acceptable' range of 5 – 8 staff per 1,000 connections translates to 30 to 48 water O&M staff for GWASCO based on its 6,000 registered connections, or 16 to 26 water O&M staff based on its 3,200 active connections. GWASCO currently has a water O&M staff of 31 (5 staff / 1,000 registered connections, 10 staff / 1,000 active connections). Appendix G10 of the 2005 Practice Manual for Water Supply Services in

[5] It is unclear if the wastewater system staff listed in the SPA are currently active and if so if they are under the control of GWASCO or are still being managed under the Kisii Municipal Council, overseen by the Town Engineer. Clarity is required in this regard.

Kenya (2005 Design Manual) describes required water staffing levels based on system-specific information. These recommended levels and calculations based on conditions specific to GWASCO are presented in Table 6-11 and result in a required water O&M staff level of 25. Based on the 2005 Design Manual and LVSWSB SPA, a water O&M staff of 25 to 30 is probably appropriate for current conditions of the water system, but will need to be increased as additional customers are added and re-activated.

Table 6-11. GWASCO Water O&M Staff Required per 2005 Design Manual Appendix G10

Staff Category	Water supply staff required for full water treatment production > 500 m^3/d, operation 13-24 hrs / d	GWASCO Water O&M Staffing Requirement
Water Operator Grade I	1	1
Water Operator Grade IIA	1	1
Water Operator Grade IIB	1	1
Water Operator Grade III	1 per 200 water meters	6*
Chemical or general attendant Grade I	3	3
Pump attendant Grade I	1 per pumping station	2
Pipe Fitter Grade I	1	1
Pipe Fitter Grade II	1	1
Labourer	4	4
Line Patrollers	1 per 25 km of pipelines	5*
TOTAL		**25**

**Actual number of water meters and kilometers of pipeline unknown. Assume 1,200 water meters, 125 km of pipelines.*

Requirements for wastewater staffing are presented in Table 4.2.12 of the 1998 Aftercare Study on the National Water Master Plan and reproduced below in Table 6-12. Based on initial estimates provided by GWASCO, the system serves an estimated 6,000 people with piped sewer connections (however GWASCO noted in June 2007 this number may actually be 10,070 or 16,000). Based on 6,000 people served, the guidelines suggest that GWASCO's present wastewater O&M staff of 10 should be sufficient. However, optimal staffing levels for each town are very site-specific and considering the size of the Kisii Wastewater Treatment Facility, sewer network, and its intended service population of 50,000 to 100,000, additional staff may be warranted. As additional customers are connected, it is expected that 28 staff or more could be required based on recommendations in the Aftercare Study.

The 1992 *Waste Stabilization Ponds: A Design Manual for Eastern Africa* includes recommended staffing levels specifically for lagoon systems (Table 6-13). This document recommends a staff of 2 for pond systems designed to serve 10,000 people (1 laborer and 1 watchman). However, considering the Kisii Wastewater Treatment Facility was apparently designed to treat wastewater from 50,000 to 100,000 people, required staffing for the treatment facility alone could be expected to be 12 to 17 after additional customers are connected. This is similar to the recommendations in the Aftercare Study (Table 6-12), which recommend a treatment works staff of 15 for a service population of 50,000 to 100,000 (excludes collection system staff). The source of funding for an increase in staff will likely come from adjustment of the sewer tariff to become more in line with Kenyan average rates (discussed further under *Tariffs* below).

Table 6-12. Wastewater O&M Staffing Guidelines, 1998 Aftercare Study on the National Water Master Plan

Function	Position	Population Connected to Sewerage				
		10,000-25,000	25,000-50,000	50,000-100,000	100,000-300,000	>300,000
Management & Process Control	Manager	0	0	1	1	1
Treatment Works Operations & Process Control	Superintendent	0	0	1	1	1
	Trade effluent inspector	1	1	2	2	4
	Technical Assistant	0	0	1	1	1
	Laboratory technicians	0	1	1	2	2
Treatment Works Maintenance	Foreman	1	1	1	2	2
	M/E tradesmen	0	1	2	2	4
	Laborers	2	3	4	6	10
	Drivers	0	1	1	2	4
	Watchmen	1	1	1	3	5
Collection System Maintenance	Superintendent	0	0	0	1	2
	Foreman	1	1	2	4	6
	M/E tradesmen	0	0	1	2	3
	Laborers	4	6	10	20	30
TOTAL		10	16	28	49	75

Table 6-13. Recommended Staffing Levels for Waste Stabilization Pond Systems

Population Served	**10,000**	**25,000**	**50,000**	**100,000**	**250,000**
Foreman/Supervisor	-	-	1	1	1
Mechanical Engineer[a]	-	-	-	1	1
Laboratory Technician[b]	-	1	1	1	2
Assistant Foreman	-	1	2	2	2
Laborers	1	2	4	6	10
Driver[c]	-	1	1	1	2
Watchman[d]	1	1	3	5	5
TOTAL	**2**	**6**	**12**	**17**	**23**

Source: Waste Stabilization Ponds: A Design Manual for Eastern Africa. Mara, Alabaster, Pearson and Mills, 1992.

[a] Dependent upon amount of mechanical equipment used.
[b] Dependent upon existence of laboratory facilities.
[c] Dependent upon use of vehicle-towed lawn mowers, etc.
[d] Dependent upon location and amount of equipment used.

Operation, Maintenance, and Management Systems

Layout drawings are available for the wastewater treatment works, but not for either of the water treatment works or distribution system. No operation and maintenance manuals were provided. It is unclear if any kinds of schedules for regular operation and maintenance, including preventative maintenance, exist. Detailed equipment inventories were not provided. No annual reports, environmental audits, other similar information were provided. Balance sheets or other information summarizing breakdown of costs and revenues was not provided, although billing and collection information was provided, as was a summary of electrical expenditures.

In general, operation and maintenance of the existing system is poor. The wastewater treatment facility does not have any operators on site. Operations at other facilities are severely limited by a lack of reliable power, transportation, tools, training, and laboratory equipment for taking basic measurements. All chemical dosing is done by rule of thumb or estimation.

Monthly electricity costs for GWASCO are 7.2 million KShs per year (~600,000 KShs per month) and some monthly bills are reportedly as high as 800,000 KShs. Electricity rates are presently 7 KShs/kW-hr and GWASCO uses about 20,000 kW-hrs/week. In comparison, KEWASCO, which has an almost entirely gravity system, teported very low average energy usage of around 250 kW-hrs/week, about 80 times less than GWASCO. Electricity use is presumably limited to pumping systems at Kegati Water Treatment Works and possibly some limited office electrical use. According to GWASCO, electricity bills are currently paid by the government, but staff noted that this subsidy would soon end and they would be responsible for paying this monthly bill. GWASCO noted that fuel costs for a generator would be 22,000 KShs per day, possibly more. Assuming daily costs of 22,000 KShs, monthly costs could be expected to be around 700,000 KShs/month, slightly higher than present average electricity costs. However, it is assumed that this estimated cost is if a generator were used exclusively for power needs. Additional analysis of present and future electrical costs using a generator is required.

The UN-Habitat Kisii Report (November 2005) noted that total direct expenditure for the 2004/2005 financial year was 16.2 million KShs and total true expenditure was 22 million KShs. This is in comparison to billed revenue for the same year of KShs 14.7 million and collected revenue of 10.5 million. The total electricity bill was reportedly 8 million KShs (half of total ditect expenditures) and wages were 6.4 million KShs. Chemical costs were estimated at 2.2 million. Other management and maintenance costs were estimated at 7 million KShs.[52] The basis for UN-Habitat's estimations is not provided and the difference between direct expenditures and true expenditures is unclear.

No current mapping exists for Kisii. The most recent available Survey of Kenya topographic maps are from 1997. The only water system mapping provided consists of a hand drawn map of the system by GWASCO staff and a sketch developed by UN-Habitat as part of its November 2005 teport. Layout drawings of the sewer system were prepared in 1991-1992 and are based on aerial photography from 1984 or earlier. UN-Habitat, together with the Regional Center for Mapping of Resources for Development (RCMRD) in Nairobi is currently preparing detailed GIS maps based on recent satellite imagery.

Many illegal connections are expected to exist in Kisii, but an effective means for removing such connections does not exist. GWASCO staff have reportedly been threatened when entering some neighborhoods to fix illegal connections. GWASCO also noted that it suspects some of its own staff of accepting bribes from citizens to avoid having water shut off or paying bills.

Tariffs

GWASCO presently uses the national guideline water tariff rates outlined in the Water Act (Table 6-14). The average effective water tariff charged in Kisii is 30 KShs/m^3 based on reported 2005 total water sold divided by total billings (Table 6-16). Based on available information, the current average tariff charged in Kenya is estimated to be approximately 38 KShs/m^3.

Table 6-14. Kenya Urban Water Tariffs Per Water Act (November 1999)

	Category	Charge		
a)	Unmetered	200	KShs	/ month
b)	(i) Metered use < 10 m^3	200	KShs	/ month
	(ii) Metered use 10-20 m^3	25	KShs	/ m^3
	(iii) Metered use 20-50 m^3	30	KShs	/ m^3
	(iv) Metered use 50-100 m^3	45	KShs	/ m^3
	(v) Metered use 100-300 m^3	75	KShs	/ m^3
	(vi) Metered use 300+ m3	100	KShs	/ m^3
c)	Kiosk sold by m^3	15	KShs	/ m^3
d)	Kiosk by 20 L jerrycan	2	KShs	/ 20 L
e)	Bulk sale for resale	15	KShs	/ m^3

The basis of Kisii's sewer rates is unknown, but the average effective wastewater tariff charged in Kisii is 2.5 KShs/m^3 according to GWASCO's reply on the initial study survey and based on revenues divided by an assumed treated flow of around 500 m^3/d. Based on available information, the current average sewer tariff charged in Kenya is estimated to be approximately 11 KShs/m^3.

The amount of revenue derived from other fees charged by GWASCO (new and reconnection water and sewer fees, monthly water meter rents, rental fees for urban water kiosks, fines for illegal water connections, testing of water meter fees, etc.) was not provided.

Kisii's tariffs are presently below national averages for water rates and far below national averages for wastewater. Available information, including stakeholders workshops held by UN-Habitat in early 2006, suggest that Kisii residents would be willing to pay more for quality water and wastewater service but have concerns regarding the ability of the poorest residents to pay. It should be noted that many residents obtain questionable quality water from vendors who charge volumetric rates many times that of GWASCO's rates. According to Kisii's website, average 2006 per capita income in Kisii is estimated to be approximately 2,000 KShs, although uncertainty exists regarding this figure.[53]

Billing and Revenue

Billing is performed manually by billing clerks after data is collected from meter readings from the various meter reading zones (Table 6-15). Meter readers record data into meter books by hand. Billing systems are not computerized. The billing process starts on the 18th of each month and runs to the 25th. A water tariff table ('National Water Conservation and Pipeline Corporation New Tariffs', undated) is used to translate consumption in cubic meters into charges in shillings. All bills are reviewed and checked by a revenue officer before being provided to the meter readers for distribution to the customers. Totals of billing for all ledgers are then taken in order to compare the quantity of water sold and revenue billed at the end of each month. GWASCO noted that approximately 80% of consumers pay their water and sewer bills each month. However, billings and collections data provided by GWASCO for 2005 indicates a payment ratio of 90% (total billing of 14.4 Million KShs, Collection of 12.9 Million KShs).

Table 6-15. GWASCO Water Meter Reading Zones

Zone I	Zone II	Zone III	Zone IV (Town Area)	Zone V	Zone VI	Zone VII
Jogoo Nyambera Ndizine Nyamatro	Kegati Bobaracho Nyosia Nyanko Nyaguta Nyanderema Nyaura	Nyanchwa Nubia (Nyaora) Daraja Mbili St. Stephen/Nyangina Gesonso Suneka	Gudka Hospital Anglican Nwagetonto Pojta Senet Kobil Nwkaja Langai Farm House 1, 2 Kebirigo/Masaba Nyachae Milimani	Menyinkwa Masongo Ekerubo	Itibo Otamba Kiogoro Matongo	Matunwa Itumbe Boronyi Ogembo

Table 6-16. GWASCO Water and Wastewater Billing and Collections

Month (2005)	Water Produced (m^3)	Water Sold (m^3)	Water Billing (KShs)	Sewage Billing (KShs)	Total Billing (KShs)	Water Collections (KShs)	Sewer Collections (KShs)	Total Collections (KShs)
Jan	93,490	48,500	1,212,500	40,570	1,253,070	1,222,895	28,052	1,250,946
Feb	94,950	44,341	1,183,525	46,530	1,230,055	1,465,479	18,193	1,483,672
Mar	89,430	47,350	1,253,280	50,235	1,303,515	1,265,898	36,664	1,302,561
Apr	90,470	44,930	1,138,750	46,380	1,185,130	1,206,335	24,988	1,231,322
May	76,420	30,192	1,026,018	23,908	1,049,926	1,031,818	28,067	1,059,885
Jun	91,960	34,529	1,103,368	24,231	1,127,599	956,295	20,627	976,921
Jul	77,120	42,670	1,153,600	35,340	1,188,940	1,020,687	8,489	1,029,176
Aug	76,670	35,230	1,243,750	37,830	1,281,580	802,241	21,445	823,686
Sep	82,520	36,940	1,106,518	20,160	1,126,678	698,430	17,282	715,712
Oct	87,740	30,328	1,020,425	23,531	1,043,956	1,127,321	26,193	1,153,513
Nov	77,820	33,586	1,202,360	26,025	1,228,385	1,104,437	16,450	1,120,887
Dec	87,730	32,891	1,334,150	28,426	1,362,576	752,722	17,770	770,492
TOTAL	**1,026,320**	**461,487**	**13,978,244**	**403,165**	**14,381,409**	**12,654,555**	**264,217**	**12,918,772**
Avg. Day	2,812	1,264	38,297	1,105	39,401	34,670	724	35,394

Offices, Lab Facilities, and Transportation

GWASCO's offices are located near the center of Town and appear to be sufficiently sized to suit the company's needs (Figure 6-51). Additional office space is expected to be required as the number of water and wastewater service connections increases and staffing increases. Electrical power reliability is a significant problem and blackouts occur frequently.

Laboratory facilities have not been outfitted with instruments required for carrying out basic daily, weekly, and monthly sampling. The only sampling done in Kisii is for pH and residual chlorine.

Vehicles are reportedly not adequate for basic system operation and maintenance. Some staff walk to sites to perform maintenance duties, which results in lost productivity.

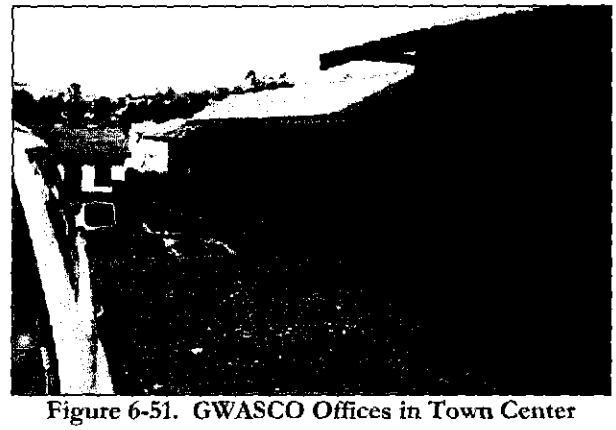


Figure 6-51. GWASCO Offices in Town Center

6.4.2 Management and O&M Needs

An accurate water and wastewater system inventory is required before meaningful planning can be accomplished. An inventory is important for almost all future work including developing O&M plans, infrastructure planning, mapping, tariff analysis, staffing planning, accounting and other activities. An inventory is the first step towards creating an asset management plan. Once the inventory is created, assets should be valued and prioritized into an asset management plan for future rehabilitation, replacement, or upgrade.

In order to maximize equipment lifespan and operating efficiency, GWASCO should document preventative maintenance plans for water and wastewater facilities, follow the plans closely, and be vigilant about recording maintenance histories for equipment.

Accurate mapping is also crucial for almost all future planning tasks. GWASCO needs to develop up-to-date electronic mapping of its water and wastewater systems. Fortunately, the basis for such mapping is currently being developed in Geographic Information System (GIS) format by UN-Habitat and the Regional Center for Mapping and Development. Once developed, a variety of layers should be included such as: existing land use; streets; neighborhoods; population density; water system features including intakes, treatment facilities, piping network, and storage facilities; wastewater collection system piping and treatment facility; water kiosks; public toilets; and bulk water meters. All water and wastewater systems included in system inventory should be included in mapping.

GWASCO appears to be adequately staffed, although staff training is expected to be insufficient. Staffing levels are expected to need to be increased as more water and sewer connections are made. Any staff member found to have accepted bribes from customers should be terminated. A detailed staffing study is required to fully assess GWASCO staffing needs.

GWASCO's current tariff structure and high UfW are part of the reason why the company to operates at a financial loss, despite having no current debt service. Low existing tariffs do not allow the company to pay normal operating costs and develop reserve funds. Available information suggests thar local residents are willing to pay more to ensure they receive high quality services. GWASCO should institute tariffs which ensure full cost recovery including O&M as well as capital projects. Additional clarity on company costs and revenues are required via a balance sheet, annual report, or similar documentation, in order to perform a meaningful analysis.

The GWASCO offices are in need of rehabilitation and new equipment. Existing offices contain old chairs, small rooms and makeshift work areas. Offices require immediate equipment upgrades. Specifically, GWASCO has will need the following:

- Desks and chairs
- Faxes, copiers
- Computers, software, and printers
- Filing cabinets
- Strong safe for cash revenue

All records and billing should be computerized and computer training is needed for staff. Installation of solar panels or an auxiliary generator should be considered to safeguard against losses of data and productivity after switching to a computer-based system.

Laboratory facilities are required to take basic daily measurements, including microbiological test kits, chemical test kits, and equipment for TSS, BOD, COD, pH, DO, and turbidity. The development of updated laboratory facilities for water and wastewater systems should be coordinated to avoid unnecessary overlap. Quality assurance and quality control checks on sampling programs are required and should be developed in consultation with LVSWSB. Infrequent sampling requiring expensive specialized equipment should be done at LVSWSB. Until laboratory facilities can be established, sampling programs should begin immediately with all analysis done at the LVSWSB laboratory in Kisumu.

No public education programs currently exist at GWASCO. An informed customer base is vital for effectively protecting public health, garnering support for local projects, and ensuring successful project implementation. GWASCO should develop public education programs. The public should be aware of the importance of clean water and sanitation, especially associated health impacts. Promotion of water conservation and installation of water-saving devices in homes could save additional water, allowing GWASCO to serve additional customers and extend time before additional supplies are needed. Many residents consume water from contaminated sources without point of use treatment and should be made aware of hazards and provided with point of use treatment chemicals to be used until adequate piped water sources are provided. Some homes are expected to have wells and pit latrines co-located and residents should be aware of potential hazards. GWASCO should begin to make the health-based case for improving public water and wastewater services.

GWASCO should seek to support and develop entrepreneurship and income-generating activities which will reduce demands on GWASCO staff. Such activities may include commercialization of water kiosks and public toilets, private exhauster services, biosolids composting and marketing, development of tree nurseries using treatment facility biosolids, algae harvesting from lagoons, and irrigated sugar cane, bamboo, or aquaculture using treated effluent.

Favorable economies of scale may be attained by regionalization of some services including leak detection and repair, chemical procurement, staff and manager training, equipment repair/rehabilitation, spare parts, bulk purchases including water meters, leak detection equipment, purchasing in-home water saving devices, a water bowser, and other activities. GWASCO should work with LVSWSB to determine appropriate regionalization programs and pursue them.

Vendors, kiosk operators and public toilet operators require training in financial management and operation to protect public health. Training and certification programs are required for these services.

GWASCO has noted that available vehicles for staff transportation are lacking and that existing equipment is old and costly to maintain. The exact number of required vehicles is not known, but it is assumed that at least three trucks and five motorcycles will be needed.

Other management needs are discussed in other sections including a water audit, bulk and consumer meter repair and replacements, an illegal connection removal plan, watershed land purchase for source protection, discussions with large water users not connected to the wastewater system regarding connections, and the development of an on-site wastewater management plan.

6.4.3 Management and O&M Recommendations

Recommendations regarding management and O&M and estimated costs and phasing are included in the detailed matrices (Appendix 6-2). Many activities require more detailed study and costs for such studies have been estimated. Recommended activities include, but are not limited to the following:

- Develop **water and wastewater system inventories and asset management plans** utilizing the toolkit proposed to be created by LVSWSB. The inventories should include major equipment, piping, tanks, and treatment systems. Available data such as age, expected useful life, condition, service history, and nameplate data should be included. Financial value of assets and list of depreciated assets should be included. Develop or use available standard forms, or purchase and customize available software (recommended) to create inventories and convert to an asset management plan by prioritizing assets and estimating future needs and costs. Priority should be given to critical infrastructure at or past the end of its useful life.
- Prepare **GIS mapping** with all water and wastewater systems included in system inventory, as well as other data layers.
- Develop a **preventative maintenance plan** and maintenance tracking system, including all inventory components, utilizing the toolkit proposed to be created by LVSWSB. The system may incorporate traditional maintenance card techniques, "out-of-the box" software, or customized software. Software packages are readily available to schedule and track all required preventative maintenance and are recommended.
- Prepare **O&M manuals** for water and wastewater facilities including layout drawings and regular maintenance requirements. Obtain manufacturer's manuals for all existing equipment, incorporate recommended maintenance into preventative maintenance plan.
- Review water and wastewater staffing levels and conduct **staff rationalization study** by an external Human Resources consultant. Study should include organizational chart development, task analysis, determination of staffing requirements, creation of job descriptions, and implementation plan for staffing changes.
- Conduct detailed **analysis of current tariff structure** in conjunction with proposed new projects and costs from asset management plan. Utilize toolkit proposed to be developed by LVSWSB and the Draft Tariff Guidelines created by WSRB. Include consultation and participation of stakeholders. Revise tariff structures so revenues cover all operational expenses and generate additional funds for capital improvements, equipment, meter replacements, planning, etc. Proposed tariffs should not be arbitrary, but rather based on real data, reasonable projections, and a transparent methodology.
- Implement **public education programs** to inform residents about the importance of water conservation, water quality, source protection, sanitation, and potential resultant financial savings. Utilize public education toolkit proposed to be developed at LVSWSB. Designate staff responsible for public education and public relations including informing customers of any expected service disruptions and handling complaints. Hold public meetings to discuss water and sanitation-related issues with continued support from LVSWSB in administering such meetings. Couple public toilet and kiosk rehabilitation and commercialization with public education. Work with local environmental and health groups on public education programs. Begin school programs addressing water conservation, health and hygiene. Consider publishing and distributing annual informational

reports to customers similar to Consumer Confidence Reporting used in the United States for educating customers about water and watershed protection.

- Consider development of **entrepreneurial opportunities** including commercialization of water kiosks and latrines/public toilets; private operation of GWASCO-owned exhauster truck(s) or Vacutug; compost production and distribution; utilization of sludge at one of several existing or possible new seedling nurseries at Suneka WWTF; algae harvesting from lagoons; irrigated sugar cane/bamboo/other; aquaculture with WWTF effluent.
- GWASCO should investigate becoming part of Kisumu-based **regionalization programs** including staff and manager training, equipment repair/rehabilitation, spare parts, chemical procurement, bulk purchases including water meters, leak detection equipment, purchasing in-home water saving devices, water bowser, public education, etc. Work with LVSWSB to develop regional programs.
- Implement **vendor, kiosk, and public toilet operator training and certification programs**. Encourage residents to only purchase water from registered vendors. Encourage vendors to become trained as kiosk operators as kiosks come on-line.
- Purchase **office equipment** including chairs, desks, faxes, copiers, computers and software, printers, filing cabinets, and safe for cash. Add additional security measures including effective door and window locks and computer data security.
- Purchase **basic tools** required for system maintenance. Construct and equip a **meter repair and calibration bench**.
- Establish a regular **staff training program**, including training of staff on performance indicators and technical, financial, and managerial skills. Include computer training. Take part in "circuit training" program proposed to be administered at LVSWSB.
- **Computerize record-keeping and billing.** A database of all water and sewer customers should be created including customer name, account number, active/inactive status, location, meter age, all meter readings, bill sent, and payments received. Utilize software capable of being used for water and sewer accounts to ensure compatibility for billing water and sewer simultaneously. All billing should be computerized.
- **Purchase vehicles** including trucks and motor cycles as required.

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2. *Kisii Water Supply Brief Report.* Prepared by Central Kisii District. Undated. Includes one-page narrative and one-page tabular summary.
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4. *Lake Victoria Region Water and Sanitation Initiative – Supporting Secondary Urban Centres in the Lake Victoria Region to Achieve the Millennium Development Goals – Kisii Town – Kenya.* United Nations Human Settlements Programme (UN-Habitat) Water for African Cities Programme, August 2004.
5. *Kisii Pre-Visit Survey and Data Request.* Completed by Kisii Water Supply District Water Area Manager with Mark J. Devine notes, 19th January 2006.
6. *US Investments in the Water Treatment/Sewer Treatment Sector in Kenya – Brief on Kericho, Kisii, Migori, Oyugis, Embu and Nanyuki Towns Water Supply and Sewerage Facilities.* Supplied by director of Water Development (Eng. K.G. Cheesang) via Jerry Okoko, 12th August 2003.

ENDNOTES:

[1] Kisii Visit Notes. Prepared by Mark J. Devine, 27th January, 2006.
[2] 'Kisii Water Supply Scheme. Project Brief' November 2001. The National Water Conservation and Pipeline Corporation. Page 2
[3] UN-Habitat Kisii Report, November 2005. pg. 15
[4] UN-Habitat Kisii Report, November 2005. pg. 16
[5] UN-Habitat Kisii Report, November 2005. pg. 16
[6] UN-Habitat Kisii Report, November 2005. pg. 16
[7] UN-Habitat Kisii Report, November 2005. pg. 16
[8] UN-Habitat Kisii Report, November 2005. pg. 15
[9] UN-Habitat Kisii Report, November 2005. pg. 15
[10] 'Kisii Water Supply Scheme. Project Brief' November 2001. The National Water Conservation and Pipeline Corporation. Page 4
[11] US Investments in the Water Treatment/Sewer Treatment Sector in Kenya – Brief on Kericho, Kisii, Migori, Oyugis, Embu and Nanyuki Towns Water Supply and Sewerage Facilities. Supplied by director of Water Development (Eng. K.G. Cheesang) via Jerry Okoko, 12th August 2003. Page 1 of 'Kisii Town Water Supply' Section.
[12] UN-Habitat Kisii Report, November 2005. pg. 30
[13] UN-Habitat Kisii Report, November 2005. pg. 15
[14] Kisii Water Supply Brief Report, Prepared by Central Kisii District. Undated. Includes one-page narrative and one-page tabular summary.
[15] UN-Habitat Kisii Report, November 2005. pg. 25
[16] January 30, 2007 Meeting with GWASCO in Kisumu.
[17] Kisii Water Supply Reticulation Network, photocopy of hand-drawn plan provided by GWASCO in 2006.
[18] Kisii Water Supply Brief Report, Prepared by Central Kisii District. Undated. Includes one-page narrative and one-page tabular summary.
[19] UN-Habitat Kisii Report, November 2005. pg. 27
[20] JICA Aftercare Study on the National Water Master Plan, 1998. Page IV-T-8.
[21] UN-Habitat Kisii Report, November 2005. pg. 50 and 'Kisii Water Supply Scheme. Project Brief' November 2001. The National Water Conservation and Pipeline Corporation. Page 2.
[22] JICA Aftercare Study on the National Water Master Plan, 1998. Page IV-50.
[23] JICA Aftercare Study on the National Water Master Plan, 1998. Page IV-50,51
[24] UN-Habitat Kisii Report, November 2005. pg. 50
[25] 'Kisii Water Supply Scheme. Project Brief' November 2001. The National Water Conservation and Pipeline Corporation. Page 3
[26] 'Kisii Water Supply Scheme. Project Brief' November 2001. The National Water Conservation and Pipeline Corporation. Page 4
[27] JICA Aftercare Study on the National Water Master Plan, 1998. Table 6.35
[28] JICA Aftercare Study on the National Water Master Plan, 1998. Table 7.3.1 (2/3)
[29] US Investments in the Water Treatment/Sewer Treatment Sector in Kenya – Brief on Kericho, Kisii, Migori, Oyugis, Embu and Nanyuki Towns Water Supply and Sewerage Facilities. Supplied by director of Water Development (Eng. K.G. Cheesang) via Jerry Okoko, 12th August 2003. Page 2 of 'Kisii Town Water Supply' Section.
[30] US Investments in the Water Treatment/Sewer Treatment Sector in Kenya – Brief on Kericho, Kisii, Migori, Oyugis, Embu and Nanyuki Towns Water Supply and Sewerage Facilities. Supplied by director of Water Development (Eng. K.G. Cheesang) via Jerry Okoko, 12th August 2003. Page 2 of 'Kisii Town Water Supply' Section.
[31] UN-Habitat Kisii Report, November 2005. pg. 73
[32] UN-Habitat Kisii Report, November 2005. pg. 62
[33] UN-Habitat Kisii Report, November 2005. pg. 62
[34] UN-Habitat Kisii Report, November 2005. pg. 26
[35] UN-Habitat Kisii Report, November 2005. pg. 26
[36] UN-Habitat Kisii Report, November 2005. pg. 26
[37] US Investments in the Water Treatment/Sewer Treatment Sector in Kenya – Brief on Kericho, Kisii, Migori, Oyugis, Embu and Nanyuki Towns Water Supply and Sewerage Facilities. Supplied by director of Water Development (Eng. K.G. Cheesang) via Jerry Okoko, 12th August 2003. Page 1 of 'Kisii Town Water Supply' Section.

7. MIGORI **7-1**

7.1 General Information and Projections **7-1**
7.1.1 Location 7-1
7.1.2 Topography, Geology, and Climate 7-1
7.1.3 Land Use and Roadway Infrastructure 7-2
7.1.4 Power Supplies 7-5
7.1.5 Population 7-7
7.1.6 Water Demand and Service Goals 7-10
7.1.7 Wastewater Flows and Service Goals 7-13

7.2 Water **7-15**
7.2.1 Water System Overview 7-15
7.2.2 Water Sources and Intakes 7-17
7.2.2 (a) Water Sources and Intakes Description 7-17
7.2.2 (b) Water Sources and Intakes Needs 7-22
7.2.2 (c) Water Sources and Intakes Improvement Options 7-23
7.2.2 (d) Water Sources and Intakes Recommendations 7-27
7.2.3 Water Treatment 7-28
7.2.3 (a) Water Treatment Description 7-28
7.2.3 (b) Water Treatment Needs 7-28
7.2.3 (c) Water Treatment Recommendations 7-29
7.2.4 Water Distribution 7-29
7.2.4 (a) Water Distribution Description 7-29
7.2.4 (b) Water Distribution Needs 7-34
7.2.4 (c) Water Distribution Recommendations 7-36

7.3 Wastewater **7-37**
7.3.1 Wastewater Overview 7-37
7.3.2 On-Site and Small Treatment Systems 7-37
7.3.2 (a) On-Site and Small Treatment Systems Description 7-37
7.3.2 (b) On-Site and Small Treatment Systems Needs 7-42
7.3.2 (c) On-Site and Small Treatment Systems Recommendations 7-42
7.3.3 Centralized Collection, Treatment, Disposal, and Residuals Management 7-43
7.3.3 (a) Centralized Collection, Treatment, Disposal, and Residuals Management Needs 7-43
7.3.3 (b) Centralized Collection, Treatment, Disposal, and Residuals Management Recommendations 7-48

7.4 Management and Operation and Maintenance (O&M) **7-48**
7.4.1 Management and O&M Description 7-48
7.1.1 Management and O&M Needs 7-55
7.4.2 Management and O&M Recommendations 7-57

7. MIGORI

7.1 General Information and Projections

7.1.1 Location

Migori Municipality (often still referred to as Migori Town) serves as headquarters of the Migori District of Nyanza Province.[1] The municipality is located approximately 120 km southwest of Kisumu and 20 km north of the Tanzania border. It is situated on the A1 national trunk road between Kisii and Isebania, a Tanzania border town. The municipality covers an area of 57 km^2.[2] The main population centers are situated along the A1 road between where the road crosses the Oyani River in the north and where the C13 road crosses the A1 road in the south (Map 7-1). The C1 road runs from Lake Victoria east toward Masai Mara National Reserve. The densest population is concentrated close to the Migori River, which crosses the A1 Road in central Migori.

7.1.2 Topography, Geology, and Climate

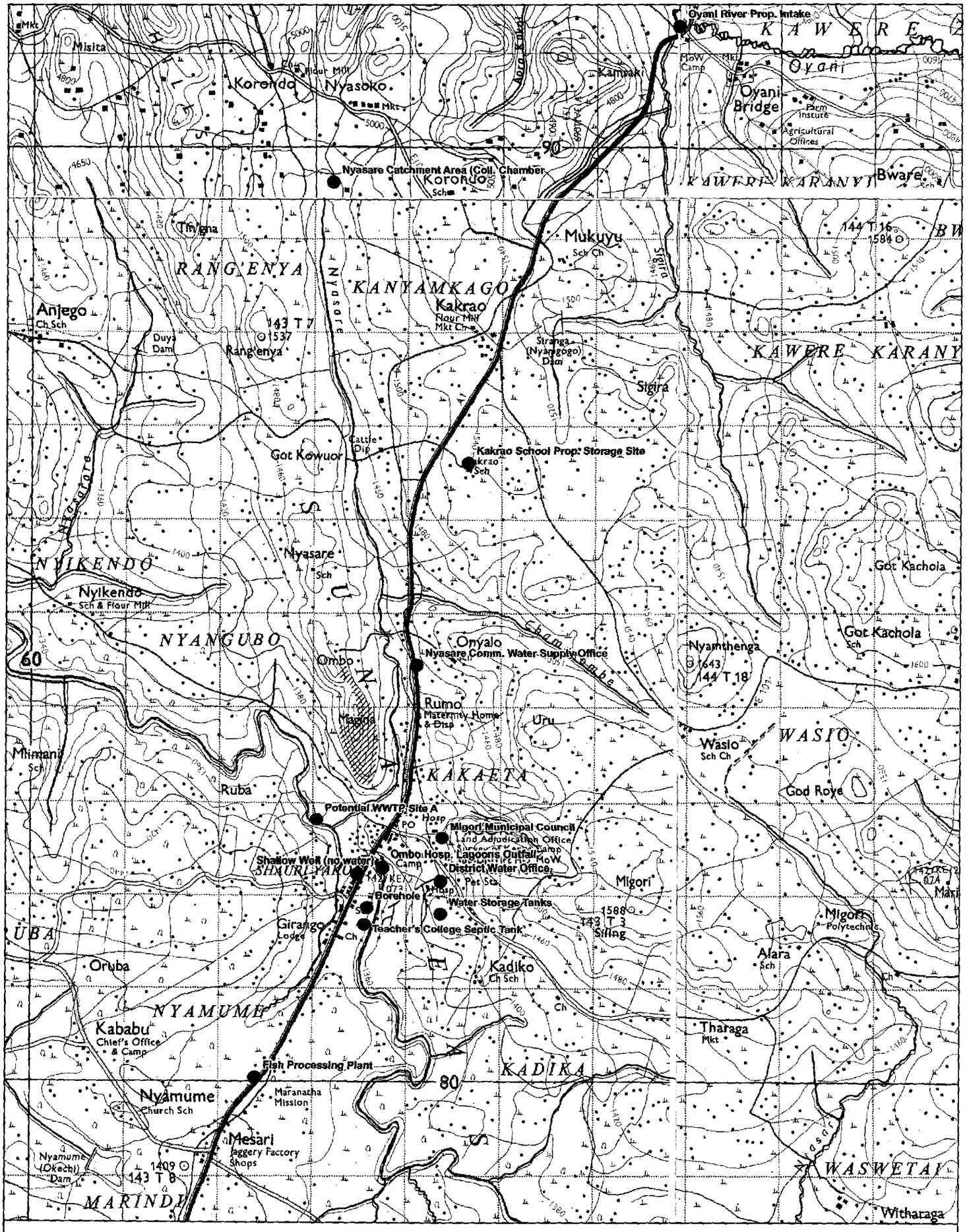
Topography

Migori District and Migori Municipality are characterized by rolling hills. Elevations in the municipality range from 1,350 m above sea level near the Migori River to over 1,600 m in the hilly areas in the eastern portions of town. Elevations in the greater district range from 1,100 to 1,700 m. The municipality is bisected by the Migori River, which flows from southeast to the northwest. The ground surface slopes upward from the Migori River (elevation 1,360 m) heading north along the A1 Road through Onyalo to Kakrao (elevation 1,540 m), then descends before reaching the Oyani River crossing in the north (elevation 1,400 m). On the south side of the Migori River, the land gradually rises along the A1 Road heading south toward the C13 Road in Marindi (1,400 m). Several large hills exist on both sides of the A1 road including Magina northwest of the town center (elevation 1,500 m) and Oruba (elevation 1,440) southwest of the town center. Hills on the east side of the A1 road include a hill in Kadika where the present main water supply tank is located (elevation 1,420) and larger hills two to three kilometers east of the A1 road which rise to elevation 1,560 m and above.

Undulating topography results in several small streams which flow in a variety of directions in the area. However, the overall landscape generally slopes from east and southeast to the west and northwest. The Migori River generally flows from southeast to the northwest and eventually joins with the Gucha River before discharging into Lake Victoria about 15 km north of the Tanzania border. The Oyani River also flows from southeast to the northwest and eventually joins with the Gucha River. Smaller streams include the spring-fed Nyasare River which discharges to the Migori River from the north, and the Ragana River which discharges to the Migori River from the South. The Sigira stream flows north from the Kakrao area and discharges to the Oyani River. Many other small streams also exist in Migori.

Geology

For the most part, the geology in Migori is composed of granite, Macalder deposits, and some Kamwango.[3] Migori sits upon a shield composed of Nyanzian system metavolcanics (also known as "greenstones"), ranging from basic to acidic volcanics. The Nyanzian geology also includes sediments and banded ironstones. Granite is found in the area as outcrops as well as in the deeper layers below.[4]



Legend

● Points of Interest

—— Rivers

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0 750 1,500 3,000 Meters

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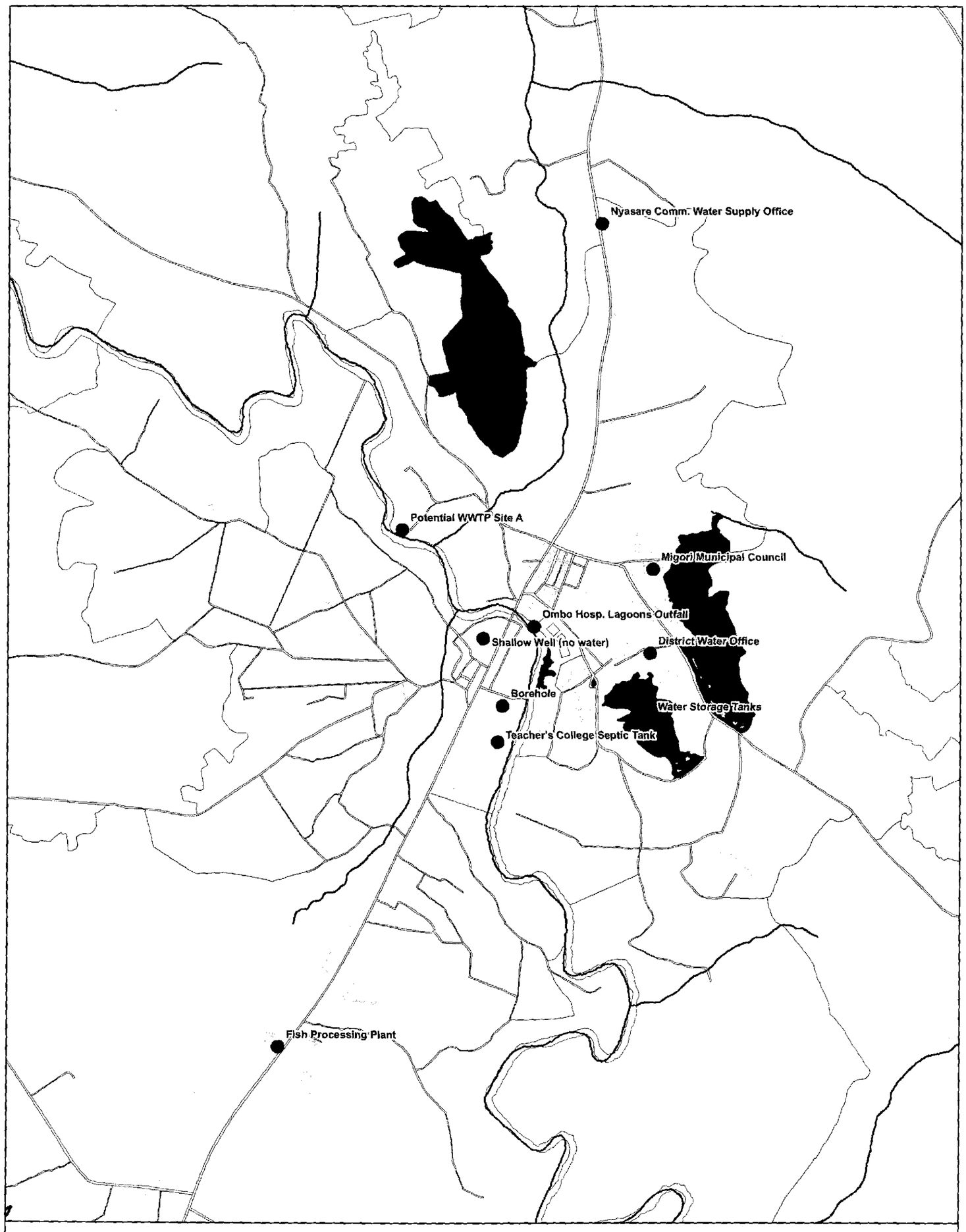
Lake Victoria South Water and Wastewater Feasibility Study

Map 7-1

Greater Migori



Landuse Subclass

- Grassland
- Large Scale Agriculture
- Small Scale Agriculture
- Woodland
- Organized Pattern
- Unorganized Patterns
- Mixed Patterns
- Points of Interest
- Rivers

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0 300 600 1,200 Meters

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N W E S

Lake Victoria South Water and Wastewater Feasibility Study

Map 7-2

Migori Town Center Landuse

Landuse Data Source: UN - Habitat

Climate

Migori has annual rainfall averaging approximately 1,400 mm[5], but has been noted to vary from 700 mm to 1,600 mm.[6] The typical evaporation rates in Migori range from 1,800 to 2,000 mm/year with high humidity. The climate is therefore drier than the two other towns studied in this report. The minimum annual temperatures in Migori range between 14° C and 18° C, while maximum temperatures range from 30° C to 34° C. The climate is good for growing a variety of cash crops including tobacco and sugar.

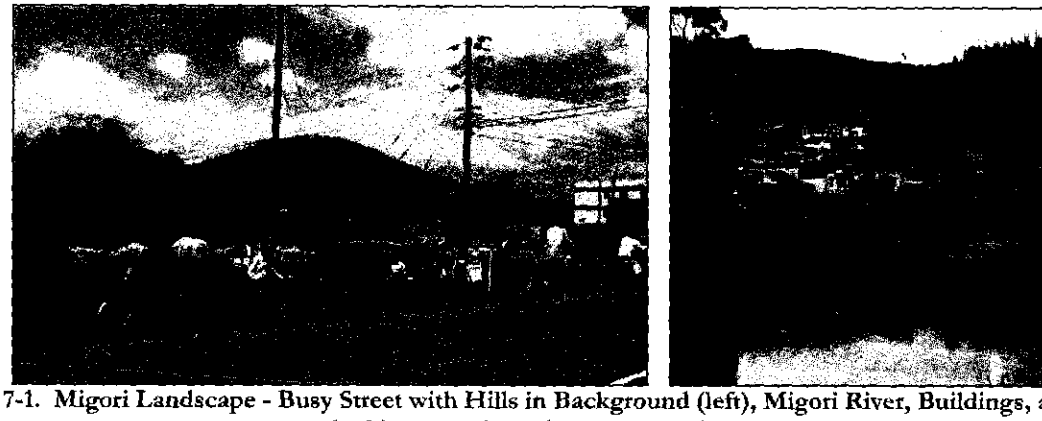

Figure 7-1. Migori Landscape - Busy Street with Hills in Background (left), Migori River, Buildings, and Hills looking west from downtown (right)

7.1.3 Land Use and Roadway Infrastructure

Migori's land use within the Central Business District (CBD) (along the A1 road close to the Migori River) includes commercial establishments, schools and universities, hospitals and other health facilities, and institutional offices including Migori District government offices. Outlying areas away from the main roadway infrastructure in the center of town consist of peri-urban areas and small scale agriculture. Government land has been set aside through the Migori Municipal Council for water and wastewater projects. The government has also noted that it may acquire more land as required for such projects.[7]

Migori has experienced rapid growth over the past several decades. It was officially designated as a Town in the 1980s, then upgraded to a Municipality and District Headquarters in the late 1990s. Migori's growth has been strongly influenced by its proximity to the Awendo sugar belt, local tobacco growing and processing, Lake Victoria and the fishing industry, and the border with Tanzania, with which Migori serves as a major trading center. Fishing in particular has had a positive impact on the economic growth of the Town, partly due to the presence of a fish processing factory south of the central business district.

Migori lies along the A1 trunk road which connects with Tanzania. A network of classified and unclassified roads serves the surrounding outlying regions.[2] During the Project Team's visit to Migori, it was observed that the A1 trunk road was paved and relatively smooth, but most other roads in Town are not paved or severely riddled with pot holes. Migori is well connected to the neighboring communities including the sugar producing area of Awendo to the north, Lake Victoria to the west, and Tanzania to the south. Some roads are impassable without four wheel drive vehicles, and many residents rely on bicycles for transportation.[8]

Mapping of population density was prepared by JICA as part of a 2001 Study[9] which indicates high density (10,000+ persons/km^2) in the main town center near where the A1 road crosses the Migori River. Density drops off sharply to less than 500 persons/km^2 within two to three kilometers of the center. Information from this mapping was used to estimate populations within the existing and proposed water and wastewater service areas described below. More detailed mapping is currently being developed as part of a UN-Habitat funded GIS mapping project. The Regional Center for Mapping of Resources for Development (RCMRD)

in Nairobi is carrying out this project and provided some preliminary information including a land use map (Map 7-2) and satellite imagery (examples provided in Figure 7-2 and Figure 7-3). Figure 7-4 and Figure 7-5 depict examples of existing land use and roadway infrastructure in Kisii.

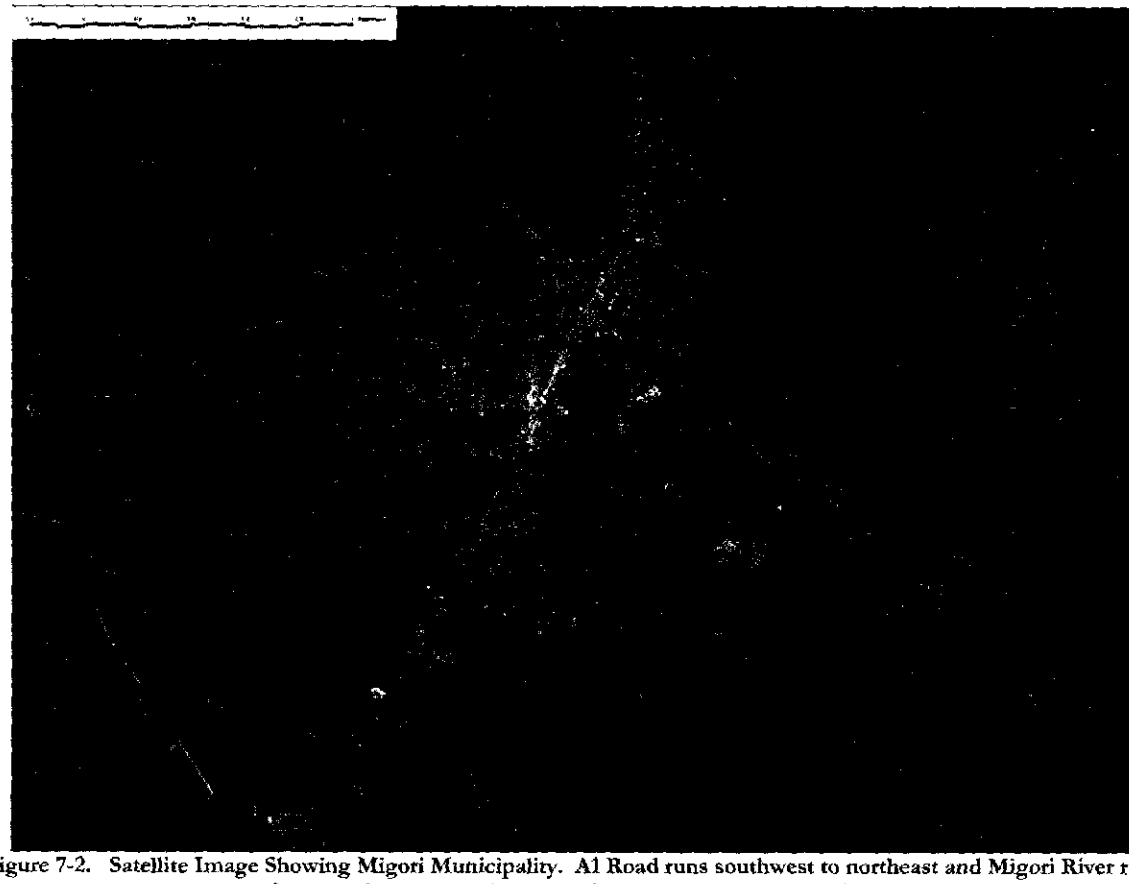

Figure 7-2. Satellite Image Showing Migori Municipality. A1 Road runs southwest to northeast and Migori River runs from southeast to northwest. C13 Road is visible at lower left.

Source: UN-Habitat. Image prepared by Regional Center for Mapping of Resources for Development (RCMRD), Nairobi

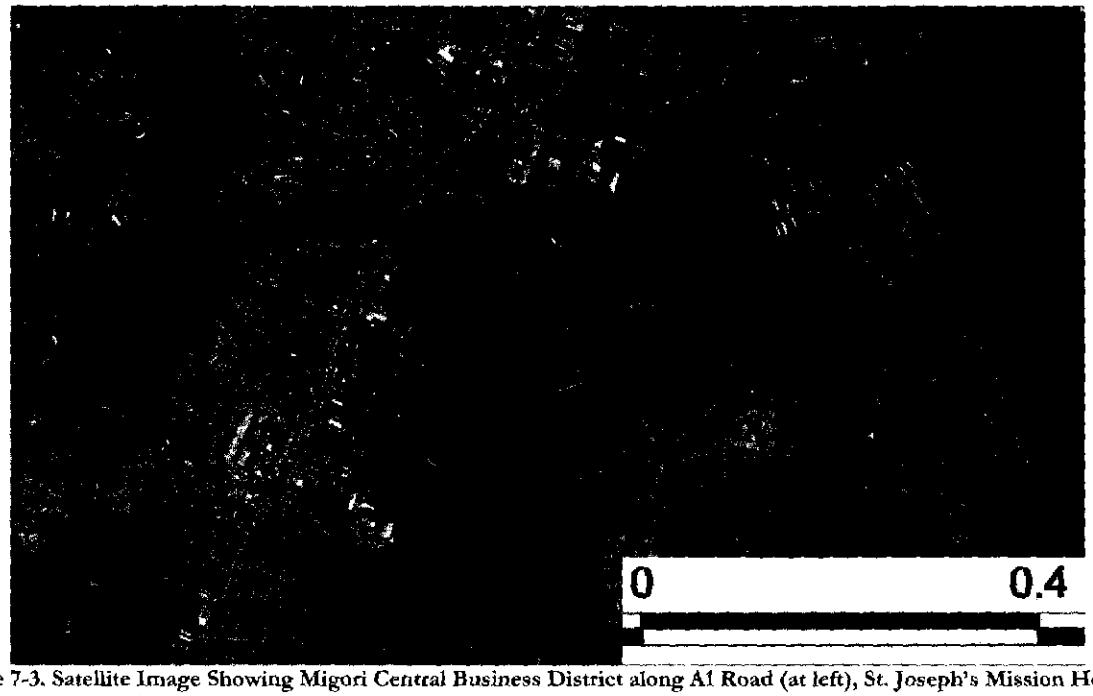

Figure 7-3. Satellite Image Showing Migori Central Business District along A1 Road (at left), St. Joseph's Mission Hospital Wastewater Treatment Lagoons (center), and the Administration Road and Government Offices (upper right)
Source: UN-Habitat. Image prepared by Regional Center for Mapping of Resources for Development (RCMRD), Nairobi

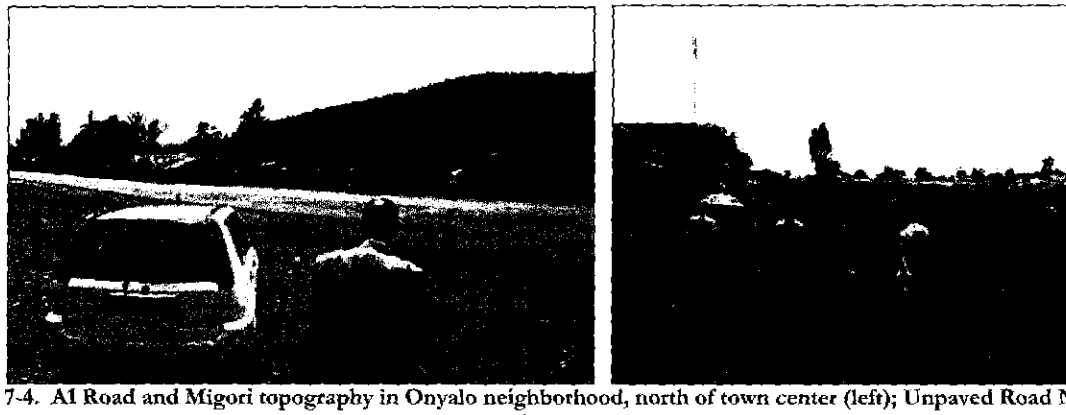

Figure 7-4. A1 Road and Migori topography in Onyalo neighborhood, north of town center (left); Unpaved Road Near the Market in the Town Center (right)

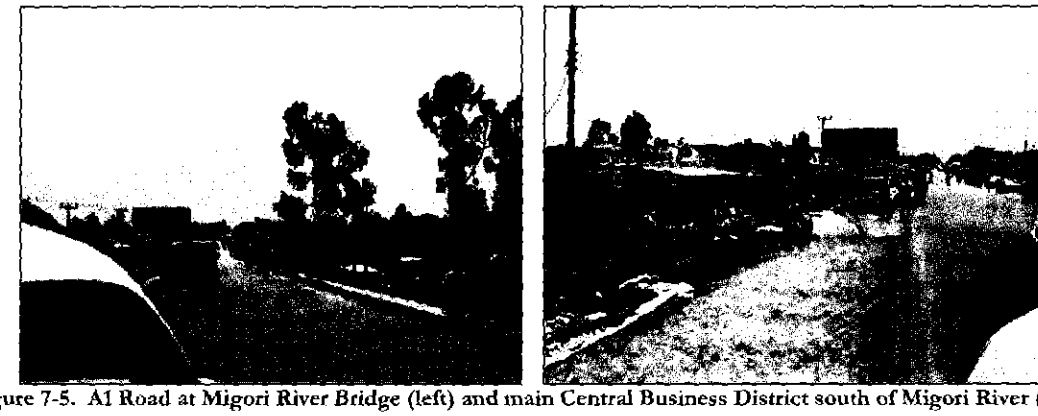

Figure 7-5. A1 Road at Migori River Bridge (left) and main Central Business District south of Migori River (right)

Changes in land use during the study period are expected to be primarily in the form of escalating urbanization via increasing density of residential and commercial development along the major roadways. The majority of this increased density is expected to occur around central Migori, especially in present peri-urban areas. The development of improved water supply along the main transportation corridors is also expected to influence increasing density of development. Residential areas are expected to increase in density as population increases and will likely expand into outlying areas currently occupied by small farms. The Project Team was not made aware of any particular planned developments which would significantly change expected growth patterns in and around existing developed areas.

7.1.4 Power Supplies

The town has an electricity distribution network that covers most of the densely populated areas, but reliability problems and frequent blackouts plague the existing system. Migori is connected to the national power grid and receives power from the Kenya Power and Lighting Company. Power outages occur daily and frequent voltage fluctuations cause problems with pumping equipment. MIKUTRA (water service provider for Migori) staff noted that power is typically only available 25% of the day due to frequent blackouts and low voltage, which is expected to be partially attributable to its location on the outer reaches of the existing grid. [10] Loss of power was noted by MIKUTRA to occur hourly, and frequent outages were observed by the Project Team during visits. Many residents in the region rely on burning wood and charcoal for domestic energy needs.

Figure 7-6. Migori Gasoline Pump Equipped with Hand Crank for use During Frequent Power Outages

The MIKUTRA boreholes require reliable electricity for pumping and do not have a source of auxiliary power. Incoming voltage reportedly fluctuates widely during the day, which causes causing motors to run hot, contactors to burn out, and forcing operators cease operation of the pumping equipment. This is in addition to times when pumping is forced to cease due to power outages.

Unreliable electrical power is a significant factor limiting water production and will weigh heavily on future decisions regarding water and wastewater technology choices. Schedules for Kenya Power and Lighting Company improvements in electrical power reliability in the area are presently unknown. Current electricity rates are approximately 7 KShs/KW-hr. Current power use for the existing boreholes is expected to be less than 20,000 kW-hr/month, although this requires confirmation because detailed data was not available including new boreholes. MIKUTRA reported expenditures on electricity in its 2005 annual report varied from less than 15,000 KShs/month to approximately 110,000 KShs/month, and averaged approximately 70,000 KShs/month. Other information provided by MIKUTRA noted the monthly electricity cost was approximately 158,000 KShs.[11] Depending on which figures are accurate, electricity costs represent one third to one half of MIKUTRA's total expenditures.

It is recommended that preference be given to gravity systems for future water and wastewater infrastructure improvements whenever feasible to avoid problems associated with power reliability and costs. However, renewable energy sources may be appropriate for some systems and should be explored during more detailed design phase work. Diesel fired generators, although expensive to operate, are expected to be the simplest and most effective way to quickly boost available power supplies and increase water production.

The hilly topography of Migori is well suited for the development of hydropower supplies. According to records provided by MIKUTRA, low flow in the Oyani River at the A1 road bridge is approximately 0.188 m^3/s, or approximately 16,000 m^3/d. Other data for the 1KB11 monitoring station on the Oyani River indicates flow varying from less than 1 m^3/s to 4 m^3/s in 1984 and 1985. It is not certain if the 1KB11 station is at the A1 bridge over the Oyani River. Assuming flow in the Oyani varies from 0.2 m^3/s to 2 m^3/s and a head of 10 m is available, electricity production in the range of 5,000 to 70,000 kW-hours per month could be generated, assuming 50% overall hydropower station efficiency.

The Sigira Stream runs through a relatively steep ravine from near Kakrao to where it joins the Oyani River near the A1 road crossing. Flow data was not available for this stream, but assuming a 50 m drop is available and flow approximately $1/10^{th}$ of that in the Oyani River, electricity production in the range of 3,000 to 30,000 kW-hours per month could be generated, assuming 50% overall hydropower station efficiency.

The above estimations are based on very limited data and are presented here for order of magnitude comparison only. Detailed data on available flows and topography are required before the hydroelectric potential of the streams can be assessed. In addition, KenGen reportedly cutrently operates a hydropower facility at Gogo dam, approximately 30 km downstream of the A1 bridge at the at Oyani-Gucha river confluence. No information was available about this facility, but MIKUTRA staff and LVSWSB noted that the mining industries in Macalder that the dam was intended to serve with electricity no longer exist and that surplus power may be available or additional capacity may be able to be added. Additional information is also required regarding this facility.

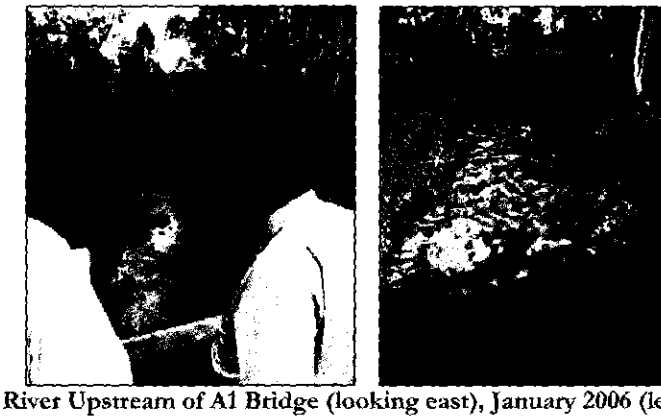

Figure 7-7. Oyani River Upstream of A1 Bridge (looking east), January 2006 (left), April 2006 (right)

In addition to hydropower, other potential renewable power supplies include wind, solar, and biomass. It is unclear if any such projects have been implemented or are in the planning stages in Migori. In general, it is expected that while solar power may be cost effective for small demands such as backup power for offices, it is not yet cost effective for larger demands such as pumping. Drawbacks associated with wind power include variability resulting in the need for large, costly energy storage facilities. Biomass facilities utilizing agricultural waste from sugar and rice farms (bagasse) in the region to create producer gas may have merit and should be explored.

7.1.5 Population

7.1.5 (a) Existing Population

Migori has a population of approximately 124,000 people within in the municipality boundaries, of which a total population of approximately 81,000 are estimated to live within central areas that can be reasonably expected to be served by the MIKUTRA-operated Migori water supply system (the current population served by MIKUTRA in Migori is less than 20,000). Existing information on population in the Migori area is presently expected to be imprecise. Migori experiences a substantial population increase during the day due to the commercial activities within Town attracting large influxes of people from outlying areas, especially on market days. The town serves as the District Headquarters and is a major economic center of the region, especially due to its proximity with the Tanzania border, which make it a trading hub. Despite its vibrant commercial activity, the lack of adequate water and sanitation services hinders economic development.

During a January 2006 meeting with local business and government leaders, it was noted that most businesses in town are small or medium sized and their development cannot continue to grow without reliable piped water supplies and reasonably priced and reliable electricity.[12,13] It was noted that small businesses are the future of Migori, but that businesses have either stopped moving to Migori or are now moving out due to the lack of water.[14]

Migori was first established as a small trading center in 1931 and in 1997 attained a municipal status and was designated as the district headquarters for Migori District.[15] Offices of the Migori District Commissioner, other district departmental heads, the municipal and county councils, and major parastatal organizations are all located in Migori. Major healthcare and educational institutions exist in town including St. Joseph's Mission (Ombo) Hospital and Migori Teachers Training College. Major sources of employment in the area include the South Nyanza Sugar Company (SONY), the British American Tobacco (BAT) Company, and the Prinsal Fish Factory. Other local businesses include motor vehicle repairs and metal fabricating. Migori's major crops are sugar cane and tobacco, although other commercial crops are grown including nuts and various fruits. Raising livestock is undertaken by some residents in the peri-urban areas.

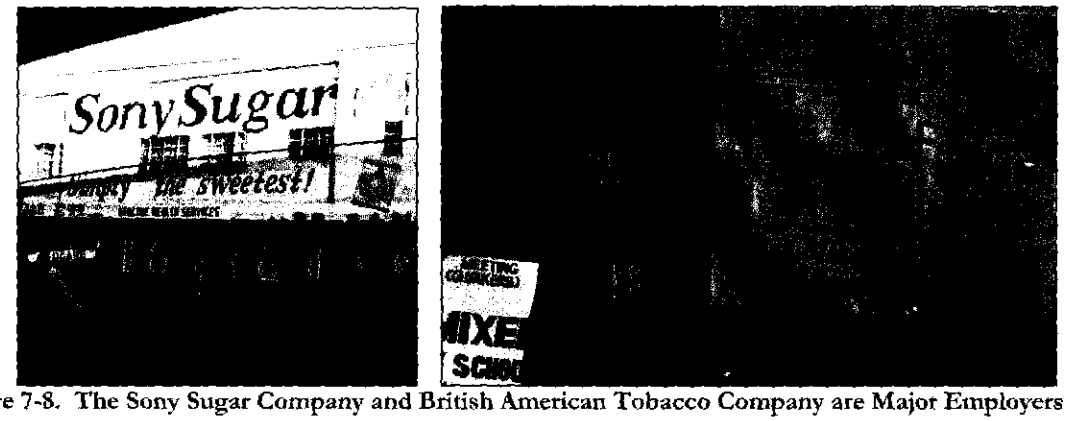

Figure 7-8. The Sony Sugar Company and British American Tobacco Company are Major Employers in the Migori Area

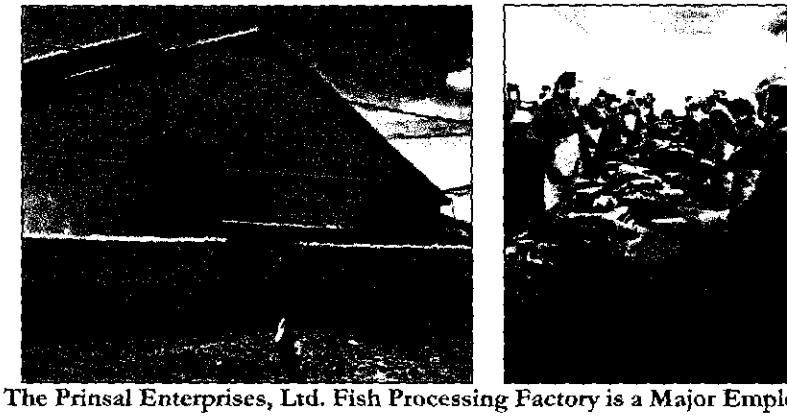

Figure 7-9. The Prinsal Enterprises, Ltd. Fish Processing Factory is a Major Employer in Migori

Figure 7-10. Migori Open Market near Migori River and A1 Road on Market Day

Figure 7-11. Migori Municipality Mayor (Gentleman in Center) and Migori Residents at Open Market

A detailed neighborhood-by-neighborhood study of population and other socio-economic indicators (referred to as a "baseline cluster survey") is currently underway by UN-Habitat. The results of this forthcoming study should be used to improve the accuracy of population, water demand, and wastewater flow projections contained in this report.

The average annual household income in Migori was estimated by MIKUTRA as 28,800 KShs[16], while UN-Habitat estimated average monthly household income in Migori as 83 USD/month (approximately 70,000 KShs/year) in their August 2004 study.[17] JICA categorized estimated household income levels in its 2001 Study and noted that approximately half of Migori residents are of low income. According to the Migori District Water Officer, 80% of residents live in unplanned settlements.

7.1.5 (b) Population Projections

Available population projections (JICA, Government of Kenya, MIKUTRA, LVSWSB, and UN-Habitat) were reviewed in order to develop projections for the purposes of this study. Significant differences in population projections exist due to overlapping census districts which have changed over the years and the fact that some estimates are for the entire municipality while others are for the main town area only. JICA and the Government of Kenya estimates are apparently for the entire municipality while those of MIKUTRA, UN-Habitat, and LVSWSB are for the main town area. Most estimated growth rates vary from 3% to 4.5%, although the Government of Kenya assumed a growth rate of 9%, based on census data which was skewed due to expansion of the town boundaries in the 1990s. Based on the available data, it was resolved to estimate an overall growth rate during the study period of 3.2% for the municipality and 3.5% for the main town area. Municipality and town population projections are presented below in Table 7-1 and Table 7-2. The feasibility study projections for the town area represent the expected water service area population based on population density mapping prepared by JICA and the satellite imagery provided by UN-Habitat. A detailed description of the water service area is provided under section 7.2 below. Assumptions regarding income levels were based on JICA estimates and assume improvement in per capita income over the study period.

Table 7-1. Summary of Migori Municipality Projections

	1	2	3
Year	JICA Feb 2001 Report	'U.S. Investments in Water Treatment/Sewer Treatment Sector in Kenya' Government of Kenya Document (2003)	Feasibility Study Projections
2005	120,000	140,000	120,000
2010	150,000	-	150,000
2015	180,000	260,000	180,000
2025	240,000	770,000	240,000

Notes:
Projections rounded to nearest 10,000, projections extrapolated based on implied growth rate.
1 – Implied growth rate of 3.2%
2 – Implied growth rate of 9%. Note that Government of Kenya Projections did not take into account the fact that large growth during the period 1989-1999 was due to expanding the town borders by 50%, not due to natural growth. Therefore, the GOK estimates over-estimate growth rate..
3 – Implicit growth rate of 3.2%.

Table 7-2. Summary of Migori Municipality / Water Service Area Population Projections

	1	2	3	4
Year	MIKUTRA (Pre-Visit Survey and 'Welcome to Migori' document) (2006)	LVSWSB MIWASCO WSP Rapid Assessment (Urban Center Only) (undated, assume 2006)	UN-Habitat (2004)	Feasibility Study Projections (Water Service Area) (2006)
2005	50,000	80,000	60,000	80,000
2010	70,000	100,000	80,000	100,000
2015	-	120,000	90,000	120,000
2025	100,000	190,000	150,000	160,000

Notes:
Projections rounded to nearest 10,000, projections extrapolated based on implied growth rate.
1 – Implicit overall growth rate of 3%
2 – Implicit overall growth rate of 4.5%
3 – Implicit overall growth rate of 4.5%.
4 – Implicit overall growth rate of 3.5%. Calculation based on assumption that only those areas with density greater than 1,000 persons / km^2 can be cost-effectively served by a town water supply system. JICA 2001 Population Density mapping (Appendix G1) and UN-Habitat satellite imagery used for estimation of service areas. Actual projected service area described in Water section below.

Table 7-3. Projected Migori Population and Income Distribution

	Initial (2006)	Future (2015)	Ultimate (2025)
High / Medium Income %	53%	60%	70%
Low Income %	47%	40%	30%

Notes:
Initial population projections are based on JICA 2001 categories and assume approximately 1% change per year.

7.1.6 Water Demand and Service Goals

7.1.6 (a) Overview of Present Water Demand and Service Goals

MIKUTRA maintains more than 600 water service connections, although the exact number of active customers is unclear and over 500 connections are unmetered. Assuming over 15 persons are served per connection, it is estimated that approximately 10,000 residents are served by individual water connections

(IWC). MIKUTRA does not maintain any water kiosks. Therefore, approximately 12% of the estimated service area population and 8% of the estimated town population is served by a piped water connection or water kiosk from MIKUTRA. The Nyasare Water Supply Association operates a community water supply including kiosks and serves a similar number or residents as MIKUTRA, as described below.

According to MIKUTRA records for 2005, average day water production is approximately 450 m^3/day. Due to a lack of consumer meters, it is impossible to assess the level of unaccounted-for-water (UfW). However, considering the current poor state of the existing distribution system, it is assumed that UfW is 50%, which is comparable to observed UfW rates in other towns in the region. Based on the present estimated service population calculated above, per capita consumption is estimated at 23 liters per capita per day (lpcd) and per capita demand including UfW is estimated at 45 lpcd. These are aggregate values including all commercial, municipal, and industrial demands.

Existing town and service area population and service population goals are presented in Figure 7-12. In order to meet the 2015 Millennium Development Goal (MDG) for water service, the existing unserved population in the service area should be reduced from its present value of 88% to 44% by 2015. This can be accomplished by increasing the number of customers served from approximately 10,000 to 58,000 (includes expected population increase).

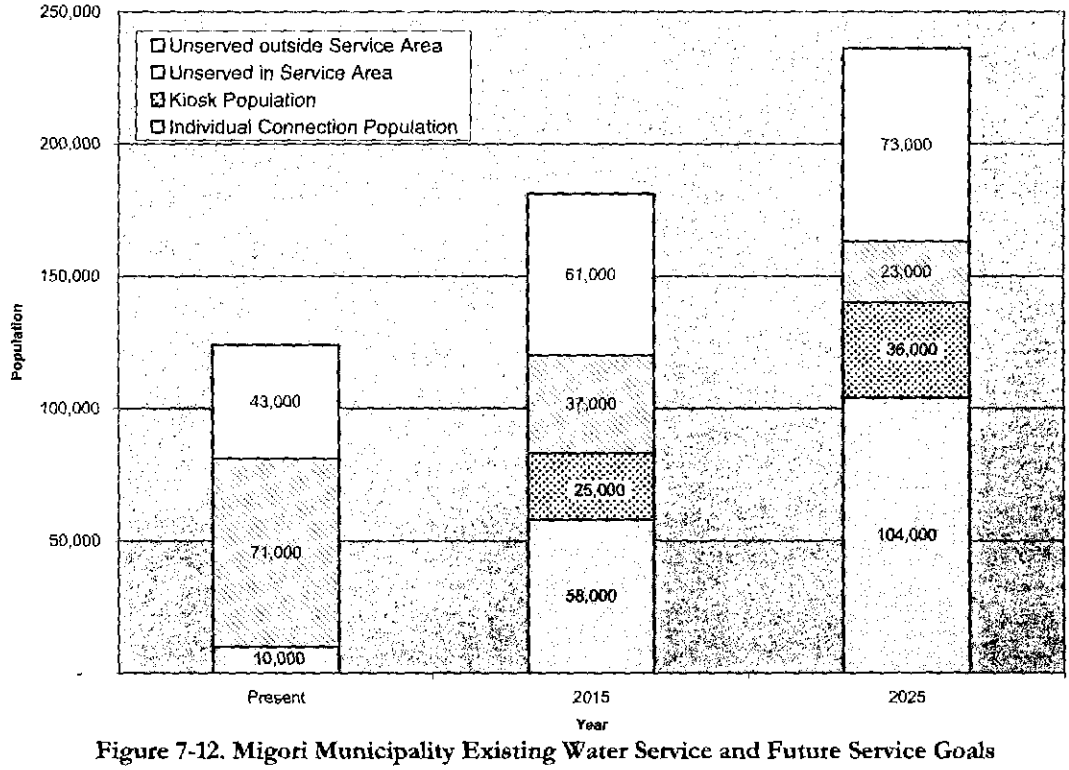

Figure 7-12. Migori Municipality Existing Water Service and Future Service Goals

7.1.6 (b) Domestic Water Use

Domestic water demand projections were developed based on the methodology described in Section 2. The projections are based on a variety of data and assumptions, including:

- Available consumption, demand, and UfW estimates
- Expected service area population growth
- Estimated current and future customer income levels
- Estimated per capita water demand growth

- Expected reduction in UfW

Detailed tables of domestic water use demand calculations are presented in Appendix 7-1.

7.1.6 (c) Large Water Users

Water use projections for large users were developed based on the methodology described in Section 2. MIKUTRA provided water use records for the four largest water user accounts in Kisii, which are the prison (16 m^3/d), District Hospital (10 m^3/d), the Fisheries Department (8 m^3/d), and Migori Secondary School (3 m^3/d). MIKUTRA noted that other large users on the Migori Water Supply system include Gilly Hotel, Girango Lodge, Highway Hotel, Migori District Headquarters, and Kadika Girls High School, but water use records were not provided.

Other large water users exist in town, which rely on private water supplies (usually boreholes) including the Prinsal Enterprises, Ltd. Fish Factory, Migori Teacher's College, St. Joseph's Mission Hospital, and several others. Based on conversations with the aforementioned large users, it is assumed that they will eventually be connected to the MIKUTRA system once capacity is available, as this is their intention.

Actual water use records provided by MIKUTRA may be inaccurate because most of the few existing water meters are old and expected to be under recording flows. Additional allotments for other large water users and market day demands have been assumed and actual water use data for large users not connected to the MIUKUTRA system were used when available for projections. Large water user demands are assumed to grow at the same rate as the Town population. Detailed tables of large user water demands and projections are presented in Appendix 7-1.

7.1.6 (d) Projected Water Demand

Table 7-4 presents a summary of existing and projected water demand and consumption for the study period in the projected water service area. Per capita water demand and consumption is expected to rise dramatically as the number of service connections increases. However, per capita demand and consumption are expected to level off or decrease slightly during the period 2015 to 2025 due to an assumption that customers added during that time will have lower incomes and therefore lower per capita water use. UfW is expected to be reduced over time and reach 15% by 2025. It should be noted that these water demand projections are based on a variety of assumptions and should be revisited and revised as appropriate during preliminary design when new data is available.

Widely varying projections of water demand exist. According to the Migori District Water Office, the current daily demand is approximately 3,000 m^3/d and will reach 5,291 m^3/d by 2025, presumably for the existing service area. UN-Habitat estimated current demand at 2,700 m^3/d. JICA projected that water demand would reach 20,000 m^3/d by 2010[18], while the Government of Kenya predicted demand would be over 86,000 m^3/d by 2025. JICA and Government of Kenya projections are for the entire Municipality, not just the projected service area. UN-Habitat did not project long term water demands.

Table 7-4. Migori Existing and Projected Water Demand and Consumption for Service Area

	Initial (2006)**	Future (2015)	Ultimate (2025)
Water Production (m^3/d)	450	10,000	16,000
Per Capita Water Demand (lpcd)*	45	120	114
Unaccounted for Water (UfW)	50%	15%	15%
Water Sold (m^3/d)	227	8,500	13,600
Per Capita Consumption (lpcd)*	23	102	97

**Aggregate value including individual domestic connections, large users, and kiosks.*
***Initial water demand and consumption shown are actual values based on 2005 data provided by MIKUTRA. Actual water production required to adequately serve existing customers is greater.*
Note: Per capita demand and consumption decline after 2015 as a result of expected increasing number of customers in lower income categories with lower water use.

7.1.7 Wastewater Flows and Service Goals

7.1.7 (a) Overview of Present Wastewater Flows and Service Goals

The only existing wastewater treatment system in Migori is a privately-owned lagoon system serving St. Joseph's Mission Hospital and staff housing, and is owned and operated by the Diocese of Homa Bay. The system discharges to a set of waste stabilization ponds, from which the effluent flows into the Migori River. The remaining residents of Migori either have pit latrines, cesspools, septic tanks, or other on-site systems. The Migori Municipality Council is presently responsible for removing accumulated solids from the pit latrines and septic tanks.[19] As water service provision and per capita water use increase, an adequate wastewater collection and treatment system will become increasingly important to protect public health and the environment as wastewater flows will increase and exceed the capacity of existing on-site systems.

Projected wastewater flows were based on standard estimation procedures as described in Section 2 and goals were based on the MDG targets and a projected wastewater service area covering about 70% of the population in the most densely populated areas of the water service area. Therefore, the population within the projected wastewater service area is presently estimated to be 56,000 and expected to approximately double by 2025.

Existing town and service area population and service population goals are presented in Figure 7-13. In order to meet the 2015 MDG for wastewater, the existing unserved population in the service area should be increased from its present value, which is assumed to be 100% (flows to the St. Joseph's Hospital Lagoon System are unknown), to 50% by 2015. This can be accomplished by increasing the number of customers served by either piped connections or public toilets from zero to 70,000 (including expected population growth). As detailed in the wastewater section below, all residents currently relying on on-site wastewater systems should be included in a proposed on-site wastewater management program.

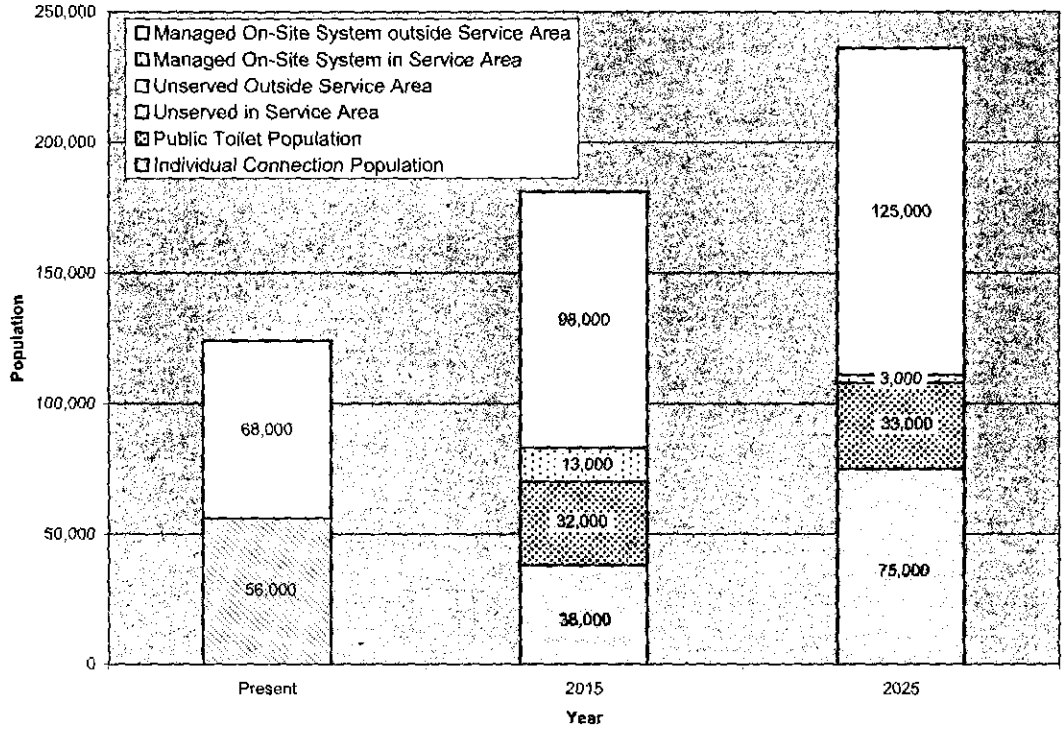

Figure 7-13. Migori Municipality Existing Wastewater Service and Future Service Goals

7.1.7 (b) Domestic Wastewater Flows

Domestic wastewater flow projections were developed based on the methodology described in Section 2. The projections are based on a variety of data and assumptions, including:

- Available flow data and current per capita flow estimates
- Expected service area population growth
- Estimated per capita water demand growth

Detailed tables of domestic water use demand calculations are presented in Appendix 7-1.

7.1.7 (c) Wastewater Flows From Large Users

Wastewater flow projections for large water users were developed based on the methodology described in Section 2. The calculations assume wastewater flows are 80% of water usage for connected large users. It is expected that the largest water users within the proposed sewer service area will eventually be connected to the wastewater system. Wastewater flows from large water users are assumed to grow at the same rate as the Town population. Actual water use records provided by MIKUTRA, from which wastewater flow estimates were derived, may be inaccurate because many existing water meters are old and expected to be under recording flows. Additional allotments for wastewater flows from other large water users and market day demands have been assumed. Detailed tables of wastewater flows and projections from large water users are presented in Appendix 7-1.

7.1.7 (d) Projected Wastewater Flow

Table 7-5 presents a summary of existing and projected wastewater flow for the study period. Per capita flow is expected to rise with an anticipated growth of population in medium and high income categories. It should

be noted that these wastewater flow projections are based on a variety of assumptions and should be revisited and revised as appropriate during preliminary design when new data is available.

Table 7-5. Migori Existing and Projected Wastewater Flows

	Initial (2006)	Future (2015)	Ultimate (2025)
Wastewater Flow (m^3/d)	N/A	4,100	7,400
Per Capita Wastewater Flow (lpcd)*	N/A	59	69

** Per person served. Aggregate value including individual domestic connections, large users, and public toilets/latrines.*

7.2 Water

7.2.1 Water System Overview

Residents of Migori get their water from a variety of sources. Residents obtain water by direct abstraction from one of the streams in town including: the Migori River, Nyasare River, Oyani River, and their tributaries; springs; water vendors; rainwater harvesting; shallow wells; community boreholes with hand pumps; or bottled water. About 20% of the Migori population is expected to receive water from one of two piped water distribution networks in town, although per capita use from piped water supplies is expected to be low (< 25 lpcd).

The piped networks include Migori Water Supply (production ~450 m^3/d) operated by MIKUTRA, and the Nyasare Water Supply Association (NWSA) community-based water supply (production ~200 m^3/d). In general, the MIKUTRA system provides water to a limited area along the Administration Road and the A1 road in the central business district, mostly south of the Migori River. The NWSA system provides water to residents northwest of the central business district and along the A1 road north of the Migori River. Unaccounted for water associated with these two distribution networks is expected to be in excess of 50%, although metering data is not available for the Migori Water Supply system.

Other local water sources include several private and institutional boreholes which produce an estimated total of 50 m^3/hr (Table 7-6). Assuming the private and institutional boreholes are able to produce water 25% of the time due to power outages, the total estimated present capacity of Migori Water Supply, NWSA, and the known private boreholes in town is less than 900 m^3/d (Table 7-7). No water quality information is available, but MIKUTRA expects that water from boreholes in Migori is "generally good for human consumption".

Table 7-6. Migori Private and Institutional Borehole Capacity

Private / Institutional Borehole	Reported Production Capacity (m^3/hr)
Prinsal Enterprises, Ltd. Fish Factory	16.3
Maranatha Mission Hospital	1.5
Migori Boys School	0.5
Migori Teachers College	12.0
St. Joseph's (Ombo) Mission Hospital #1	6.2
St. Joseph's (Ombo) Mission Hospital #2	6.2
District Hospital	5.0
Pastor Machage Hospital	1.7
J.H. Okwanyo	1.2
TOTAL	**50.4**

Table 7-7. Migori Estimated Total Water Production from Various Sources

Source	Estimated Total Production (m^3/d)
MIKUTRA Boreholes	450
NWSA Springs	200
Known Private & Institutional Boreholes Combined*	303
TOTAL	**953**

**Assumes 35.9 m^3/hr total capacity, operating 6 hours per day (25% of time due to reported frequent power outages)*

According to MIKUTRA, the Migori Water Supply system produced approximately 450 m^3/d in 2004 and 2005 and provided water to about 10,000 people. Official reporting forms (Migori 2005 Annual Report Draft Tables) indicate an implicit 16% UfW, but MIKUTRA staff estimated UfW at 67% on an initial data gathering survey for this study. UfW estimates are unverifiable due to a lack of calibrated master and very few consumer meters. However, assuming 50% UfW, which is typical for systems in the region, per capita consumption is 23 lpcd. The Migori Water Supply System does not have any water kiosks.

According to the Nyasare Water Supply Association, the system produced approximately 200 m^3/d in 2004 and 2005 and provided water to around 15,000 people with 51% UfW. This results in an estimated per capita water use of only 7 lpcd, presumably because most NWSA customers obtain water from water kiosks, not individual connections.

Overall, it can reasonably be assumed that per capita water consumption from individual piped water connections or communal drawing points in Migori is currently less than 25 lpcd. Assuming a total present population of approximately 120,000, then 20% of residents in Migori have the benefit of access to a piped water supply (including kiosks), although many people are apparently getting by with very limited quantities of water.

According to local officials, as a result of poor water quality and limited quantity, "people are dying" and there is an urgent need for improved water service provision.[20] The present water service provision situation

represents a public health crisis. According to Town officials, a large percentage of the municipal budget is used for purchasing bottled water for residents.[21]

In general, current service provision of water supply in Migori is inadequate. New, larger supply sources are required and most of the existing water supply infrastructure needs upgrading or replacement. The largest existing water mains are 110 mm (4") diameter, which is inadequate for large-scale water service provision in a municipality of this size.

7.2.2 Water Sources and Intakes

7.2.2 (a) Water Sources and Intakes Description

Non-Piped Sources

Most residents in Migori obtain water from a variety of non-piped sources as noted above including streams, springs, water vendors, rainwater harvesting, shallow wells, community boreholes with hand pumps, and bottled water. Although water quality information is not available, most major surface water bodies in Migori, including the Migori River, are expected to be unsafe for human consumption due to chemical and bacteriological contamination. A number of private boreholes provide water to businesses and institutions as listed in Table 7-6. Photos of these sources are depicted in the figures on the following pages.

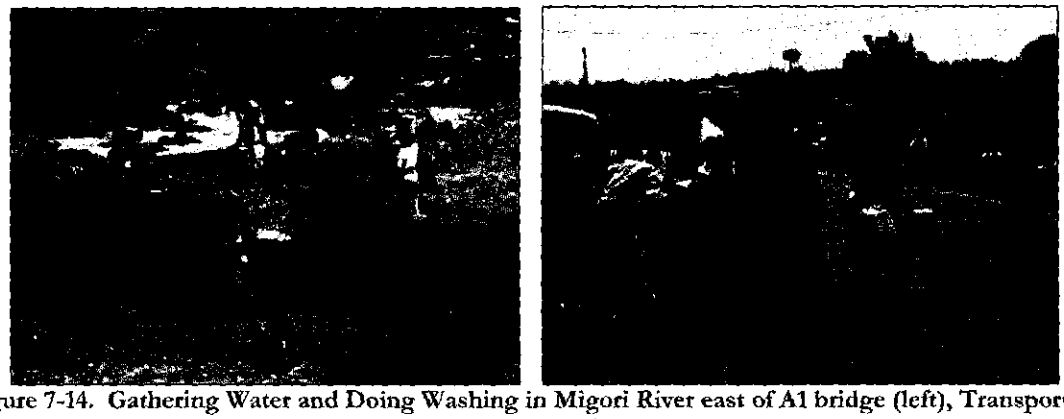

Figure 7-14. Gathering Water and Doing Washing in Migori River east of A1 bridge (left), Transporting jerrycans of Water by Bicycle (right)

Figure 7-15. Migori River adjacent to Migori Open Market West of A1 Bridge

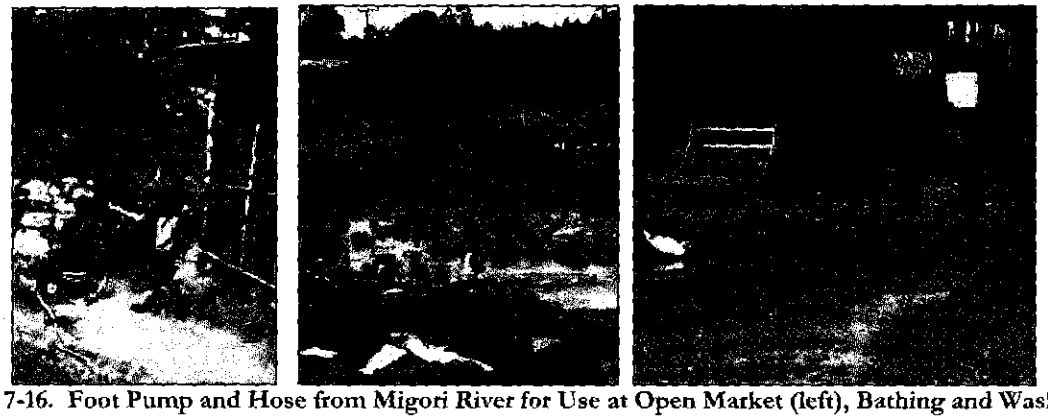

Figure 7-16. Foot Pump and Hose from Migori River for Use at Open Market (left), Bathing and Washing in Migori River near Open Market (center), Boy Carrying Water from Migori River near Open Market (right)

Figure 7-17. Cistern and Foot Pump Formerly Serving Migori Open Market with Water from Migori Water Supply, Currently Dry

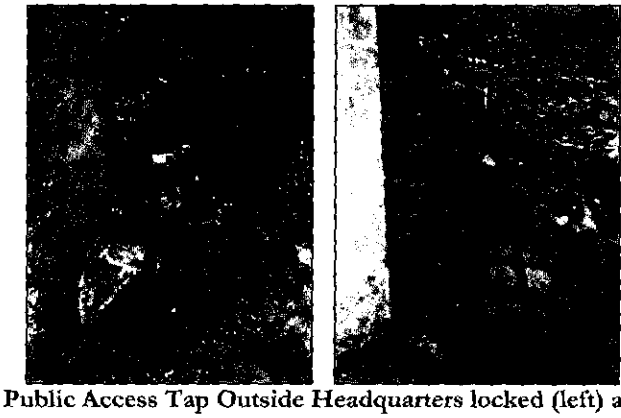

Figure 7-18. NWSA Public Access Tap Outside Headquarters locked (left) and unlocked (right)

Figure 7-19. Vendors Utilize Hand Carts and Trucks to Fill Containers at NWSA Public Access Tap

Figure 7-20. Rainwater Harvesting System at St. Joseph's Mission Hospital supplements supplies from a borehole on-site

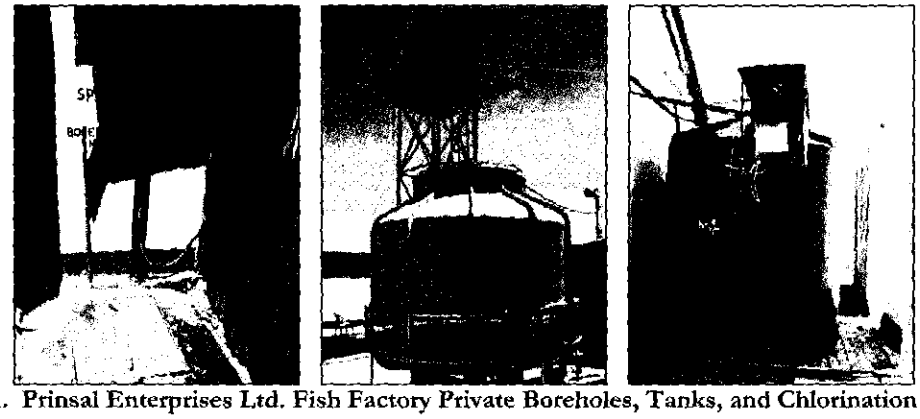

Figure 7-21. Prinsal Enterprises Ltd. Fish Factory Private Boreholes, Tanks, and Chlorination Equipment

Migori Water Supply

The MIKUTRA-operated Migori Water Supply provides water to a distribution network from boreholes drilled primarily along the banks of the Migori River. Fourteen boreholes exist in the system, constructed with funding from the Ministry of Water Resources, JICA, and the El Nino Environmental Programme (ENEP). Four of the boreholes were constructed as part of ENEP and were intended to replace adjacent low-production boreholes installed by the Ministry. Two boreholes have been added in the past year, referred to as the 'Tree Nursery' borehole and the 'New' borehole.

As of January 2007, only three boreholes were functional: Ministry Boreholes Number 3 and 4 and the Tree Nursery borehole. The New borehole has not yet been tested but is expected to come on-line soon. Ministry Borehole 3 and the New and Tree Nursery boreholes are all located on the east side of the Migori River, within approximately 100 to 200 meters of the River. They are all located close to the central business district (within 1 km) and are generally situated across the river from Migori Teacher's College and Migori Secondary School. Ministry Borehole 4 (Figure 7-22 and Figure 7-23) is located on the west side of the Migori River near Migori Secondary School, also within approximately 100 to 200 meters of the River and less than 1 km from the central business district. Ministry Borehole Number 5, located near Migori Teacher's College several hundred meters south of Ministry Borehole 4, was abandoned within the past few years due to suspected contamination from failing wastewater disposal systems at the college.

Based on estimates from different sources, the capacity of Ministry Boreholes 3 and 4 are between 10 and 20 m^3/hr each. The Tree Nursery borehole is reportedly able to produce 10 m^3/hr. Voltage fluctuations and blackouts, water level fluctuations, and a lack of sufficient storage capacity prevent the pumps from being able to run continuously. The wells generally operate less than 12 hours per day, possibly less than 6 hours per day. None of the boreholes have sampling ports installed and recent water quality information is not available. Groundwater depths in Migori range from 50 m to 100 m for confined aquifers, or 5 m to 15 m for unconfined aquifers hydraulically connected to surface water supplies such as the Migori River.[22]

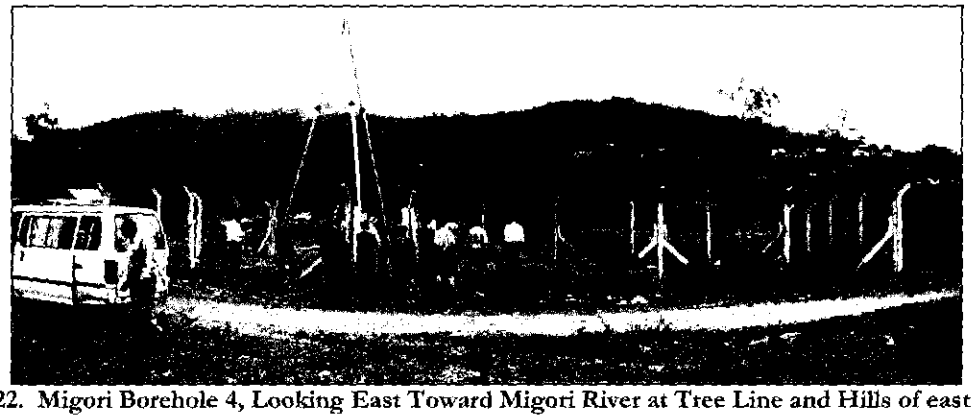

Figure 7-22. Migori Borehole 4, Looking East Toward Migori River at Tree Line and Hills of east Migori in Background

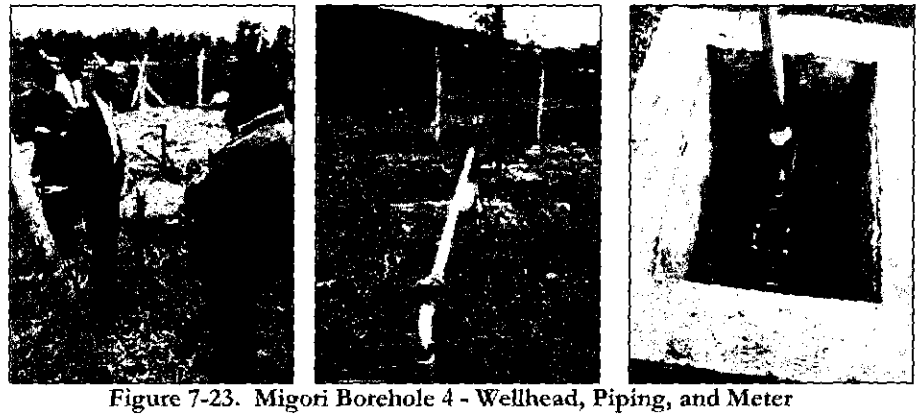

Figure 7-23. Migori Borehole 4 - Wellhead, Piping, and Meter

Nyasare Water Supply Association

The Nyasare Water Supply Association (NWSA) community-based water supply system obtains water from a network of developed springs in the upper reaches of the Nyasare river watershed, approximately 8 km north of the town center. Water from seven individual spring collectors is routed to a central collector manhole. From the central collector, water flows by gravity to storage tanks located approximately 2.5 km north of the town center along the A1 road at the NWSA headquarters. The System was constructed in 1994 with funds provided by the Austrian Government.

When the system was constructed, the area around the springs was largely undeveloped. However, squatters have settled throughout the area and established homes and small farms growing tobacco, sugar cane, and maize. The original design capacity of this spring was reportedly 350 m^3/d but by the year 2000 the available withdrawal had been reduced to 230 m^3/d. According to data provided by NWSA, in 2004 and 2005 the system produced an average of 200 m^3/d and averaged approximately 50% unaccounted for water. According to the Nyasare Water Supply Association, "The project was initially designed to serve 10,000 people but is now serving well over 15,000 people."[23]

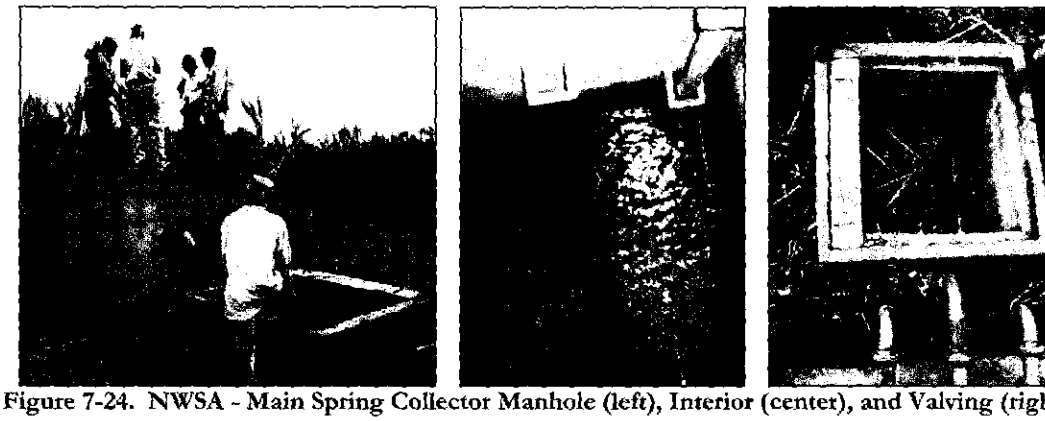

Figure 7-24. NWSA - Main Spring Collector Manhole (left), Interior (center), and Valving (right)

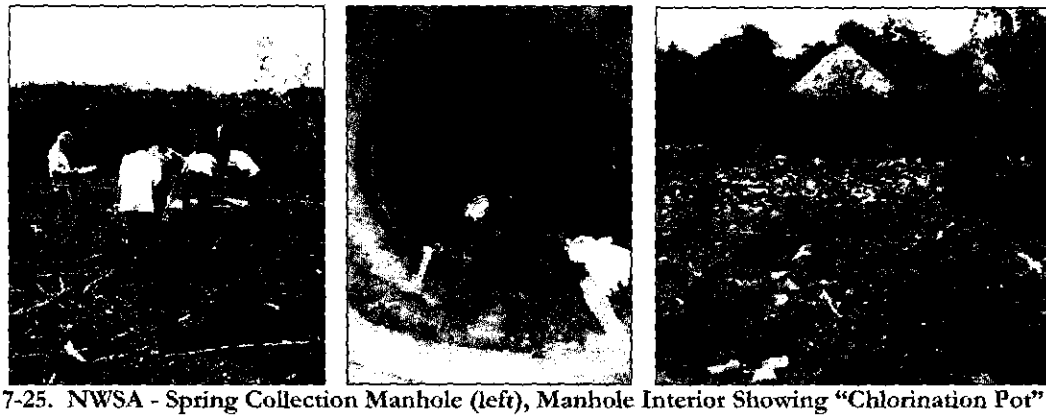

Figure 7-25. NWSA - Spring Collection Manhole (left), Manhole Interior Showing "Chlorination Pot" on Rope (center), Adjacent Squatter Homes and Tobacco Farm (right)

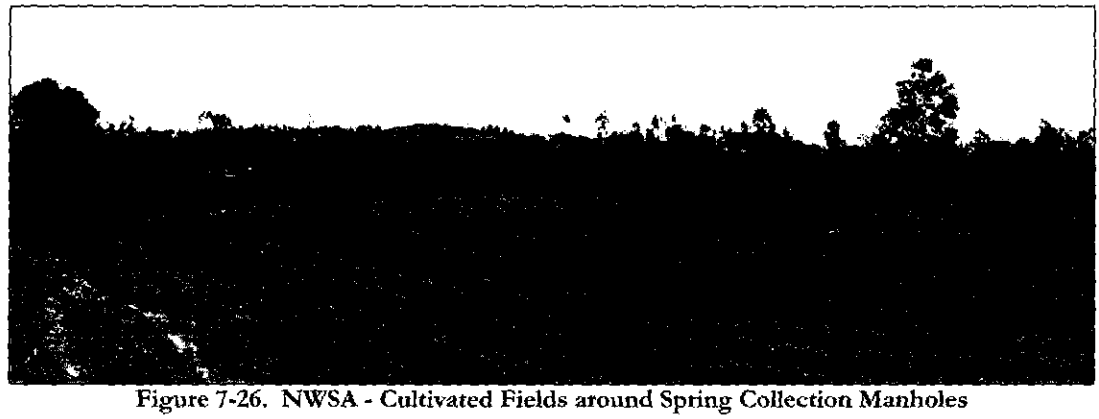

Figure 7-26. NWSA - Cultivated Fields around Spring Collection Manholes

7.2.2 (b) Water Sources and Intakes Needs

Migori Water Supply System

The existing Migori Water Supply system is estimated to serve approximately 10,000 residents in Migori, which is about 13% of the proposed water service area population of 80,000 and about 8% of the existing town population of 124,000. As noted above, another approximately 15,000 residents are reportedly served by NWSA. The remainder of residents obtain water from a variety of sources. It is assumed for the purposes

of this study that the water service goals will be met by expansion and improvement of the Migori water supply system.

Demand in the service area is projected to reach 10,000 m^3/d by 2015 and 16,000 m^3/d by 2025. Current total water abstraction and production is less than 500 m^3/d, so an approximate twenty-fold increase in production is expected to be required by 2015. In order to meet this demand via boreholes, approximately 50 to 70 would be required by 2015, assuming each borehole is able to produce 150 to 200 m^3/d. Considering the fact that fourteen boreholes exist in the MIKUTRA system, but only three are presently operating, this infrastructure has proven difficult to maintain. A system of 50 to 70 boreholes would be extremely complex to maintain and very costly to operate, especially if generators are required to ensure they produce at their rated capacities. It is unlikely that a sufficient number of sites and groundwater capacity exists in Migori. The quality of water produced by existing boreholes is unknown, but may be compromised due to their location within the densely developed areas of town. Due to these reasons, a surface water supply source is recommended for meeting the future needs of Migori. The need for a surface water supply source has been identified by other previous studies, including a 2001 JICA Study which noted the following:

> *"Approximately sixty boreholes would be required to meet the projected water demand from groundwater. It is doubtful that the available resource can meet this demand and such a well field would be extremely complex to operate. It is therefore assumed that a surface water source will have to be developed."*[24]

Key criteria for selecting a surface water supply source include the quantity and quality of flow available, the potential for gravity flow to the main population centers, and the level of watershed protection available. The development of a surface water supply will require extensive detailed study and time. Therefore, in the meantime, MIKUTRA will need to maximize the production capacity of its existing system in order to try to meet present demands. This will need to be accomplished via a variety of required improvements to the existing system including rehabilitation of existing wells and distribution systems and adding auxiliary power, metering, storage capacity, and security improvements to prevent theft and vandalism.

Nyasare Water Supply System

The existing capacity of the spring source has decreased over time and contamination is suspected to have increased, both of which are likely due to increasing squatter encroachment and small scale agriculture. Through the Institute for International Cooperation (IIZ), the Austrian Government is considering funding a second phase of the Nyasare Water Supply Project. Additional source water protection is required and additional springs may need to be developed or a new source will need to be identified.

7.2.2 (c) Water Sources and Intakes Improvement Options

Migori Water Supply

Improvement options for water sources and intakes may be categorized into those relating to a new surface water supply source and those relating to increasing capacity of the existing system. With regard to the development of a new water supply source, six primary potential sources were identified and examined. The sources are depicted in Figure 7-27 and Figure 7-28. The advantages and disadvantages of each source are summarized in Table 7-8.

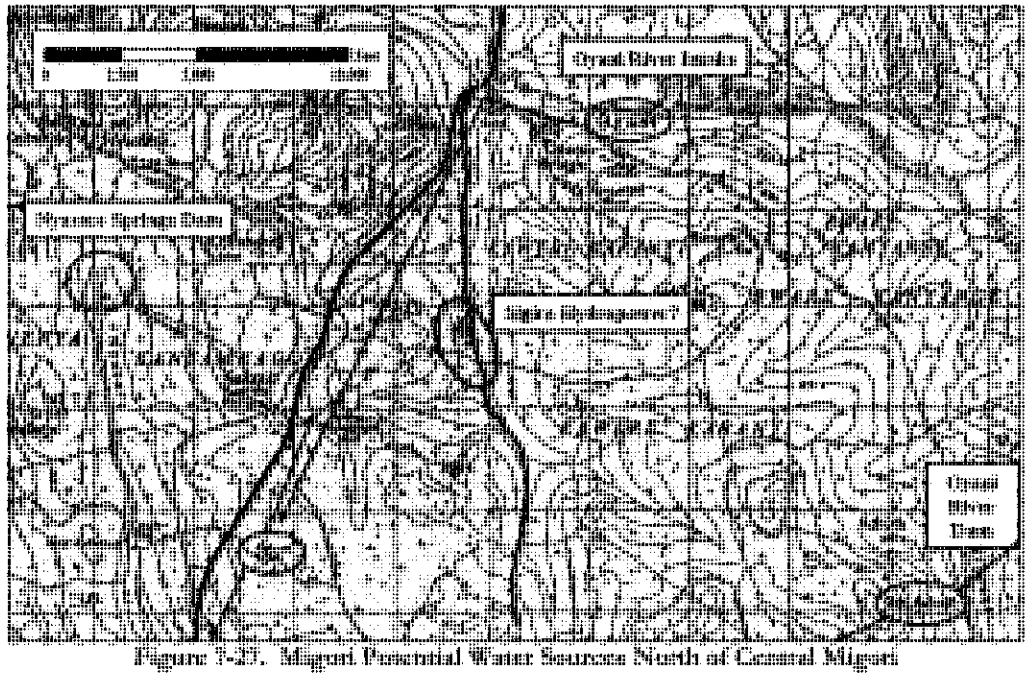

Figure 7-27. Migori Potential Water Sources North of Central Migori

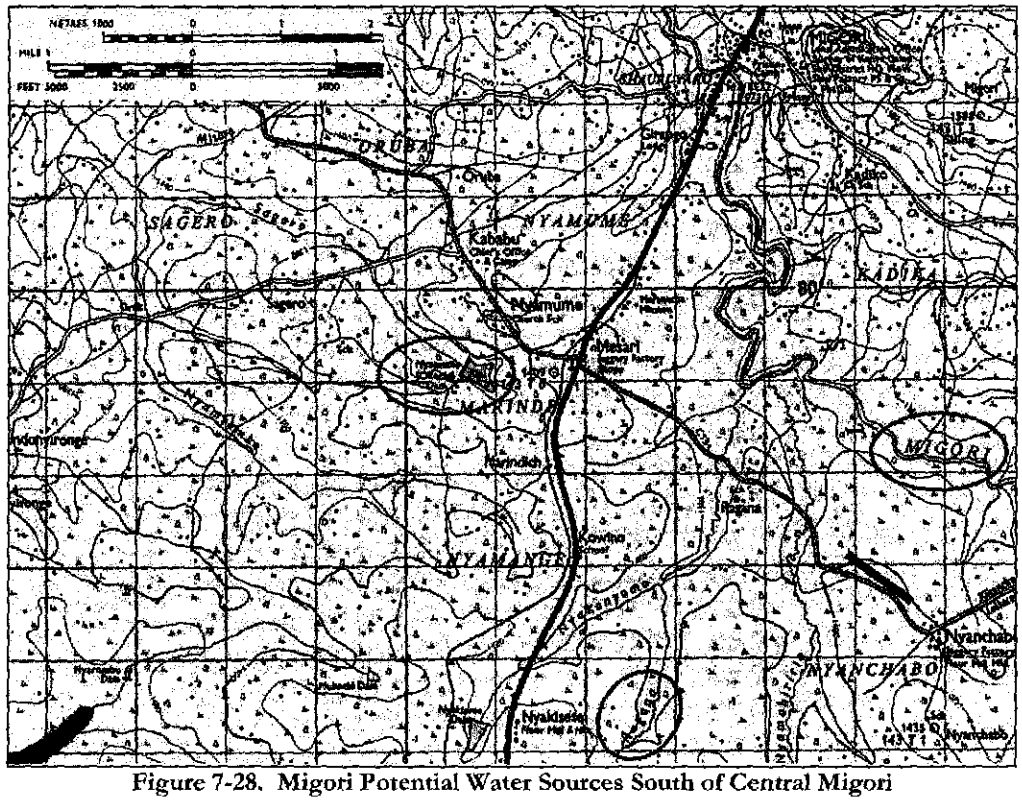

Figure 7-28. Migori Potential Water Sources South of Central Migori

Table 7-8. Potential Future MIKUTRA Surface Water Supplies

Source	Advantages	Disadvantages
Oyani River at Oyani Bridge	Reported low flow approximately 16,000 m^3/d sufficient to meet demands without need for a dam in near future. Development within watershed is limited. Three phase power available at site. Access to main A1 road available. Cross country water mains not required. Potential hydropower on Oyani or Sigira Stream tributary.	Some farming activities in watershed. Pumping required to transport water over hill at Kakrao to Town (120 to 140 m elevation difference). Proposed site ~10 km from town center.
Dam on Oyani River at Kakremba	Source thought to be well protected in upper reaches of river. Potentially favorable stream morphology, hydropower potential.	Requires ~16 km pipeline along roadways in uncertain and likely poor condition with multiple stream crossings. Some cross country mains may be required. Intake elevation ~1,460 m must be pumped to ~1,600 m at Got Kachola. High cost associated with dam construction, environmental impact mitigation. Location higher in watershed will result in lower flows than at Oyani Bridge. Roadway and bridges improvements may be required.
Dam at Nyasare Springs	Potential gravity flow to town.	Springs area is densely developed by squatters with small farms, resulting in expected degradation of water quality. Yield from existing spring boxes has declined from 350 m^3/d in 1994 to 200 m^3/d; sufficient flow may not be available, MIKUTRA noted Nyasare River low flow ~1,100 m^3/d. Dam cost in this area expected to be high due to lack of narrow ravine; construction may be infeasible. Approximately 4 km of cross country mains required.
Ragana River south of C13 Road in Ragana	Limited pumping required. Close to major roadways.	Requires pumping. Over 5 km from town center. Low flows insufficient to meet demands; MIKUTRA noted low flow < 1,000 m^3/d. Water quality reportedly poor due to poor roadway drainage systems in area and high levels of erosion.
Migori River upstream of town center	Potential gravity flow to town.	Minimal slope would require very large diameter main to overcome frictional losses for gravity transmission. Poor water quality due to extensive development in watershed. Large flow variability. MIKUTRA noted low flow < 3,000 m^3/d, insufficient to meet demands. Limited access to major roadways.
Existing Dam at Nyamume (Okechi)	Pre-existing infrastructure. Close to major roadways.	Limited catchment area results in low water availability, expected to be insufficient to meet demand. Existing reservoir reportedly heavily silted. Currently used for watering livestock.

MIKUTRA staff have indicated that their preference is for the Oyani River as a source, with intake at Oyani Bridge, which is approximately ½ km upstream of the A1 road bridge. This option requires pumping from the proposed intake at Oyani Bridge over the hill at Kakrao, which is 120 to 140 meters higher in elevation. Hydropower available from the Oyani River or Sigira Stream near the intake or on the Oyani at Gogo Dam may be able to provide some of the pumping power requirements. If this option is selected, source water protection measures will need to be enacted as soon as possible to prevent degradation of water quality in the watershed and water treatment will be required and a site is available at Kakrao. According to MIKUTRA, the watershed upstream of Oyani Bridge has a population of approximately 5,000 within a 4 km^2 area. The area contains tobacco farms, some livestock operations, and tree nurseries. MIKUTRA has indicated that the

proposed intake location is privately owned by the late Tobias Okiro (survived by six sons) but that it may be available for purchase. A tree nursery is currently adjacent to the proposed intake site. Land upstream of the intake may possibly be purchased to set aside source protection area, although it is privately owned and squatters are presently living on the land. A farm institute and agricultural office exists upstream of the proposed intake and it may be possible to work with these entities regarding best management practices and public education. Photos of this potential source are included in Figure 7-29, Figure 7-30, and Figure 7-54.

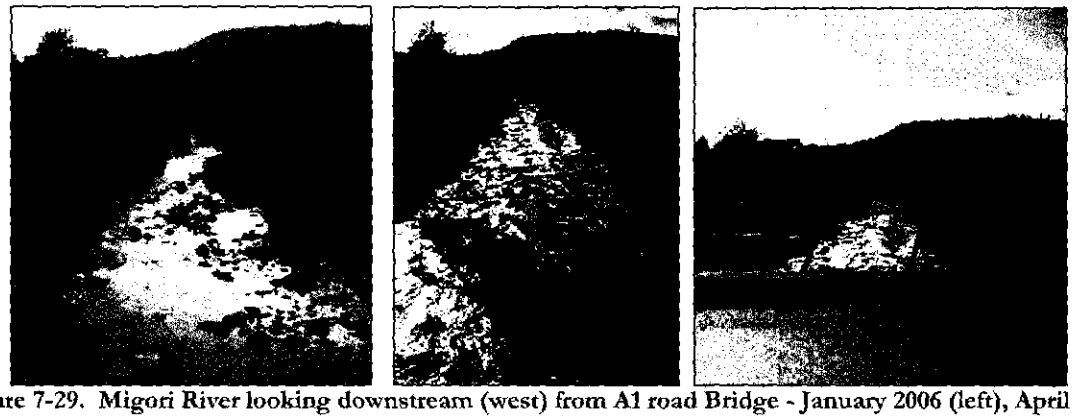

Figure 7-29. Migori River looking downstream (west) from A1 road Bridge - January 2006 (left), April 2006 (center, right)

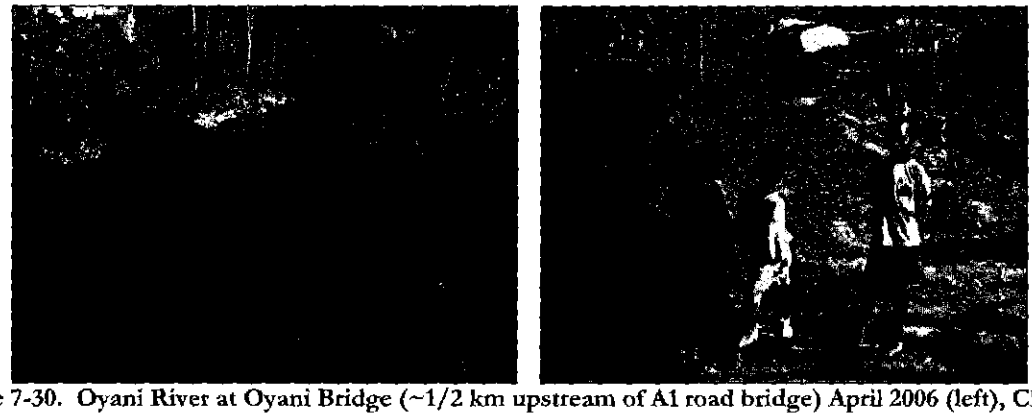

Figure 7-30. Oyani River at Oyani Bridge (~1/2 km upstream of A1 road bridge) April 2006 (left), Children and Homes Near Oyani Bridge (right)

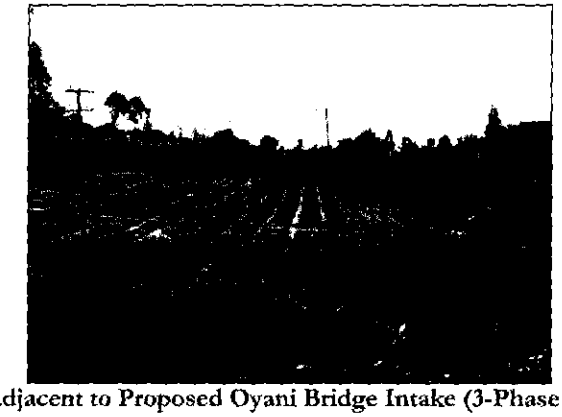

Figure 7-31. Tree Nursery adjacent to Proposed Oyani Bridge Intake (3-Phase overhead power lines visible)

In order to increase the capacity of the existing water system, an assessment of the existing boreholes is required in the interest of assessing which ones may be cost-effectively rehabilitated and re-commissioned.

Existing studies and information from MIKUTRA present sometimes conflicting information regarding the status of existing boreholes. In addition, auxiliary power is required at existing boreholes to ensure they are able to maximize production. Other wellhead improvements are required including sampling ports, calibrated master meters, and security. Source water protection programs are also required to restrict activities within the zone of influence of the boreholes in order to maintain raw water quality.

Nyasare Water Supply System

The IIZ was reportedly considering one of two options to increase the capacity of the system. One option is to develop additional springs (NWSA's preferred option), the other is the construction of a dam on the Oyani River to retain 500,000 m^3 along with the construction of a slow sand filtration treatment facility. The association is investigating acquiring/taking land around the springs to prevent farming and contamination from pesticides/fertilizers.[25] NWSA has noted that it is considering incorporating its system into the MIKUTRA system in order to create one viable water service provider in Migori. The status of any present activities in this regard is unknown.

7.2.2 (d) Water Sources and Intakes Recommendations

Based on available information, the recommended option for augmenting water supplies to meet future demands in Migori is through surface water abstraction. Based on the potential sources identified, an intake and pumping station should be constructed on the Oyani River near Oyani Bridge, if shown to be the preferred in subsequent detailed studies. Although up-front costs associated with the recommended option will be high, it is the best option for reliably producing a large supply of high quality water during all seasons. Until this new source is developed, upgrades to the existing boreholes are required to increase water production. Recommendations for sources and intakes and estimated costs and phasing are included in the detailed matrices (Appendix 7-2). Recommended activities include, but are not limited to the following:

- Ensure that all functioning boreholes have a **calibrated flow meter, sampling tap, dipper tubes, pressure gauges, and non-return valves**.
- **Evaluate all boreholes** including present capacity and water quality to determine potential and cost for re-commissioning. Analysis should consider the fact that boreholes will eventually be replaced by a surface water source. Evaluation should consider if either Ministry Borehole 3 or adjacent ENEP Borehole 3 should be primarily utilized, depending on which has greater yield, with the other to serve as standby. The same analysis should be performed for Ministry and ENEP Borehole 4. Consider re-commissioning of Ministry Borehole 5 after upgrades to Migori Teacher's Training College wastewater system. Consider JICA 2001 (Sec. 4.3) and UN-Habitat 2004 (Sec. 5.3, Rec 1.1) recommendations for boreholes. It is expected that Ministry Boreholes 1,2,7,8 and ENEP 1 and 2 are not viable.
- **Based on evaluation, re-commission viable boreholes** and **properly decommission all unviable boreholes** to prevent contamination of aquifer.
- Install **auxiliary power diesel generators for viable boreholes** after detailed evaluation of optimal size and location of generators, ensuring they serve multiple boreholes where possible.
- Obtain all available **historic flow data** for the Oyani River and other potential source streams from the Water Resources Management Authority (WRMA).
- Clarify **permitted abstraction volumes, ownership of permits, and present status** for Oyani River and other sources; clarify potential for increased abstraction.
- Establish **flow and water quality monitoring station** on the Oyani River to gather data required for application for intake per Government of Kenya regulations.
- Conduct **detailed study including preliminary design and cost estimation to compare available options and confirm Oyani River is best option for source augmentation**. Include evaluation of option to site intake on Oyani River near Oyani Bridge tree nursery with pumped raw

water to a new treatment facility adjacent to Kakrao school, followed by gravity flow to town. Study should include analysis of quantity and quality data for Oyani River as required by GOK, and a watershed sanitary survey. Treatment and distribution studies are included as separate tasks, but expected service areas and elevations must be considered simultaneously.

- **Evaluate electrical power options and costs.** Determine status and reliability of three phase power available at Oyani Bridge. Consider hydropower to provide a portion of pumping power requirements, possibly utilizing Sigira stream (tributary to Oyani) or Oyani itself. Begin monitoring flow in Sigira stream. Determine status of Gogo Dam generating station, if excess capacity exists, or if capacity may be added. Consider a biomass gasification plant using sugar cane waste or other locally available organic materials. Detailed ground survey or accurate leveling measurements are required as part of this task to evaluate feasibility.
- Undertake **source protection measures** for Oyani River watershed including watershed delineation, water quality threat assessment, development of a watershed management program including farming best management practices, and consideration of land purchase for watershed protection. Also implement source protection measures at existing borehole sites including security fencing and restricting activities within zone of influence. Develop public education programs regarding source water protection and conservation.
- If determined to be preferred option, **construct intake and pump station at Oyani River with raw water pressure pipeline** to treatment facility, expected at Kakrao school. Expansion of the intake, pumping system, and pipeline capacity will be needed in the future.

7.2.3 Water Treatment

7.2.3 (a) Water Treatment Description

The boreholes on the east side of the Migori River (Borehole 3, Tree Nursery Borehole, New Borehole) pump to a storage facility on Kadika Hill, several hundred meters south of the MIKUTRA offices. An existing calcium hypochlorite feed system is located at the storage site but the unit is old (constructed ~1950s) and dosing is arbitrary and may not be in use. Boreholes on the west side of the river (currently only Borehole 4) pump directly into the distribution network without treatment. No pH adjustment is performed although anecdotal information suggests the groundwater is aggressive and is having detrimental affects on distribution system components.

7.2.3 (b) Water Treatment Needs

Hypochlorite disinfection and pH adjustment using soda ash or lime may be required at the existing storage facility as well as for the wells on the west side of river which pump directly into the distribution system. The most recent water quality data available is from the 1970s and is insufficient for determining disinfection and treatment requirements. The original chemical feed tanks at the waterworks sites are assumed to have surpassed their expected lifetimes and should be replaced. Sizing of required equipment should be determined based on flows and water quality analysis from existing and recommissioned boreholes.

Required treatment equipment for the existing and recommissioned boreholes is expected to include new chlorine contact and dosing equipment as well as pH adjustment. On the west side of the river it is expected that treatment could occur at a new storage tank facility prior to entering the distribution system. On the east side of the river, treatment should occur at the existing storage site. New storage and treatment facilities should be designed to be able to function effectively as part of the expanded distribution system constructed after the new surface water supply source is developed.

Treatment will be required for the proposed new surface water source. Conventional treatment utilizing proven technologies (coagulation, flocculation, sedimentation, filtration, and disinfection) is recommended. Available land has been identified adjacent to Kakrao School. Sufficient land appears to be available at the site and its elevation would allow for gravity flow into the distribution network. Detailed requirements for treatment will be determined in subsequent detailed studies depending on raw water quality and actual available land area.

Figure 7-32. Proposed Treatment Site Adjacent to Kakrao School

7.2.3 (c) Water Treatment Recommendations

Detailed recommendations for water treatment and estimated costs and phasing are included in the detailed matrices (Appendix 7-2). Recommendations include, but are not limited to, the following:

- Perform **updated water quality testing and evaluation of existing equipment to evaluate need for new borehole chlorination, pH adjustment**. Develop plan to meet immediate chlorination and pH adjustment needs, keeping in mind that a major system overhaul with new treatment facility is likely, rendering some measures temporary. Include all existing wells, wells proposed to be re-commissioned, and the two new wells.
- **Replace existing calcium hypochlorite feed system** at Kadika Hill tank site for east side boreholes and **install new chlorine contact system** for west side boreholes. Also **add pH adjustment** if required. Install additional pumping, pipe work, as required.
- Conduct **study for constructing new water treatment facility**. Estimate costs, determine permitting requirements, and develop preliminary design. Include recommendations for laboratory to be located at the treatment facility.
- **Design and Construct treatment facility** on available land near Kakrao School (if selected site) with capacity for 2015 demand and expansion capability to 2025 expected demand. Include laboratory facilities.

7.2.4 Water Distribution

7.2.4 (a) Water Distribution Description

7.2.4 (a) 1. Service Area

An approximation of the existing extent of the MIKUTRA water distribution network and the NWSA water distribution network is depicted in Figure 7-33. The focus of this section is on the MIKUTRA water distribution network although reference is made to the NWSA system were relevant. In general, the MIKUTRA system provides water via water mains along the Administration Road and along the A1 road

from near Migori Stadium north of the Migori River heading southwest through the central business district to just past the Migori Teachers Training College. The NWSA system provides water to residents northwest of the central business district and along the A1 road north of the Migori River.

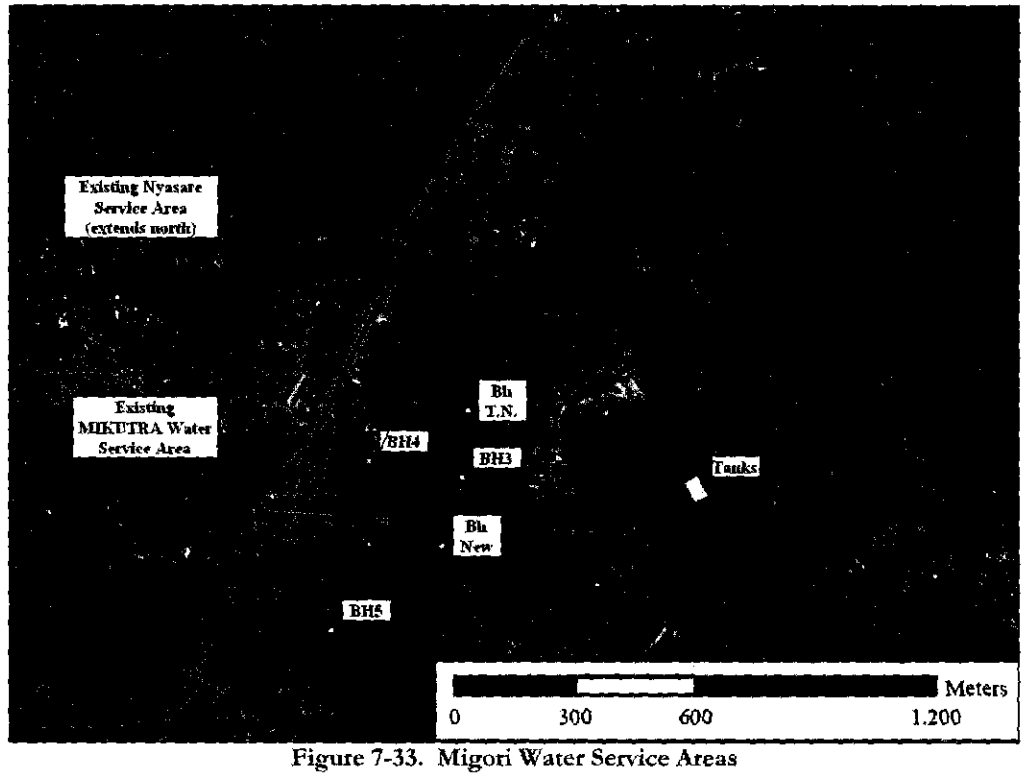

Figure 7-33. Migori Water Service Areas

The Migori water supply distribution system was constructed in 1981 and currently supplies water from three boreholes.[26] Water from Borehole 3 and the Tree Nursery Well on the east side of the Migori River is pumped to a storage facility at Kadika Hill. From the storage facility, water flows by gravity into the distribution system via an 80 mm (3") galvanized steel main, which transitions to a 50 mm (2") asbestos cement, then galvanized steel main which runs north to just southeast of Migori Stadium where it enters a break pressure tank at Ora estate. From the break pressure tank, water flows into an 80 mm (3") galvanized steel main, which transitions to a 50 mm (2") galvanized steel main along the A1 road. A 1.4 km section of the piping between the main storage facility and the break pressure tank was replaced with 110 mm (4 in) uPVC water main.[27] The entire distribution network is estimated to contain approximately less than 10 km of water mains (probably ~ 4 km).

The exact number of water service connections and consumer meters is unclear. For the purposes of this report, it is assumed that there are approximately 600 water service connections and that less than 200 are metered. Previous reports and estimates vary widely (Table 7-9). According to information provided by the Migori District Water Office in January 2006, there were 623 connections, of which approximately 100 are metered. According to information provided by MIKUTRA in August 2006, there are 538 active connections (197 of which are metered), 367 disconnected connections, 58 vacated connections, and 171 connections where water does not reach, for a total of 1,134 connections. According to UN-Habitat (2004) there are a total of 847 connections, of which 248 are metered. According to JICA (2001) there are 577 connections, of which 34 are metered. According to the Migori Water Supply Annual Report for 2005, there were 577 connections at the end of 2005. According to the Ministry of Water and Irrigation's Migori District Annual Report (2004), there were 406 water connections in 2004.[28] According to the MIKUTRA Water Service Provision Agreement (2006) there are 164 metered connections.

Table 7-9. Migori Water Supply Estimated Water Service Connections and Meters

Source	Number of Active Connections	Number of Metered Connections
Migori District Water Office (2006)	623	100
MIKUTRA (2006)	538	197
UN-Habitat (2004)	847	248
JICA (2001)	577	34
Migori Water Supply Annual Report (2005)	577	N/A
MWI Migori District Annual Report (2004)	406	N/A
MIKUTRA SPA (2006)	N/A	164
FEASIBILITY STUDY ASSUMPTION	**~600**	**< 200**

7.2.4 (a) 2. Pressure Zones and Pumping

The Migori water supply system is comprised of two pressure zones, separated by a break pressure tank near the stadium at Ora estate. Elevations in the supply system vary from approximately 4,800' (1,463 m) at the highest elevation (Kadika storage site) to approximately 4,425' (1,349 m) at the lowest elevation in the distribution system. The break pressure tank is located at approximately 4,650' (1,417 m). Other than the pumps at each borehole, there is no additional booster pumping in the system.

7.2.4 (a) 3. Storage

The Migori water supply system currently has the following water storage tanks according to information provided by MIKUTRA in August 2006:

- 100 m^3 and 136 m^3 masonry tanks at main storage site on Kadika Hill
- Two 50 m^3 masonry balancing and break pressure tanks at Ora estate
- 15 m^3 and 23 m^3 elevated plastic tanks at Migori Teachers College
- Old steel elevated tank at market (6 m^3, no longer in use)

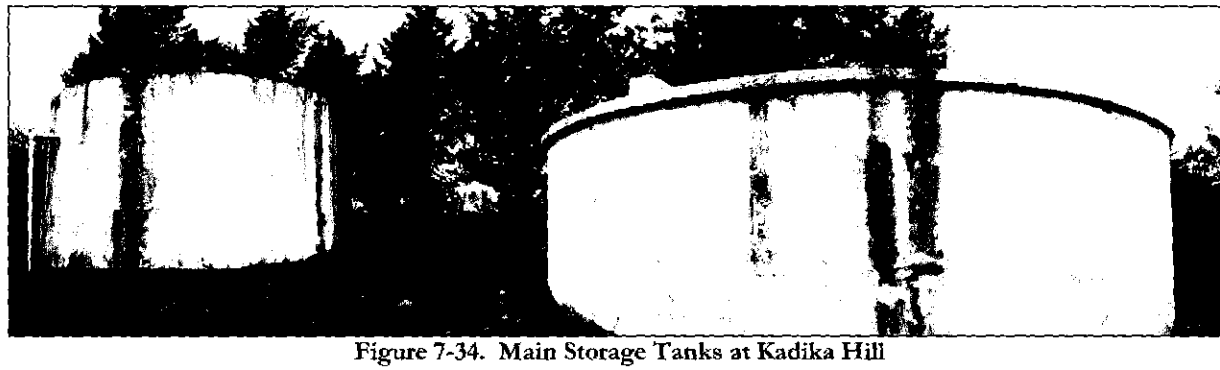

Figure 7-34. Main Storage Tanks at Kadika Hill

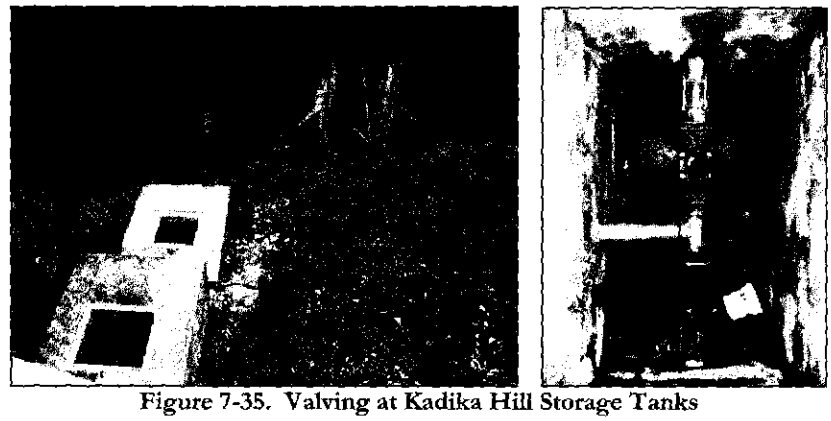

Figure 7-35. Valving at Kadika Hill Storage Tanks

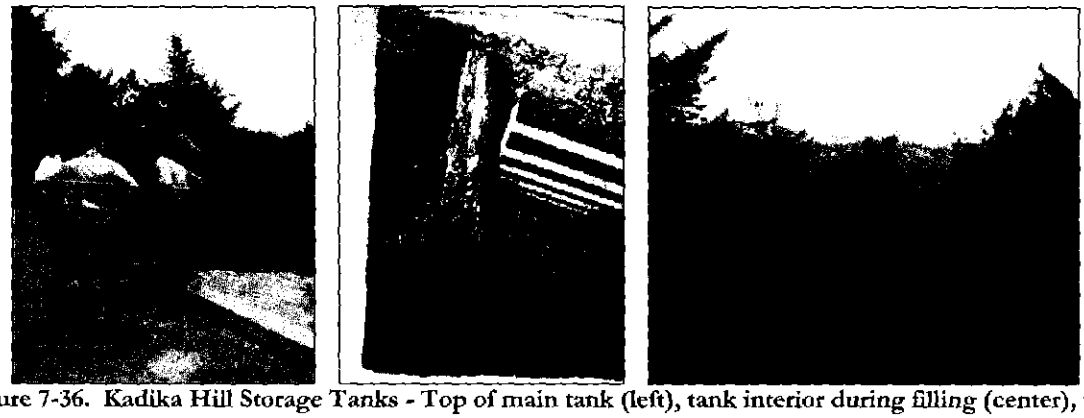

Figure 7-36. Kadika Hill Storage Tanks - Top of main tank (left), tank interior during filling (center), view from tank toward west (right)

7.2.4 (a) 4. Hydrants and Fire Protection

No fire hydrants exist in the system.

7.2.4 (a) 5. Unaccounted for Water and Metering

Unaccounted for Water

As noted above, estimates of unaccounted for water (UfW) vary from 16% to 67%. For the purposes of this study it is assumed that UfW is approximately 50%, which is similar to other systems in the region. The main reason cited by MIKUTRA for high UfW levels is the fact that most consumers are unmetered and billed a flat rate. Leakage and illegal connections may also play a role in UfW. Once meters are installed, the former District Water Officer, Mr. Njenga, noted that he expected UfW to reduce by 20% within 6 months. [29] If current UfW is 67%, a reduction in UfW to 20% would enable MIKUTRA to nearly double its present service population. Clearly, nearly doubling the number of customers served without increasing water production would have a significant impact on the health and economic well being of the town as well as MIKUTRA's revenues. Unaccounted-for-water can be more clearly identified and isolated through the collection and analysis of bulk and consumer water meter data.

Bulk Water Meters

Bulk meters are required to quantify UfW, assess system integrity, and isolate problem areas. No bulk meters are known to exist in the distribution network. Meters exist at some borehole wellheads but are expected to require calibration or replacement.

Consumer Water Meters

The number of consumer meters in the MIKUTRA system is unclear, but it is assumed that less than one third of customers are metered and that most meters are old and probably under-recording usage.

7.2.4 (a) 6. Nyasare Water Supply Distribution Description

The NWSA distribution system serves the rural consumers in the Nyasare valley and the Migori residents west of the A1 road and some residents on the east side. The system was originally designed to serve 10,000 people, but currently reportedly serves more than 15,000. The distribution system is comprised of uPVC pipes that range in diameter from 25 to 110 mm (1 to 4 in). Varying descriptions of the distribution system exist, but according to NWSA, the system consists of 320 individual house connections, 11 water kiosks, and 45 communal drawing points (standpipes) which serve rural households. All the house connections and kiosks are metered. The water produced at the springs is measured via a bulk meter.[30] The NWSA system has two 100 m^3 reinforced concrete tanks for storage at its main headquarters near Onyalo. Reported UfW from in the NWSA system is 51%, which is likely attributable to water use at unmetered communal drawing points. During the Project Team's visit to the NWSA headquarters, water vendors were observed taking free water from a NWSA communal drawing point for sale in town.

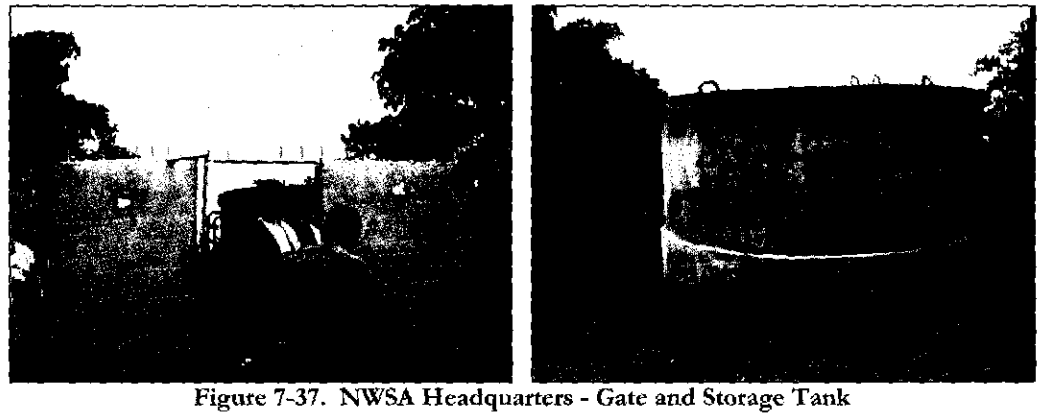

Figure 7-37. NWSA Headquarters - Gate and Storage Tank

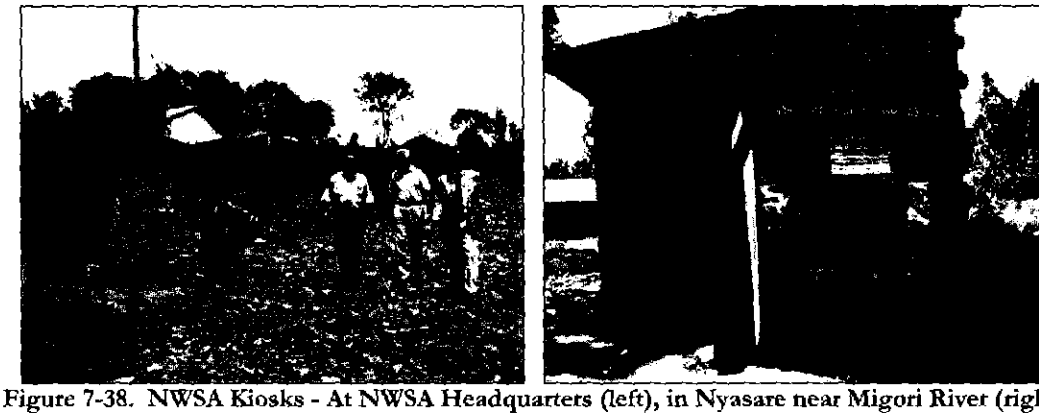

Figure 7-38. NWSA Kiosks - At NWSA Headquarters (left), in Nyasare near Migori River (right)

7.2.4 (b) Water Distribution Needs

As noted above, current UfW in the distribution network is expected to be 50% or more. MIKUTRA estimates UfW is 67%. If this percentage were immediately reduced to 20% or less, the number of people MIKUTRA can serve would double and revenues would increase dramatically. Expected sources of UfW are high water use at unmetered connections, leaks, and illegal connections. It is likely that some reportedly non-active connections are actually still receiving water. Most active connections do not have water meters installed and therefore have no incentive to curb excessive water use. Flat rate connections are expected to be used to supply water to a number of households. All illegal connections should be eliminated or registered and metered. Meters should be installed at all presently flat rate (unmetered) connections. Reduction of UfW should be a main and immediate priority for MIKUTRA.

There is a comprehensive lack of knowledge regarding water production and losses in the existing system and the number of customers and meters in the system.

Major upgrades and expansion of the existing system are required to meet future demands. Based on population density mapping prepared by JICA and satellite imagery available from UN-Habitat, a proposed service area has been developed (Figure 7-39) which presently contains about 80,000 residents and is expected to double in population during the study period. In general, the proposed service area includes the central business district, west of A1 to the densely populated portions of Oruba hill, south along the A1 road to the intersection with the C14 road in Mesari, southeast on the Administration road beyond the existing extent of the system into the densest development area in Kadika, and north along the A1 road to or past Onyalo. Some overlap with the existing NWSA system exists and consideration should be given to merging the two systems. The number of kilometers of water mains, number of storage tanks, and number of water service connections required for this expansion have been roughly estimated as part of this study for feasibility analysis. This effort will require thousands of water service connections and many thousands of meters of water mains. Detailed plans will need to be developed and estimates in this study re-evaluated once more detailed information is obtained.

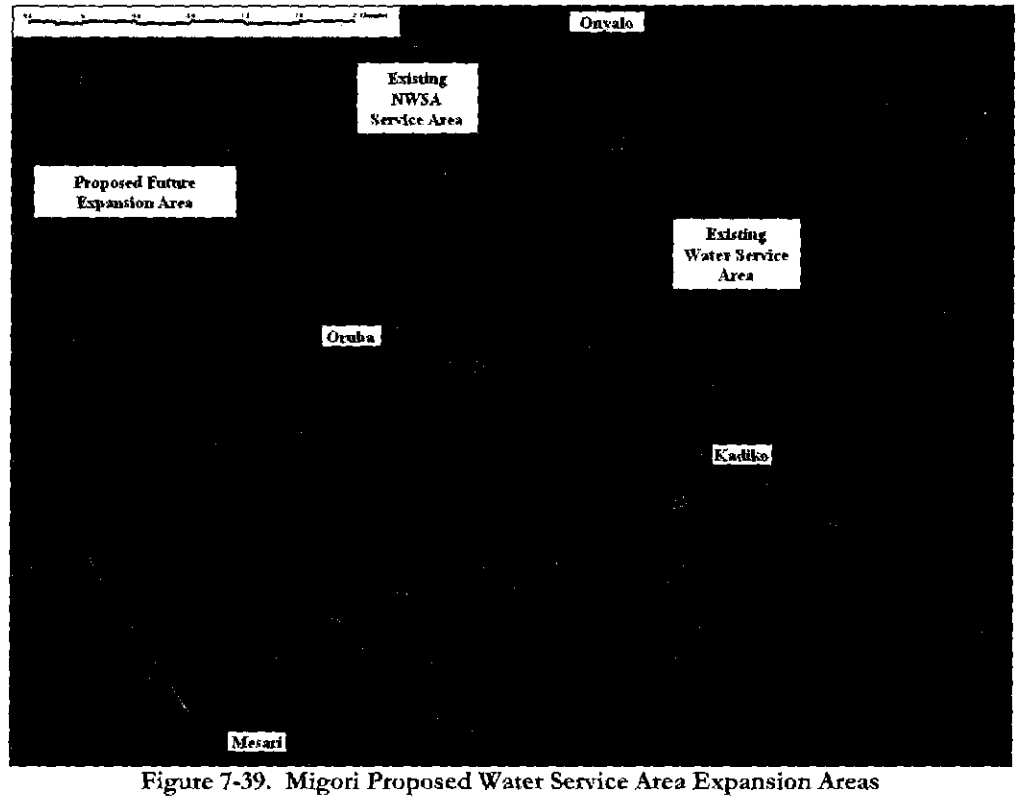

Figure 7-39. Migori Proposed Water Service Area Expansion Areas

According to the 2005 Practice Manual for Water Supply Services in Kenya (pg A 28), it is recommended that "capacity for fire fighting should not be less than 10 lps for 2 hours". It also notes that providing for piping not less than 100 mm or 150 mm in very high value commercialized areas normally ensures adequate water supply at the hydrant (pg A 116). Consideration should be given to increasing capacity/diameter of water mains and installation of hydrants to allow for fire fighting capacity.

According to the 2005 Practice Manual for Water Supply Services in Kenya, water storage volume should include balancing storage to reduce peak flows and emergency storage to safeguard against interruption of supply. Balancing storage should be 50% of the daily water demand of the area served by the tank, while emergency storage should provide water sufficient for a 12 hour supply breakdown. Therefore, assuming any 12 hour supply breakdown will require approximately 50% of daily water demand, total required storage is approximately one day's demand. Present useable storage capacity for Migori Water Supply of less than 350 m^3 is less than the present average day demand (approximately 450 m^3) and is therefore inadequate for present conditions. It has been noted that existing borehole pumps have been shut down due to inadequate storage capacity. Additional storage is required now and significant new storage will be required in the future. Existing storage facilities require regular maintenance. The existing tanks lack shutoff valves and are likely to be in need of other repairs and possibly cleaning.

Water is needed in informal settlements, markets, and other unserved areas. Many residents in unserved areas currently rely on vendors who provide questionable quality water at high cost. Many Migori residents obtain water from wells, springs, and streams, many of which are expected to be contaminated. Water kiosks the preferred solution for quickly increasing access to water, especially in informal settlements. No water kiosks currently exist in the MIKUTRA system. The condition of the water kiosks visited in the NWSA system were relatively poor (they were also closed). Kiosks are required in Migori and they should be standardized and commercialized. Dozens of kiosks will be required in order to cost-effectively meet the Millennium Development Goal and long-term service targets. Pilot programs, kiosk standardization programs, and

training for operators will be required. It is expected that kiosks will be particularly useful in informal settlements, but many mixed income areas will also likely benefit from well-operated water kiosks. Water vendors are currently fulfilling a very important need that is being unmet by MIKUTRA. This should be recognized and water vendors should be considered as part of the existing water supply infrastructure. However, vendors should be regulated and licensed. It is expected that many water vendors may successfully transition to kiosk operation.

There are no bulk water meters and relatively few consumer water meters installed in Kisii. Bulk metering is important for identification of UfW sources and consumer meters act at the "cash register of the water system". Bulk meters are needed throughout the distribution system and data should be recorded and analyzed regularly. Consumer meters older than 10 years are generally expected to be under recording flows, thereby reducing revenue. Most existing meters in Town are expected to be in need of replacement and many new consumer meters are needed for flat rate connections. Many new service connections are required within the existing distribution system to keep pace with population growth and also to extend service to additional areas.

7.2.4 (c) Water Distribution Recommendations

The primary focus for immediate work related to the distribution system should be on reducing UfW and improving metering. Detailed planning for distribution system improvements and expansion is beyond the scope of this study, but preliminary phasing and costs have been estimated for the purpose of feasibility analysis. Detailed recommendations regarding the distribution system and estimated costs and phasing are included in the detailed matrices (Appendix 7-2). Note that some distribution system-related recommendations are included in the 'Management' section of the matrices and are not listed here. Recommended activities include, but ate not limited to the following:

- Develop an **inventory of the existing water distribution system** including pipes, valves, tanks, pumps, kiosks, etc. including **mapping** and identification of areas with dry pipes no longer served.
- Determine optimal locations for **bulk water meters** and install them. Calibrate / replace meters at existing boreholes.
- Institute program of **consumer meter installation and replacement**. Approximately 700 to 1,000 consumer meters are expected to be needed immediately for existing active flat-rate customers, illegal connections, and re-activated customers.
- Implement comprehensive program to investigate and register / remove **illegal connections**. Utilize proposed LVSWSB toolkit and model by-law. A structured program should be developed to quantify and address the issue including public education and bylaw enforcement. Develop and implement an incentive program to encourage all flat rate customers to install water meters.
- Perform system-wide **water audit** to clarify water balance, UfW sources, and identify problem areas.
- Make **immediate repairs to distribution system** as outlined in detailed matrices.
- Develop and implement System-Wide **Leak Detection and Repair** program. Program should initially focus on known leaks, then utilize remote leak detection equipment on key water mains, utilizing proposed LVSWSB-owned and operated leak detection equipment and "circuit-rider" operator. Note that most mains are undersized and will require replacement. The goal is to immediately boost available water by repairing leaks which are large and cost effective to repair. Encourage NWSA to perform a coordinated similar program in parallel.
- Implement a **water conservation education and assistance** program to inform residents about the importance of conservation and potential monetary savings. Include bulk purchase of water saving devices including sink aerators, low flow showerheads, and similar devices for free or reduced rate distribution.
- Utilize Kiosk and Public Toilet Toolkit (proposed to be created by LVSWSB) to create **plan for building, managing, and maintaining water kiosks.** Include training for kiosk operators. Utilize

mapping for optimal location of kiosks within 400 meters of users. Immediately install three kiosks as pilot program in densely developed areas such as the open market and bus park. Dozens of kiosks are expected to be required during the study period.

- Review water audit results, mapping, system inventory, source augmentation study, and other information and **develop a prioritized plan for distribution system expansion.** Estimate costs of system expansion, including storage and pumping.
- **Implement plans for distribution system expansion.** New required facilities will include water mains and service connections, valves, hydrants (to be determined), bulk and consumer water meters, storage tanks, and pumping systems for remote high elevation areas. Approximately 10,000 new service connections, tens of thousands of meters of water mains and ten to twenty thousand cubic meters of storage are expected to be required.

7.3 Wastewater

7.3.1 Wastewater Overview

Migori has no centralized wastewater collection and treatment facility. The only wastewater treatment facility in Migori is a lagoon treatment facility serving Saint Joseph's Mission Hospital and staff housing. The facility is owned, operated, and maintained by the Diocese of Homa Bay.

The majority of Migori residents and businesses rely on septic tanks, cess pits, pit latrines, septic tanks, and other means of on-site wastewater disposal. Some residents and businesses directly discharge wastewater into open drainage or local rivers and streams. Many people live in close proximity to these on-site systems, which are generally poorly maintained, and myriad health problems have resulted including diarrhea, typhoid, cholera, and other diseases. According to the Migori Municipality Mayor, the economy of the town is good but growth is limited by lack of services, including wastewater collection and treatment, without which they are not permitted to build multistory buildings.

Once the water systems have been expanded, per capita water consumption and wastewater generation will increase. Present per capita water consumption is less than 25 lpcd for those relatively few residents connected to a piped network. For the majority of residents, consumption is expected to be lower. Drastically increased wastewater generation rates are expected to exceed the capacity of existing wastewater disposal systems and the infiltration capacities of the soil. Therefore a wastewater collection and treatment system is required for densely developed areas to minimize disease transition and negative environmental effects.

7.3.2 On-Site and Small Treatment Systems

7.3.2 (a) On-Site and Small Treatment Systems Description

Public Toilets and Latrines

No public toilets exist in Migori. However three pit latrine locations exist, all of which are improperly maintained or not in use. Table 7-10 provides a summary of the existing latrines with descriptions provided by MIKUTRA. The Migori Municipality Council is currently responsible for upkeep of the public latrines.

Table 7-10. Public Latrines in Migori

Location	Number of Stalls	Condition
Soko Mjinga	7	Masonry and "mabati" construction. In poor condition and should be condemned. No water or lighting available.
Bus Park	4	Masonry construction. The structure looks good but is not in use. 12 new stalls are planned for the new bus park.
Main Market	12	Masonry construction. In use but not properly maintained.

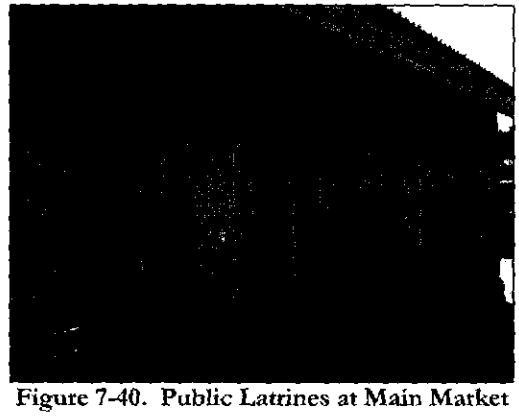

Figure 7-40. Public Latrines at Main Market

On-Site Wastewater Management Systems

The use of pit latrines is common in the densely populated lower income neighborhoods, while some septic tanks exist at institutions and higher income estates. It is expected that some tight tanks may also exist. Most residents rent their homes and the wastewater disposal systems, typically latrines, are overseen by the landlords. It is expected that thousands of pit latrines exist in Migori. Assuming one pit latrine or septic system exists for every 10 to 20 persons, there may be 6,000 to 12,000 on-site wastewater disposal systems in Migori.[1]

Latrines, septic systems, and tight tanks require periodic pumping to remove accumulated solids or liquids and solids (septage). However, it is expected that solids are not removed from many household pit latrines and that they are simply abandoned when full. Most latrines in the informal settlements are not accessible by standatd exhauster equipment. This situation results in potential health effects, especially considering that in most areas sufficient supplies of water are not available for washing. Failing latrines and other on-site wastewater systems discharge organic pollution to the ground in densely populated areas, sometimes near wells and springs. In some cases, wastewater is discharged directly to local surface water bodies.

The Migori Municipality Council is responsible for emptying sludge from septic tanks and other on-site systems throughout the town. However, the Council does not own an exhauster, so most pit latrines are allowed to fill up and new latrines are dug to replace them. Some businesses such as the Prinsal Enterprises Fish Factor periodically hire the municipal exhauster from Kisii which drives approximately 70 km to empty its septic tank. When septage removal does occur from on-site wastewater systems, the septage is commonly discharged to a makeshift waste disposal facility located near Lichota Ranch, approximately 8 km southeast of Migori, off the C13 roadway.

[1] Assumes approximately 120,000 people use on-site systems. Design standards used in the 1991 Kericho Sanitation Project Draft Criteria Report by GKW Consult note that one latrine would serve 16 people and one septic tank would serve 10 people.

Large Wastewater Discharges and Small Treatment Systems

No pretreatment program or sampling programs currently exist in Migori to monitor discharges from businesses and institutions. Several facilities generate large quantities of wastewater that must be dealt with on-site, including Migori Teacher's College, Prinsal Enterprises Fish Factory, the District Hospital, the Government of Kenya Prison, and St. Joseph's Mission Hospital. Three of these facilities were visited by the Project Team as described below and all appeared to constitute public health threats in their current state.

The **Migori Teachers College** current wastewater disposal system is comprised of two septic tanks and pit latrines (Figure 7-41, Figure 7-51, Figure 7-42). The septic tanks serve the staff houses, kitchen, and administration buildings. The remaining facilities are served by the pit latrines. Due to problems associated with the existing system, the college has developed plans for a new on-site wastewater management system. MIKUTRA has cited the failing system as the reason why it was forced to cease pumping from Borehole 5, which is located near the college.

The following description of the existing situation is based on the College's proposal for a new wastewater management system. Estimated water use at the college is 85 m^3/d. The two septic tanks are installed in parallel, each containing two compartments. From the septic tanks, effluent is piped to a series of "soakaways" (3 trains of 6 soakaways). The soakaways are approximately 1.2 m (3.9 ft) in diameter and are filled with broken rocks. There are several areas of the wastewater disposal system which are in need of rehabilitation. Some manhole covers are broken while others are displaced. Four manholes near the septic tanks are blocked by hardened sludge. Two manholes are overflowing. The septic tanks are filled with debris, floating matter, and hardened scum and are ¾ filled with sludge. The soakaways are filled with water and the ground around the soakaways is marshy and water logged, and there are indications of groundwater interference of the soakaways. There is no cut-off drainage to prevent runoff from entering the soakaways and the area surrounding the soakaways.[31]

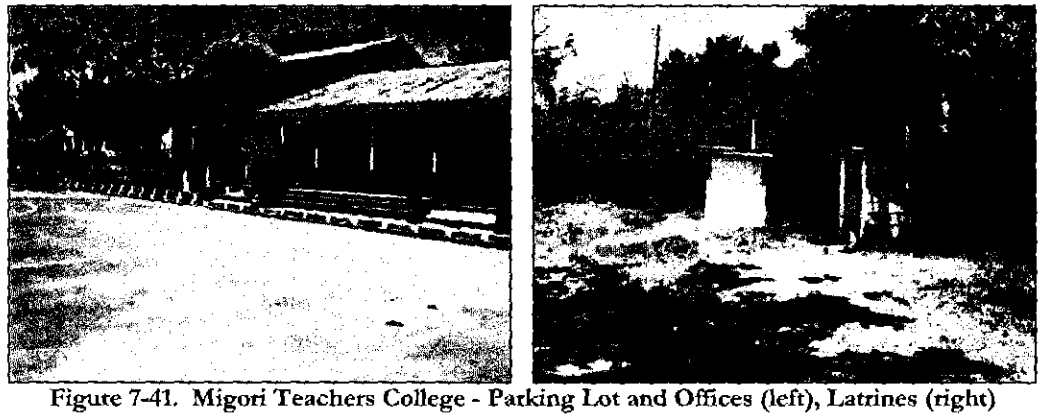

Figure 7-41. Migori Teachers College - Parking Lot and Offices (left), Latrines (right)

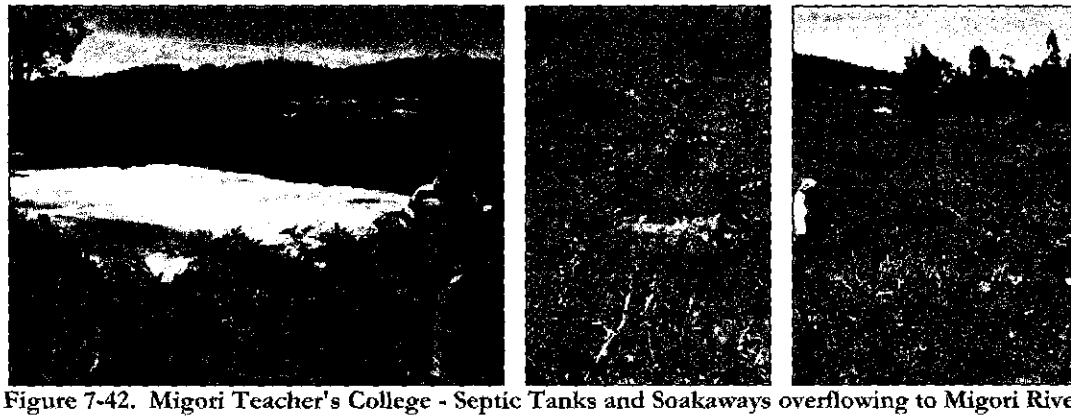

Figure 7-42. Migori Teacher's College - Septic Tanks and Soakaways overflowing to Migori River

The **Prinsal Enterprises, Ltd.** Fish Factory reportedly uses 40 to 70 m^3/d as part of its fish cleaning and processing activities. Fish waste is washed into drains leading to an open septic tank behind the factory (Figure 7-43). During the Project Team visit, the tank was full and overflowing to maize fields and wetlands behind the factory which drain to the Oyinjo River, a tributary of the Migori River. The waste appears to have a very high biological oxygen demand, but does not receive any treatment other than limited sedimentation. The factory reportedly hires an exhauster from Kisii to periodically empty the tank.

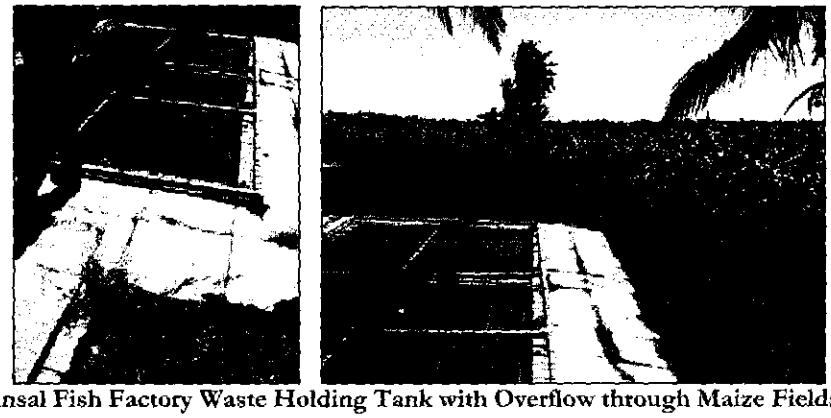

Figure 7-43. Prinsal Fish Factory Waste Holding Tank with Overflow through Maize Fields to Oyinjo River (Tributary to Migori River)

St. Joseph's Mission Hospital has its own collection and treatment system. Wastewater from hospital buildings and staff housing (Figure 7-44) discharges into waste stabilization ponds (Figure 7-45, Figure 7-52, Figure 7-46). The system is owned, operated, and maintained by the Diocese of Homa Bay. Little maintenance is done at the ponds and no operator was stationed at the facility during the Project Team visit. The pond system consists of two lagoons in series. The first is approximately 100 m x 50 m x 1.6 m deep and the second is 50 m x 50 m x 1.6 m deep. The design capacity of the system is unknown. The hospital treats patients with a variety of communicable diseases. No disinfection or sampling is performed on the effluent, which discharges directly to the Migori River several hundred meters upstream of the A1 road bridge. During the Project Team's visit to the site, people were observed bathing in the river opposite from the discharge location. The ponds were reportedly last dredged (manually) in 2001.

Figure 7-44. St. Joseph's Mission Hospital - Sign (left) and buildings (right)

Figure 7-45. St. Joseph's Mission Hospital - Lagoon Treatment System

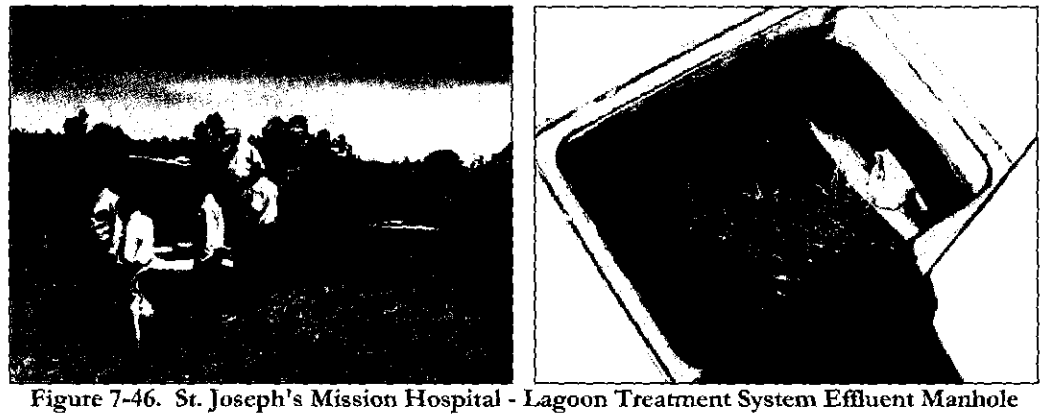

Figure 7-46. St. Joseph's Mission Hospital - Lagoon Treatment System Effluent Manhole

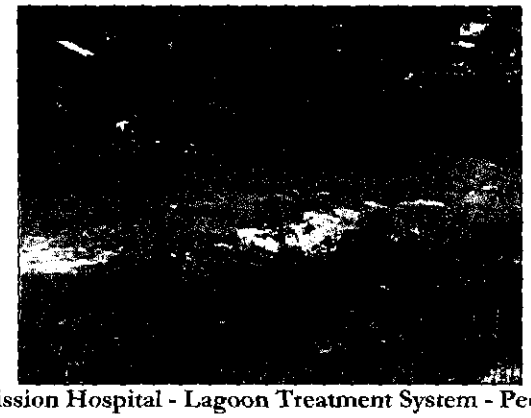

Figure 7-47. St. Joseph's Mission Hospital - Lagoon Treatment System - People Washing and Bathing in Migori River Opposite from Effluent Discharge Location

7.3.2 (b) On-Site and Small Treatment Systems Needs

The lack of sanitary wastewater disposal in Migori presents a public health threat that has resulted in documented elevated levels of disease in addition to nuisance problems associated with odors and breeding of flies and mosquitoes. The preferred long term solution to the existing wastewater problem is the construction of a centralized wastewater collection and treatment system (discussed below under Section 7.3.3). However, until such a system is put in place, needs related to on-site systems and small treatment systems should be addressed.

Existing public latrines are inadequate and poorly maintained and managed. Insufficient or no latrines exist at key locations. Public latrines and toilets are an important piece of wastewater management infrastructure and should be appropriately commercialized, regulated, maintained, and new facilities constructed. These facilities will be very important in achieving the Millennium Development Goals and long term service targets. A plan should be developed for MIKUTRA to takeover oversight of existing facilities, construct new facilities, and ensure this infrastructure is safe, sustainable, and a source of local income generation.

Many on-site wastewater systems (latrines, soak pits, septic systems, tight tanks, etc.) are expected to be failing and represent an acute public health hazard and a public nuisance. Failing on-site systems contaminate local public and private groundwater and surface water supplies. These systems can adequately protect public health and are often more cost effective than public sewers in low density areas. However, these systems must be appropriately designed and maintained in order to protect public health. MIKUTRA should institute management systems to inventory and oversee operation of these facilities and ensure they are properly maintained, including periodic pumping of accumulated solids.

Migori does not currently have any means of exhausting the thousands of on-site wastewater systems that exist in town. Equipment for removing accumulated septage is urgently needed, including equipment for removing septage from difficult locations in informal settlements. An analysis should be petformed to detail the exact equipment required.

A sampling program is needed to determine impacts from known large wastewater dischargers. Temporary means of reducing public health and environmental impacts are expected to be required for large dischargers until they can be connected to a new centralized collection and treatment facility.

The present septage disposal site near Lichota Ranch is important as a temporary means of disposing of septage. However, it should be inspected and evaluated to determine how best to ensure the site is safe for continued use until a centralized wastewater collection and treatment system is constructed. The site will likely require upgrades to ensure a minimum level of safety and environmental protection.

St. Joseph's Mission Hospital Lagoons may be more effectively managed as part of a MIKUTRA wastewater system and could potentially be expanded or upgraded. This possibility should be explored.

7.3.2 (c) On-Site and Small Treatment Systems Recommendations

The primary focus for immediate work related to the wastewater collection system should be on developing a management program for existing systems. Recommendations tegarding on-site and small treatment systems and estimated costs and phasing are included in the detailed matrices (Appendix 7-2). Recommended activities include, but are not limited to the following:

- Develop an **on-site wastewater system inventory, tracking system, and program for mandatory periodic inspections and pump-outs.** Utilize toolkit proposed to be developed at

LVSWSB. The system should include provisions for management of private septage haulers including a manifest system and requiring discharge only at approved locations.

- Evaluate the need for **exhauster equipment** and purchase. Consider viability of purchasing a Vacutug for informal settlements. Consider encouraging private haulers to operate in Migori, and possibly lease a MIKUTRA-owned exhauster to private individuals.
- Inspect **Lichota Ranch septage disposal site** to determine adequacy for continued use as a temporary disposal site. Site should meet minimum criteria (level ground, include fencing, trenching, etc.). Prepare design to bring site up to reasonable standard for interim use, estimate cost, and construct.
- **Rehabilitate and commercialize existing public latrine facilities** in accordance with toolkit proposed to be created by LVSWSB (including fixed prices, signage, lighting (solar?), security, certified operator, lease agreements, etc.). **Develop a plan for constructing new public toilets/latrines**, including provisions for future conversion to water flush systems in areas where water is not currently available. **Construct new public toilets/latrines, starting with a pilot program**. Potential pilot sites include the two markets, stadium, and informal settlements. It is expected that dozens of public toilet installations will be required during the study period.
- **Sample effluent** from Prinsal Enterprises Ltd. (fish factory) and St. Joseph's Mission Hospital lagoons; sample river water upstream and downstream of discharges. Evaluate wastewater management at GK Prison and other large users. Depending on effluent sampling results, **add disinfection** at St. Joseph's Mission Lagoons if required and make **temporary upgrades** to other systems as needed.
- Begin discussions / negotiations with **St. Joseph's Mission Hospital** regarding possible takeover of operation and maintenance of the lagoons and possible expansion to accept wastewater from other users. Estimate potential capacity increase resultant from adding roughing filter and supplemental aeration. Area north of lagoons not occupied and expansion may be possible. De-sludge first (anaerobic) lagoon if needed, perform basic system maintenance.
- Implement **public education** programs regarding on-site system maintenance and basic sanitation practices. Work with local groups such as the newly-formed Town Environment Committee which is trying to replace pit latrines with septic systems.

7.3.3 Centralized Collection, Treatment, Disposal, and Residuals Management

7.3.3 (a) Centralized Collection, Treatment, Disposal, and Residuals Management Needs

A centralized wastewater collection and treatment facility is required to reduce public health and environmental impacts of untreated wastewater discharges to the environment. Increased wastewater generation rates resulting from increased water consumption are expected to exceed the capacity of existing on-site systems (many of which are expected to presently be failing) and the infiltration capacities of the soil. Therefore a wastewater collection and treatment system is required for densely developed areas to minimize disease vectors and negative environmental effects. Priority connections include all schools, hospitals, industries, and municipal buildings. Notably, connections must include the Prinsal Fish Processing Factory, Migori Teachers' College, St. Joseph's Mission Hospital (or improve and continue using the existing facility), both markets, the District Hospital, prison, police station, and sports stadium.

Based on available population density information, mapping, satellite imagery, and discussions with MIKUTRA about areas with the greatest need for wastewater services, the following preliminary wastewater collection priority areas were proposed:

1. East of A1 Road, south of Road to Kadiko
   Including Municipal Offices, Prison, St. Joseph's Hospital

2. Along A1 Road south of Migori River
   Including Prinsal Fish Processing Facility, Migori Teacher's College
3. East of A1 Road, north of Road to Kadiko
   Milimani Area
4. Along A1 Road north of Migori River
   Onyalo area
5. West of A1, Oruba Area

These areas are nearly coincident with the proposed water distribution service area in some areas, although slightly smaller in extent. It has been estimated that the population in the wastewater service area is approximately 70% of the population in the proposed water service area. The population within the projected wastewater service area is presently estimated to be 56,000 and expected to approximately double by 2025. Due to the cost and engineering feasibility of adding individual connections for the most densely developed areas and informal settlements, it is expected that public toilets will be used to effectively meet service goals in many areas.

Due to the topography of Migori, it is expected that a wastewater treatment site can be selected at low elevation near the Migori River that allows most or all wastewater to be collected by gravity. Government land is available through the municipal council for a wastewater treatment facility, including several parcels slated for this specific purpose. MIKUTRA noted that government can also acquire additional land as required. Four primary potential sites were identified with MIKUTRA and examined (Figure 7-48). The advantages and disadvantages of each site are summarized in Table 7-11.

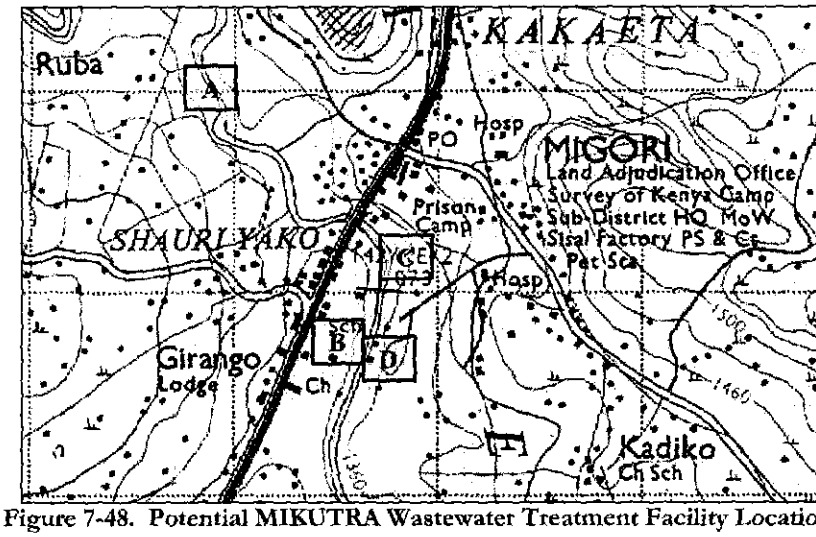

Figure 7-48. Potential MIKUTRA Wastewater Treatment Facility Locations

Table 7-11. Potential MIKUTRA Wastewater Treatment Facility Locations

Site Name	Location	Advantages	Disadvantages
A – Town Owned Parcels on Either Side of Migori River	~1 km northwest (downstream) of A1 Migori River Bridge, near confluence of Nyasare River	Town-owned land (~12 ha total) specifically slated for wastewater treatment. Sufficiently downstream to allow for gravity collection from entire proposed service area. Buffered from population centers, yet relatively close to point of generation.	Some squatters located on site. Location of parcels on two different sides of river is not ideal and additional land acquisition may be required. Residents were observed bathing in river adjacent to site (but site is downstream of most users)
B – Adjacent to Migori Teachers College	On river at Migori Teachers College ~1 km southeast of A1 Migori River Bridge (upstream)	Centrally located.	Site adjacent to two schools and outdoor sports area. Up-gradient of some major water users. Discharge would be upstream of downtown area and river water users / bathers.
C - Upgraded existing St. Joseph's Hospital lagoons	~1 km southeast of A1 Migori River Bridge (upstream)	Centrally located. Existing infrastructure.	Up-gradient of some major water users. Discharge upstream of downtown area and water users / bathers. Insufficient capacity for entire municipality, but may serve additional areas with improvements.
D - Wooded area Across Migori River from Migori Teachers College	~1 km southeast of A1 Migori River Bridge (upstream)	Town-owned land.	Up-gradient of some major water users. Discharge would be upstream of downtown area and water users / bathers.

Figure 7-49. Potential Wastewater Treatment Site A, Town Owned Parcels on Either Side of Migori River - Looking west toward river

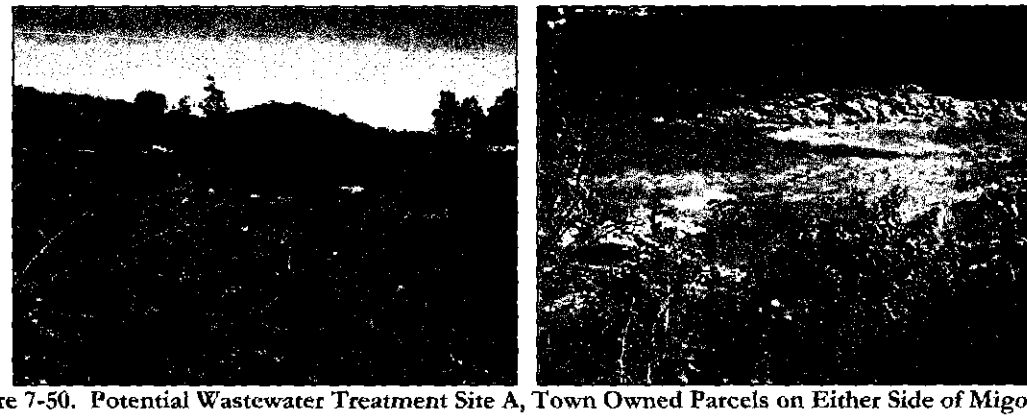

Figure 7-50. Potential Wastewater Treatment Site A, Town Owned Parcels on Either Side of Migori River (April 2006) - Looking east (left) and south (right)

Figure 7-51. Potential Wastewater Treatment Site B, Adjacent to Migori Teachers College - View looking east toward Migori River. St. Joseph's Mission Hospital and Kadika Hill visible in background.

Figure 7-52. Potential Wastewater Treatment Site C, Upgraded existing St. Joseph's Hospital lagoons, Migori River Visible in Background

Figure 7-53. Potential Wastewater Treatment Site D, Wooded area (at right) Across Migori River from Migori Teachers College. St. Joseph's Hospital buildings visible at left.

Based on available information, Site A is the preferred location due to its elevation which allows for gravity collection from most areas, situation downstream of the town center and away from dense development, and the fact that the site is already owned by the municipality. Additional land acquisition and relocation of squatters may be required. The most appropriate technology is three-stage lagoons if sufficient land area is available. Options for decreasing footprint include the addition of aeration and recirculation if needed. A septage receiving station should be included at the wastewater treatment facility for sludge from exhauster trucks. MIKUTRA expects that the community would allow the reuse of treated wastewater for non drinking purposes such as downstream irrigated agriculture.

A composting program is recommended for processing the wastewater sludge into a stable and useful biosolids product. Covered drying beds will be required at the treatment facility. MIKUTRA has noted that the community is likely to accept the use of treated sludge in agriculture provided that the facilities are available to adequately treat the sludge. A formalized sludge re-use program will need to be developed including marketing and sensitization of residents. Potential beneficial reuse options include: soil amendment for agriculture or tree nurseries (Figure 7-54), soil stabilization, amendment for on-site plantings of bougainvillea at treatment facility for odor control, or off-site plantings at public toilets, kiosks, and public buildings.

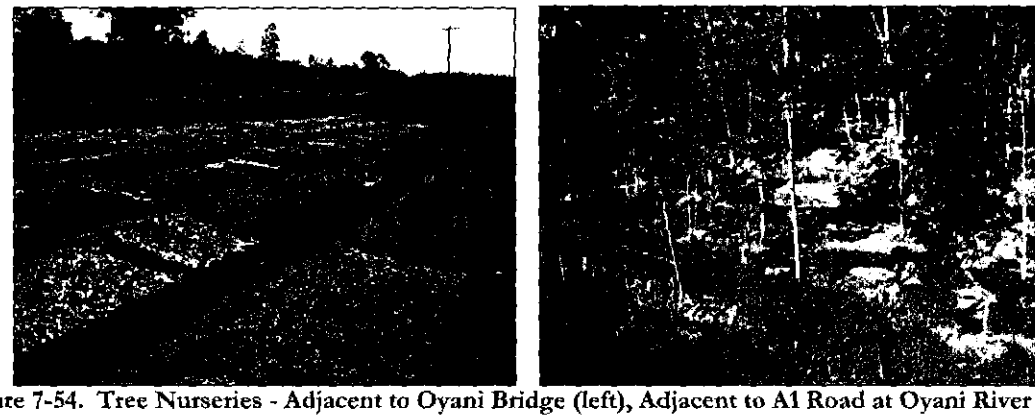

Figure 7-54. Tree Nurseries - Adjacent to Oyani Bridge (left), Adjacent to A1 Road at Oyani River (right)

In addition, it may be advisable for MIKUTRA to takeover operations of the St. Joseph's Mission Hospital lagoons and upgrade them to function as a satellite treatment facility. This would take advantage of this existing valuable infrastructure and minimize collection system length and cost. Upgrade options for this facility include the addition of a roughing filter or supplemental aeration, the addition of disinfection, expansion into the open area north of the existing lagoons, and the construction of a wetland for effluent polishing.

7.3.3 (b) Centralized Collection, Treatment, Disposal, and Residuals Management Recommendations

The primary focus for immediate work related to centralized wastewater collection, treatment and disposal should be on detailed studies and cost estimation. Detailed planning for the required new facilities is beyond the scope of this study, but preliminary phasing and costs have been estimated for the purpose of feasibility analysis. More detailed analyses will be required to clearly define required projects. Recommendations regarding wastewater treatment facilities and estimated costs and phasing are included in the detailed matrices (Appendix 7-2). Note that some wastewatet treatment recommendations are included in the 'Management' section of the matrices. Recommended activities include, but are not limited to the following:

- **Prioritize list of future sewer connections** based on major water users. Expected large users include: Migori Teachers' College, Prinsal Enterprises Ltd., St. Joseph's Mission Hospital, District Hospital, Municipal offices and police station, prison, markets, schools, and sports stadium. **Begin discussions / negotiations** with Prinsal Enterprises Ltd (fish factory), Migori Teacher's College (has land for potential satellite WWTF, proposed facility already), St. Joseph's Mission Hospital and others regarding connecting to a future municipal water and wastewater system.
- Perform **conceptual design of gravity collection system**, estimate number of customers served and estimate costs including permitting. Utilize GIS mapping developed as part of other tasks. Include consideration of expanded use of St. Joseph's Mission Hospital lagoons as part of overall wastewater management for Migori.
- Perform **detailed preliminary study and conceptual design of wastewater treatment** options. Determine actual size and availability of preferred treatment site "A". Devise and institute program to relocate squatters. Take soil samples, conduct site survey and flooding analysis, etc. as required. Detetmine effluent discharge standards and clarify permitting process. Perform conceptual design of treatment facility and identify permitting requirements. Estimate costs. Include consideration of expanded use of St. Joseph's Mission Hospital lagoons, including costs, as part of overall wastewater management for Migori. Design should include consideration of required future expansions.
- Design and construct **wastewater treatment facility** with septage receiving station. Expect traditional three-stage lagoons, possibly with roughing filter and supplemental aeration as area requirements dictate. Acquire sufficient land and construct facility to allow for future expansion. Incorporate sludge gas collection for electricity generation if cost-effective or if electricity grid still deficient. Include sludge handling facility with sludge drying beds, composting.
- Design and construct **gravity collection system** to serve central Migori, including lateral sewers and house connections.
- Evaluate feasibility of **downstream re-use of treated effluent**. Obtain information on predominant crops, water and nutrient needs, and proximity (downgradient preferred). Explore options for effluent reuse / polishing including constructed wetlands, aquaculture, and sugar cane, bamboo, or other crops grown downstream of treatment facilities.

7.4 Management and Operation and Maintenance (O&M)

7.4.1 Management and O&M Description

Institutional Arrangements

Migori Municipality is the headquarters of the Migori District and lies within the Nyanza Province and covers an area of 57 km^2.[32] Migori was first established as a small trading center in 1931 and in 1997 attained municipal status and was designated as the distrtict headquarters.[33] Offices of the Migori District Commissioner, other district departmental heads, the municipal and county councils, and major parastatal organizations are all located in Migori.

As of June 2006, operation of water and wastewater systems in Migori was transferred under the management of the newly-established MIKUTRA Water and Sanitation Company Limited. The name MIKUTRA is an acronym indicating that the company covers Migori, Kuria and Transmara Districts. The company operates the following water systems: Migori water supply, Rongo water supply, Isebania Water supply, Kehancha Water Supply, Lolgorian Water supply and Angata Water Supply. The company's shareholders include Migori Municipal Council, Migori County Council, Rongo Town Council, Awendo Town Council, Kehancha Municipal Council, and Transmara County Council.

The former water service provider in Migori was the District Water Office. There is no wastewater system provider, although latrines and on-site system pumping are reportedly still under the management of the Migori Municipal Council. MIKUTRA serves as the sole Water Service Provider (WSP) for Migori Municipality per its Service Provision Agreement (SPA) with the Lake Victoria South Water Services Board, dated 27th June 2006. The Company's Board of Directors is composed of members of the Migori Municipal Council, other Town and County Councils, and the Ministries of Local Government and Water. A central corporate management team handles daily operation of the company and includes a Managing Director, Technical Manager, and Commercial Manager.

Staffing

An 11th April 2006 letter from outgoing District Water Officer Mr. Njenga recommended a new staffing structure for Migori Water Supply and MIKUTRA has indicated that this staffing structure has been implemented. The structure is summarized in Table 7-12. There is no wastewater staff. Other sources have cited differing numbers of staff, so the actual present staffing levels should be re-confirmed.

Table 7-12. Migori Water Supply Staffing by Title

Staff Title	No. of Staff
Division Water Officer	1
Operator in Charge	1
Technical Maintenance Team	4
Chemical Attending and Water Regulation	1
Consumer caretakers (Patrol men)	7
Borehole pump attendants	4
Revenue collection staff	4
TOTAL	**22**

Of the 22 water system staff listed, it appears that 5 are administrative staff (Division Water Officer and Revenue Collection Staff) while the remainder are field staff. For the purposes of this analysis, it is assumed that staffing is broken down as described in Table 7-13.

Table 7-13. Migori Water Supply Present Staffing Levels by Category

	Present Number of Staff
Administrative	5
Water	17
Wastewater	0
TOTAL	**22**

A variety of standards exist for calculating appropriate staffing levels. LVSWSB has established Sector Benchmarks as outlined in Schedule E of its standard Water Services Provision Agreement (SPA). These benchmarks are presented in Table 7-14. It is assumed that this figure is for water O&M staff only and

therefore doesn't include administrative and wastewater staff. LVSWSB's SPAs do not include similar benchmarks for administrative and wastewater staff.

Table 7-14. Staffing Levels Per LVSWSB Service Provision Agreements (Schedule E)

Size of Company	Staff / 1,000 connections		
	good	acceptable	not acceptable
Large	<5	5-8	>8
Medium and Small (with up to 3 towns)	<5	5-8	>8
Medium and Small (serving more than 3 towns with different systems)	<9	9-14	>14

The 'acceptable' range of 5 – 8 staff per 1,000 connections translates to 3 to 5 water O&M staff for Migori Water Supply based on its approximately 600 active connections, or 6 to 9 water O&M staff based on its 1,134 total connections. Migori Water Supply currently has a water O&M staff of 17 (15 staff / 1,000 total connections, 28 staff / 1,000 active connections). Appendix G10 of the 2005 Practice Manual for Water Supply Services in Kenya (2005 Design Manual) describes required water staffing levels based on system-specific information. These recommended levels and calculations based on conditions specific to Migori Water Supply are presented in Table 7-15 and result in a required water O&M staff level of 16. However, the Design Manual only has recommendations for supplies producing more than 500 m^3/d. It notes that "For smaller supplies than 500 m^3 output per day and for supplies which will initially operate for less than 13 hours per day should the staff be reduced as decided by the O&M branch". Based on the 2005 Design Manual and LVSWSB SPA, a water O&M staff of less than 16 is probably appropriate for current conditions of the water system. However, staff increases will be required as additional customers are added and re-activated.

Table 7-15. Migori Water O&M Staff Required per 2005 Design Manual Appendix G4

Staff Category	**Water supply staff required for full water treatment production > 500 m^3/d, operation 13-24 hrs / d**	**Migori Water O&M Staffing Requirement**
Water Operator Grade I	1	1
Water Operator Grade IIA	1	1
Water Operator Grade IIB	1	1
Water Operator Grade III	1 per 200 water meters	1*
Chemical or general attendant Grade I	3	3
Pump attendant Grade I	1 per pumping station	2
Pipe Fitter Grade I	1	1
Pipe Fitter Grade II	1	1
Labourer	4	4
Line Patrollers	1 per 25 km of pipelines	1*
TOTAL		**16**

**Actual number of water meters and kilometers of pipeline unknown. Assume 200 water meters, 4 km of pipelines.*

Requirements for wastewater staffing are presented in Table 4.2.12 of the 1998 Aftercare Study on the National Water Master Plan and reproduced below in Table 7-16. There is currently no centralized wastewater collection and treatment system in Migori, but some staff are required for managing on-site systems and a larger staff will be required once a centralized collection and treatment facility is constructed. Optimal staffing levels for each town are very site-specific. Considering the proposed collection and

treatment facility in Migori is expected to serve 70,000 people via individual connections and public toilets within 10 years, a staff of 16 to 28 could be required based on recommendations in the Aftercare Study.

The 1992 *Waste Stabilization Ponds: A Design Manual for Eastern Africa* includes recommended staffing levels specifically for lagoon systems (Table 7-17). This document recommends a staff of 12 to 17 for pond systems designed to serve 50,000 to 100,000 people. This is similar to the recommendations in the Aftercare Study (Table 7-16), which recommend a treatment works staff of 15 for a service population of 50,000 to 100,000 (excludes collection system staff). The source of funding for an increase in staff will likely come from new sewer tariffs in line with Kenyan average rates.

Table 7-16. Wastewater O&M Staffing Guidelines, 1998 Aftercare Study on the National Water Master Plan

		Population Connected to Sewerage				
Function	Position	10,000-25,000	25,000-50,000	50,000-100,000	100,000-300,000	>300,000
Management & Process Control	Manager	0	0	1	1	1
Treatment Works Operations & Process Control	Superintendent	0	0	1	1	1
	Trade effluent inspector	1	1	2	2	4
	Technical Assistant	0	0	1	1	1
	Laboratory technicians	0	1	1	2	2
Treatment Works Maintenance	Foreman	1	1	1	2	2
	M/E tradesmen	0	1	2	2	4
	Laborers	2	3	4	6	10
	Drivers	0	1	1	2	4
	Watchmen	1	1	1	3	5
Collection System Maintenance	Superintendent	0	0	0	1	2
	Foreman	1	1	2	4	6
	M/E tradesmen	0	0	1	2	3
	Laborers	4	6	10	20	30
TOTAL		10	16	28	49	75

Table 7-17. Recommended Staffing Levels for Waste Stabilization Pond Systems

Population Served	**10,000**	**25,000**	**50,000**	**100,000**	**250,000**
Foreman/Supervisor	-	-	1	1	1
Mechanical Engineer[a]	-	-	-	1	1
Laboratory Technician[b]	-	1	1	1	2
Assistant Foreman	-	1	2	2	2
Laborers	1	2	4	6	10
Driver[c]	-	1	1	1	2
Watchman[d]	1	1	3	5	5
TOTAL	**2**	**6**	**12**	**17**	**23**

Source: Waste Stabilization Ponds: A Design Manual for Eastern Africa. Mara, Alabaster, Pearson and Mills, 1992.

[a] Dependent upon amount of mechanical equipment used.
[b] Dependent upon existence of laboratory facilities.
[c] Dependent upon use of vehicle-towed lawn mowers, etc.
[d] Dependent upon location and amount of equipment used.

Operation, Maintenance, and Management Systems

In general, operation and maintenance of the existing system is poor. Operations are severely limited by a lack of water meters, reliable power, transportation, training, tools, spare parts, manuals and preventative maintenance programs, effective recordkeeping, and laboratory equipment for taking basic measurements. All chemical dosing is done by rule of thumb or estimation. Illegal connections are expected to exist in Migori, but an effective means for identifying and removing such connections does not exist. Capacity in financial management and general administration is also lacking.

An undated, hand-drawn sketch of the existing water system was provided (drawn on an April 2000 Ministry of Lands and Housing Development Plan). Layout drawings for other facilities are not available. No operation and maintenance manuals were provided. It is unclear if any kinds of schedules exist for regular operation and maintenance, including preventative maintenance. Detailed equipment inventories were not provided. No environmental audits or other similar information specific to Migori Water Supply were provided. A simple balance sheet was provided for the year 2005 which summarizes expenses (Table 7-18).

Table 7-18. Migori Water Supply Annual Report Data for 2005

	2005
Water Produced (m^3)	164,275
Water Sold (m^3)	138,483
Water Unaccounted for (m^3)	25,792
Revenue Earned (KShs)	4,194,000
Average Water Tariff (KShs / m^3)	*30*
Revenue Collected	**2,212,342**
Expenditure on Chemicals (KShs)	58,488
Expenditure on Electricity (KShs)	876,847
Staff Salaries, Allowances (KShs)	1,486,293
Sundry Items (KShs)	65,430
Total Expenditure (KShs)	**2,487,058**
Surplus or Deficit (KShs)	***(274,716)***

Source: Table entitled 'The Production and Expenditure for Migori Water Supply for the year 2005' provided by MIKUTRA.
Note: Items in italics are calculated and were not included in source table.

Monthly electricity costs for Migori Water Supply are reportedly approximately 900,000 KShs per year (~75,000 KShs per month). According to MIKUTRA, electricity rates are presently 6.7 KShs/kW-hr and therefore Migori Water Supply uses approximately 2,500 kW-hrs/week. In comparison, KEWASCO, which has an almost entirely gravity system, reported low average energy usage of around 250 kW-hrs/week, about 10 times less than Migori. Electricity use in Migori is presumably limited to pumping systems at boreholes and some limited office electrical use.

The 'Welcome to Migori District Water Office' Document provided in January 2006 also includes expenditure information. The document states that monthly expenditure on electricity is 157,553 KShs/month, or more than double the amount reported in the 2005 annual report table. It also notes approximately 30,000 KShs/month is spent on general maintenance, which is not included in the annual report table. It notes that total expenditures are approximately 350,000 KShs/month, or around 4.2 Million KShs/year. Clarity on actual expenditures is required.

The 2005 Annual Report table provided by Migori Water Supply notes that total expenditure for the 2005 financial year was 2.5 million KShs. This is in comparison to collected revenue for the same year of KShs 2.2

million. The primary expenditures include staff salaries and allowances (60%) and electricity (35%). Chemical costs were reportedly only 2% of expenditures.

Perhaps the best available mapping in Migori is an April 2000 Ministry of Lands and Housing / Migori Municipal Council Development Plan which shows administrative divisions in the town center as well as detailed topography. UN-Habitat, together with the Regional Center for Mapping of Resources for Development (RCMRD) in Nairobi are currently preparing detailed GIS maps based on recent satellite imagery. This mapping was utilized in the development of proposed service areas. The most recent Survey of Kenya topographic maps of Migori are from 1980.

Available water system mapping includes a 1982 1:5000 scale map by the Ministry of Water Development entitled 'Migori-Kihancha Water Supply, Existing Migori Town Water Supply' (GOK Ministry of Water Development Plan prepared by Kigoni and Partners Consulting Engineers of Nairobi); a hand-drawn map of the water system by Migori Water Supply staff; and sketches developed by JICA as part of its 2001 study and sketches by UN-Habitat as part of its November 2005 report.

Tariffs

Migori presently uses the national guideline water tariff rates outlined in the Water Act (Table 7-19). The average effective water tariff charged in Migori is 30 KShs/m^3 based on reported 2005 total revenue earned divided by total water sold (Table 7-18).

Table 7-19. Kenya Urban Water Tariffs Per Water Act (November 1999)

	Category	Charge		
a)	Unmetered	200	KShs	/ month
b)	(i) Metered use < 10 m^3	200	KShs	/ month
	(ii) Metered use 10-20 m^3	25	KShs	/ m^3
	(iii) Metered use 20-50 m^3	30	KShs	/ m^3
	(iv) Metered use 50-100 m^3	45	KShs	/ m^3
	(v) Metered use 100-300 m^3	75	KShs	/ m^3
	(vi) Metered use 300+ m^3	100	KShs	/ m^3
c)	Kiosk sold by m^3	15	KShs	/ m^3
d)	Kiosk by 20 l jerrycan	2	KShs	/ 20 l
e)	Bulk sale for resale	15	KShs	/ m^3

The amount of revenue derived from other fees charged in Migori (new and reconnection water and sewer fees, monthly water meter rents, rental fees for urban water kiosks, fines for illegal water connections, testing of water meter fees, etc.) was not provided.

Migori's water tariffs are presently below the estimated national average of 38 KShs/m^3, but available information suggests residents would be willing to pay more for improved services. The District Water Office noted in early 2006 that there is a high willingness to invest in water systems and there is a high willingness to pay for improved water.[34] According to a survey performed by JICA as part of its 2001 study, "the general conclusion of the survey was that most households [in Migori] were willing to pay more for improved service delivery commensurate with the level of the tariff." The JICA study also noted:

> *"A similar survey in the areas not currently serviced established that majority of the households would be willing to pay for water at the current general water tariff of KShs 30/m^3. Simulations to establish the threshold tariff beyond which*

people would not be willing to pay revealed that even with increment of up to 30% in the tariff, people would still be willing to pay".[35]

Therefore, it can be inferred that even in 2001, many residents were willing to pay up to KShs 39/m³. It should be noted that many residents presently obtain questionable quality water from vendors who charge volumetric rates many times that of Migori Water Supply.

Billing and Revenue

All billing and record-keeping are performed by hand and all bills are hand-delivered. A clear description of how billing and revenue collection is handled was not provided and significant discrepancies in billing and revenue figures exist as described above. Due to a lack of consumer meters, most monthly bills are based on flat rate charges. Collection efficiencies reported in various sources range from 35% to over 100%, although data was unavailable to verify any calculations. Detailed information on the billing process was not provided during this study. The 2001 JICA study indicates that meter reading for the few working meters (JICA estimated there are approximately 40) is undertaken monthly. MIKUTRA noted that approximately 70-80% of consumers pay their water bills each month when the "flow is good".

Offices, Lab Facilities, and Transportation

The Migori Water Supply offices are located near the center of Town and a new main office building was recently constructed (~2002). The office has a photocopy machine, telephone, and some other basic office equipment. All record-keeping is performed by hand. Staff offices are in temporary metal huts and are inadequate (Figure 7-56). Additional office space is expected to be required as the number of water and wastewater service connections increases and staffing increases. Electrical power reliability is a significant problem and blackouts occur frequently.

Laboratory facilities do not exist for carrying out basic daily, weekly, and monthly sampling. All chemical dosing is done by estimation and it was not clear if any sampling is performed.

Vehicles are reportedly not adequate for basic system operation and maintenance. Some staff walk to sites to perform maintenance duties, which results in lost productivity. The DWO has one four-wheel-drive vehicle and two motorcycles, although only one was working in 2006.

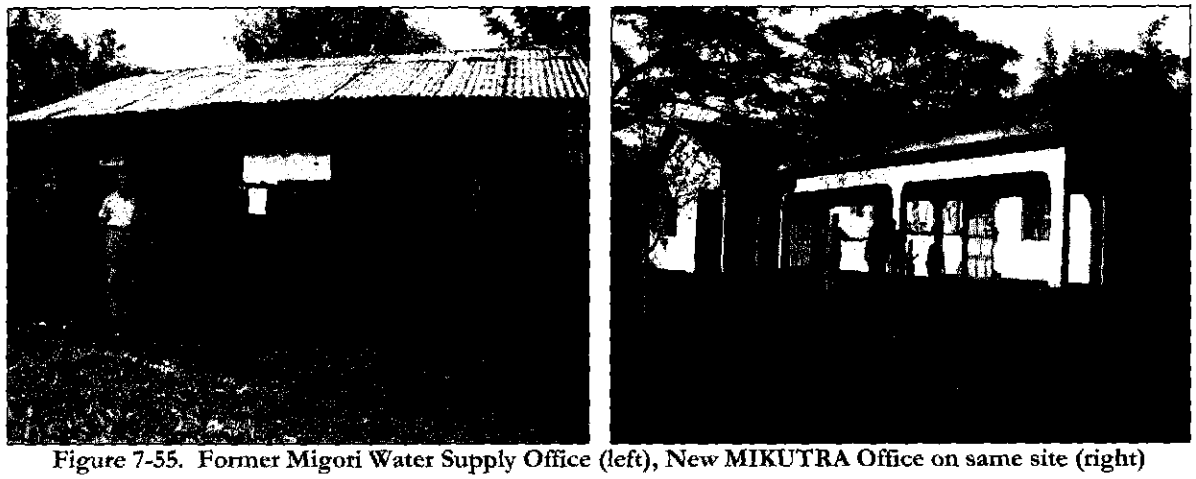

Figure 7-55. Former Migori Water Supply Office (left), New MIKUTRA Office on same site (right)

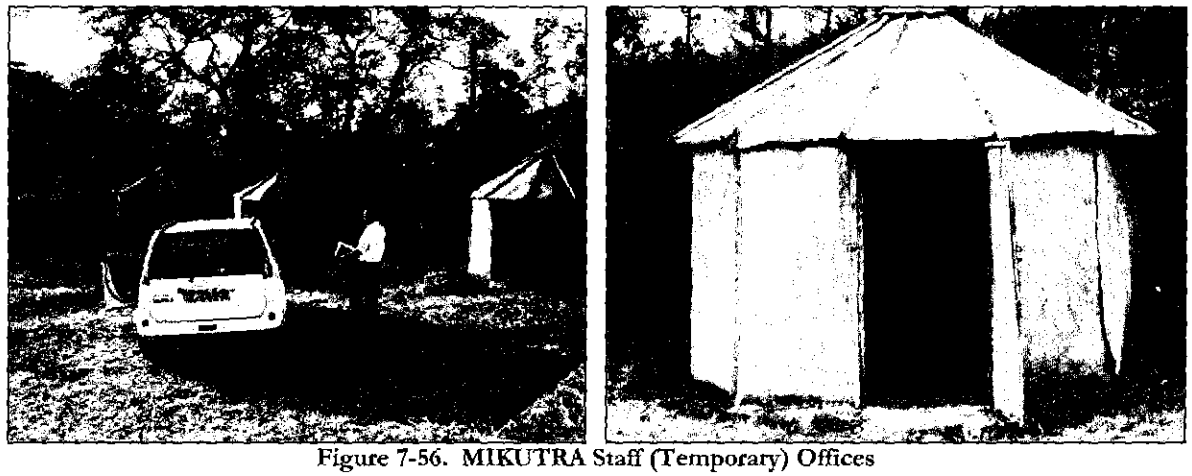

Figure 7-56. MIKUTRA Staff (Temporary) Offices

7.1.1 Management and O&M Needs

An accurate water system inventory is required before meaningful planning can be accomplished. An inventory is important for almost all future work including developing O&M plans, infrastructure planning, mapping, tariff analysis, staffing planning, accounting and other activities. An inventory is the first step towards creating an asset management plan. Once the inventory is created, assets should be valued and prioritized into an asset management plan for future rehabilitation, replacement, or upgrade.

In order to maximize equipment lifespan and operating efficiency, MIKUTRA should document preventative maintenance plans for existing facilities, follow the plans closely, and be vigilant about recording maintenance histories for equipment.

Accurate mapping is crucial for almost all future planning tasks. MIKUTRA needs to develop up-to-date electronic mapping of its systems. Considering the existing Migori Water Supply system is relatively limited in extent, this mapping effort will be particularly important for future planning. Fortunately, the basis for such mapping is currently being developed in Geographic Information System (GIS) format by UN-Habitat and the Regional Center for Mapping and Development. Once developed, a variety of layers should be included such as: existing land use; streets; neighborhoods; population density; water system features including intakes, treatment facilities, piping network, and storage facilities; and planned water and wastewater facilities. All systems included in system inventory should be included in the mapping.

MIKUTRA appears to be excessively staffed for its present water system operations and staff and management training is insufficient. Staffing levels are expected to need to be increased as water and eventually sewer connections are made. Some staff are presently required for managing on-site wastewater systems and septage disposal. A detailed staffing study is required to fully assess MIKUTRA's staffing needs.

MIKUTRA's current tariff structure and high UfW are part of the reason why the company to operates at a financial loss, despite having no current debt service. Low existing tariffs and primarily flat rate charges do not allow the company to pay normal operating costs and develop reserve funds. Available information suggests that local residents are willing to pay more to ensure they receive high quality services. MIKUTRA should institute tariffs which ensure full cost recovery including O&M as well as capital projects. Additional clarity on company costs and revenues are required via a balance sheet, detailed annual report, or similar documentation in order to perform a meaningful analysis.

The MIKUTRA offices are in need of rehabilitation and new equipment. Existing offices contain old chairs, small rooms and makeshift work areas. Offices require immediate equipment upgrades including desks and chairs, faxes, copiers, computers, software, printers, filing cabinets, and other assorted equipment.

All records and billing should be computerized and computer training is needed for staff. Installation of solar panels or an auxiliary generator should be considered to safeguard against losses of data and productivity after switching to a computer-based system.

Laboratory facilities are required to take basic daily measurements for the water system. It is expected that full laboratory facilities will be constructed when new treatment facilities are constructed. Therefore, immediate needs include temporary laboratory facilities. Quality assurance and quality control checks on sampling programs are required and should be developed in consultation with LVSWSB. Infrequent sampling requiring expensive specialized equipment should be done at LVSWSB. Until laboratory facilities can be established, sampling programs should begin immediately with all analysis done at the LVSWSB laboratory in Kisumu.

No public education program currently exist at MIKUTRA. An informed customer base is vital in effectively protecting public health, garnering support for local projects, and ensuring successful project implementation. MIKUTRA should develop public education programs. The public should be aware of the importance of clean water and sanitation, especially associated health impacts. Promotion of water conservation and installation of water-saving devices in homes could save additional water, allowing MIKUTRA to serve additional customers with existing supplies. Many residents consume water from contaminated sources without point of use treatment and should be made aware of hazards and provided with point of use treatment chemicals to be used until adequate piped water sources are provided. Some homes are expected to have wells and pit latrines co-located and residents should be aware of potential hazards. MIKUTRA should begin to make the health-based case for improving public water and wastewater services.

MIKUTRA should seek to support and develop entrepreneurship and income-generating activities which will reduce demands on MIKUTRA staff. Such activities may include commercialization of water kiosks and public toilets/latrines, private exhauster services, biosolids composting and marketing, development of tree nurseries using treatment facility biosolids, algae harvesting from existing and ptoposed treatment lagoons, and irrigated sugar cane, bamboo, or aquaculture using treated effluent.

Favorable economies of scale may be attained by regionalization of some services including leak detection and repair, chemical procutement, staff and manager training, equipment repair/rehabilitation, spare parts, bulk purchases including water meters, leak detection equipment, purchasing in-home water saving devices, emergency water bowser service, public education, and other activities. MIKUTRA should work with LVSWSB to determine appropriate regionalization programs and pursue them.

Existing vendors and proposed kiosk and public toilet operators will require training in financial management and operation to protect public health. Training and certification programs are required for these services.

MIKUTRA has noted that available vehicles for staff transportation are lacking and that existing equipment is old and costly to maintain. The exact number of required vehicles is not known, but it is assumed that two trucks and five motorcycles will be needed.

Other management needs are discussed in other sections including a water audit, bulk and consumer meter repair and replacements, an illegal connection removal plan, watershed land purchase for source protection, discussions with large water users not connected to the wastewater system regarding connections, and the development of an on-site wastewater management plan.

7.4.2 Management and O&M Recommendations

Recommendations regarding institutional arrangements, management, and O&M and estimated costs and phasing are included in the detailed matrices (Appendix 7-2). Many activities require more detailed study and costs for such studies have been estimated. Recommended activities include, but are not limited to the following:

- Develop **system inventory and asset management plans** utilizing toolkit proposed to be created by LVSWSB. The inventory should include major equipment, piping, tanks, and treatment systems. Available data such as age, expected useful life, condition, service history, and nameplate data should be included. Financial value of assets and list of depreciated assets should be included. Develop or use available standard forms, or purchase and customize available software (recommended) to create inventories and convert to an asset management plan by prioritizing assets and estimating future needs and costs. Priority should be given to critical infrastructure at or past the end of its useful life.
- Prepare **GIS mapping** with all systems included in the system inventory, as well as other data layers.
- Develop a **preventative maintenance plan** and maintenance tracking system, including all inventory components, utilizing the toolkit proposed to be created by LVSWSB. The system may incorporate traditional maintenance card techniques, "out-of-the box" software, or customized software. Software packages are readily available to schedule and track all required preventative maintenance and are recommended.
- Prepare **O&M manuals** for all facilities including layout drawings and regular maintenance requirements. Obtain manufacturer's manuals for all existing equipment, incorporate recommended maintenance into preventative maintenance plan.
- Review water and wastewater staffing levels and conduct **staff rationalization study** by an external Human Resources consultant. Include consideration of a future merger with NWSA. Study should include organizational chart development, task analysis, determination of staffing requirements, creation of job descriptions, and implementation plan for staffing changes.
- Conduct detailed **analysis of current tariff structure** in conjunction with proposed new projects and costs from asset management plan. Utilize toolkit proposed to be developed by LVSWSB and the Draft Tariff Guidelines created by WSRB. Include consultation and participation of stakeholders. Revise tariff structures so revenues cover all operational expenses and generate additional funds for capital improvements, equipment, meter replacements, planning, etc. Proposed tariffs should not be arbitrary, but rather based on real data, reasonable projections, and a transparent methodology.
- Implement **public education programs** to inform residents about the importance of water conservation, water quality, source protection, sanitation, and potential resultant financial savings. Utilize public education toolkit proposed to be developed at LVSWSB. Work with local environmental and health groups on public education programs, including the new Migori NEMA office and newly formed Town Environment Committee (currently working on replacing latrines with septic tanks). Begin school programs addressing water conservation, health and hygiene. Consider publishing and distributing annual informational reports to customers similar to Consumer Confidence Reporting used in the United States for educating customers about water sources and watershed protection. Designate staff responsible for public education and public relations including informing customers of any expected service disruptions and handling complaints.
- Consider development of **entrepreneurial opportunities** including commercialization of water kiosks (once constructed) and latrines/public toilets; private operation of MIKUTRA-owned exhauster truck(s) or Vacutug; Compost production and distribution; Utilize sludge at one of several existing or possible new seedling nurseries; algae harvesting from existing and proposed treatment lagoons; irrigated sugar cane/bamboo/other; aquaculture with WWTF effluent.
- MIKUTRA should investigate becoming part of Kisumu-based **regionalization programs** including staff and manager training, equipment repair/rehabilitation, spare parts, chemical procurement, bulk

purchases including water meters, leak detection equipment, and in-home water saving devices, water bowser service, public education, etc. Work with LVSWSB to develop regional programs.

- Implement **vendor, kiosk, and public toilet operator training and certification program.** Encourage residents to only purchase water from registered vendors. Encourage vendors to become trained as kiosk operators as kiosks come on-line.
- Purchase **office equipment** including chairs, desks, faxes, copiers, computers and software, printers, filing cabinets, and safe for cash. Add additional security measures including effective door and window locks, lighting, and computer data security. Consider purchase of solar or generator backup power for offices. Purchase sampling and laboratory equipment for basic sampling until larger laboratory is constructed at treatment facilities.
- Purchase **basic tools** required for system maintenance including tools for plumbing and electrical work, pump removal tripod, etc. Construct and equip a **meter repair and calibration bench.**
- Establish a regular **staff training program**, including training of staff on performance indicators and technical, financial, and managerial skills. Include computet training. Take part in "circuit training" program proposed to be administered at LVSWSB.
- **Computerize record-keeping and billing.** A database of all water and sewer customers should be created including customer name, account number, active/inactive status, location, meter age, all meter readings, bills sent, and payments received. All billing should be computerized.
- **Purchase vehicles** including trucks and motorcycles as required.

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1. *Lake Victoria Region Water and Sanitation Initiative – Supporting Secondary Urban Centres in the Lake Victoria Region to Achieve the Millennium Development Goals – Migori Town – Kenya.* United Nations Human Settlements Programme (UN-Habitat) Water for African Cities Programme, August 2004. [Referred to in Endnotes as 'UN-Habitat Migori Report']
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4. Migori Teachers College Wastewater Disposal System Proposal, 26th August 2005.
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10. *Water Service Provider Area and Rapid* Assessment. Migori Water and Sanitation Company (MIWASCO) Limited.
11. *Welcome to Migori District Water Office.* Summary document prepared by Migori District Water Officer, January 2006.

ENDNOTES:

[1] JICA 10 Town Study, pg. 2-1
[2] JICA 10 Town Study, pg. 2-1
[3] Welcome to Migori District Water Office, pg. 1
[4] JICA 10 Town Study, pg. 2-1
[5] JICA 10 Town Study, pg. 2-1
[6] Welcome to Migori District Water Office, pg. 1
[7] Welcome to Migori District Water Office, pg. 3
[8] JICA 10 Town Study, pg. 2-6

[9] JICA 10 Town Study Appendix G3
[10] Welcome to Migori District Water Office, pg. 2
[11] Welcome to Migori District Water Office, 'Management and Finance' page 4
[12] DSF Migori Visit Notes, pg. 2
[13] M. Devine Migori Visit Notes, pg. 2
[14] M. Devine Migori Visit Notes, pg. 3
[15] JICA 10 Town Study, pg. 2-3
[16] Migori Pre-Visit Survey and Data Request, pg. 2
[17] UN-Habitat Migori Report, pg. 2
[18] JICA 10 Town Study, Table 4.4 (before page 4-3)
[19] JICA 10 Town Study, pg. 5-1
[20] Meeting notes from Migori Mayor's office 30 January 2006
[21] Meeting notes from Migori Mayor's office 30 January 2006
[22] JICA 10 Town Study, pg. 2-11
[23] Nyasare Water Supply Association Project Overview (Highlights), pg. 2
[24] JICA 10 Town Study, pg. 4-11
[25] M. Devine Migori Visit Notes, pg. 6
[26] M. Devine Migori Visit Notes, pg. 1
[27] JICA 10 Town Study, pg. 3-5
[28] Migori District Annual Report, 2004, Section 3.2.9.1
[29] Welcome to Migori District Water Office, pg. 3
[30] JICA 10 Town Study, pg. 3-9
[31] Migori Teachers College Wastewater Disposal System Proposal, pg. 2
[32] JICA 10 Town Study, pg. 2-1
[33] JICA 10 Town Study, pg. 2-3
[34] Welcome to Migori District Water Office, pg. 4
[35] JICA 10 Town Study, pg. 2-8 to 2-9

8. PRELIMINARY ENVIRONMENTAL IMPACT ANALYSIS 8-1

8.1 Environmental Analysis Overview 8-1

8.2 Environmental Legislation 8-2
8.2.1 The Environmental Management and Coordination Act 8-2
8.2.2 The Environmental (Impact and Assessment Audit) Regulations, 2003 8-2
8.2.3 Draft Environmental Quality Standards 8-3

8.3 Evaluation Elements 3

8.4 Evaluation of Water Projects 8-4

8.5 Evaluation of Wastewater Projects 8-7

8. PRELIMINARY ENVIRONMENTAL IMPACT ANALYSIS

8.1 Environmental Analysis Overview

This study undertook the task of defining a program for bringing the water and wastewater management systems serving three towns in the LVSWSB service area (Kericho, Kisii and Migori) up to a standard of adequacy. Adequacy in this case has been defined as first meeting the water and wastewater service Millennium Development Goals by the year 2015 as prescribed, and then meeting the demands of all of the residents of the towns to the extent practical by the year 2025. The program that has been developed to attain these goals was done with attention to three guiding principals, i.e. the program must be viable, affordable and self-sustaining. The issue of viability has to do with defining what is needed in terms of infrastructure and management systems to assure that the required services can be provided. Affordability was taken to mean that the tariff system supported by the users of the services can support the costs, current and prospective, of providing the services. Self-sustaining means that a management system is in-place to assure the services are maintained in perpetuity.

The program that has been developed addresses improvements to be made by LVSWSB itself as well as each of the three towns. Categorically, the program recommendations include improvements in the areas of management systems, water systems, and wastewater systems. Management recommendations include broader use of water meters, improved record keeping, central purchasing of bulk items common to all systems and specialized equipment used periodically by all systems, training programs, public education/outreach programs, and others. Water system improvements include addressing the need for additional water supply, improving treatment capacity and capabilities, finding and fixing leaks in the existing distribution systems, expanding the existing distribution systems to provide service to areas that are not currently served, and expanding the network of water kiosks to serve informal settlements and public areas. Proposed wastewater system improvements include repairing and expanding the existing collection systems where they exist and establishing systems where they do not, improving treatment and disposal provisions, and improving public toilet facilities in informal settlements and public areas.

The improvements proposed are directed to the business of providing clean water to the people that live in the towns studied, and assuring that the wastewater that they generate is treated and disposed of in a way that is environmentally acceptable. With respect to the water supply and distribution improvements, significant environmental issues are anticipated which will need to be mitigated to the extent feasible. In essence, adequately serving the existing population will necessitate drawing more water from existing supplies as well as the identification of new supplies. The situation in this regard becomes more demanding as the population of the towns increases. As indicated, the population in each town is expected to approximately double during the study period. The study recommends the development of additional supplies from surface and ground water systems that are currently being accessed as well as the development of new surface water sources. In each case, when these recommendations are refined during preliminary design efforts, detailed environmental evaluations will have to be performed. Assessments of that nature are not within the scope of this evaluation. All proposals relative to wastewater improvements are expected to benefit the environment by providing for the management of waste that is currently fouling the environment. All improvements to hard infrastructure assets for water and wastewater will involve construction and in each case, construction-related environmental disturbances can be expected during the relatively short term period of construction.

This study is a feasibility study and as such it addresses improvements as elements of a program. Each of the elements proposed requires detailed design prior to implementation. This assessment addresses environmental impacts from a general perspective with the expectation that more detailed evaluations, to the extent necessary, will follow. Applicable local legislation and regulations are first identified and described. Elements of environmental concern germane to the issue of water and wastewater improvements are then presented. A discussion follows regarding impacts that may be expected for the water and wastewater improvements proposed. The discussion is general in nature, focusing on categorical impacts that may be

expected from water supply, treatment and distribution projects; and, wastewater collection, treatment and disposal projects. It is assumed at this level that impacts that can be expected for each of the three towns would be similar, so they are not individually discussed on a town-specific basis.

8.2 Environmental Legislation

The basis for establishing criteria for the evaluation of environmental impacts associated with the proposed projects is derived from Kenya's Environmental Management and Coordination Act, 1999. The Act and the associated regulations, The Environmental (Impact and Assessment and Audit) Regulations, 2003 and Draft Environmental Quality Standards are hereinafter discussed.

8.2.1 The Environmental Management and Coordination Act

The primary function of the Environmental Management and Coordination Act of 1999 is to provide for the establishment of an appropriate legal and institutional framework for management of the environment. The Act is administered by the National Environmental Council and implemented by the National Environmental Management Authority (NEMA). The Act defines environmental impact assessment as a "...systematic examination conducted to determine whether or not a program, activity or project will have any adverse impacts on the environment". The following regulations associated with the Act highlight those characteristics most applicable to this project:

Section 3(1) states that, "Every person in Kenya is entitled to a clean and healthy environment and has the duty to safeguard and enhance the environment." The Act goes on to state that any individual who feels that he or she has been denied these privileges has the right to address such accusations with the High Courts.

Section 58(1) states that, "Notwithstanding any approval, permit of license granted under this Act or any other law in force in Kenya, any person, being a proponent of the project, shall, before financing, commencing, proceeding with, carrying out, executing or conducting or causing to be financed, commenced, proceeded with, carried out, executed or conducted by another person any undertaking specified in the Second Schedule to this Act, submit a project report to the Authority in the prescribed form, giving the prescribed information and which shall be accompanied by the prescribed fee."

According to the 2nd schedule, *Projects to Undergo Environmental Impact Assessment*, the recommendations in this feasibility study would fall under section (4) dams, rivers and water resources including:

- Storage dams, barrages, and piers
- River diversion and water transfer between catchments
- Flood control schemes
- Drilling for the purposes of utilizing ground water resources including geothermal energy

Section 58(2) states that, "The proponent of a project shall undertake or cause to be undertaken at his own expense an environmental impact assessment study and prepare a report thereof where the Authority, being satisfied, after studying the project report submitted under subsection (1) that the intended project may or is likely to have or will have a significant impact on the environment, so directs."

8.2.2 The Environmental (Impact and Assessment Audit) Regulations, 2003

The primary objective of the Environmental Impact Assessment Audit (EIA) is to ensure that the project conforms to the regulations set forth by the National Environmental Management Authority (NEMA) of Kenya. It is important to note that the term "environment" includes all aspects of both the natural and the human environment. EIA is the study of the effects of a proposed action on the environment. Impacts that are taken into consideration include physical, biological, social, and economic characteristics. EIA is a

preventative process which seeks to minimize adverse impacts on the environment, and the ultimate objective of EIA is to aid judgmental decisions by outlining a clear picture of the alternatives which are considered, the environmental changes that are predicted, and the trade-offs of advantages and disadvantages for each alternative.

8.2.3 Draft Environmental Quality Standards

Part VIII of the Environmental Management Coordination Act focuses on environmental quality standards, and establishes a Standards and Enforcement Review Committee whose functions include the establishment of standards to include all environmental media. Committees exist for the following environmental subject areas:

- Water quality
- Waste quality
- Chemicals
- Land use
- Biodiversity
- Economic instruments
- Air quality

With the exception of the air quality committee, all committees are in the process of finalizing their respective standards.

8.3 Evaluation Elements

It is important in the evaluation process to identify an agreed upon list of environmental areas of concern for evaluation relative to the proposed improvements. In this case a list has been developed based on observations made by spending a considerable amount of time in the study area, discussions with knowledgeable people native to the area, a review of local literature and familiarity with programs of the type proposed. The list is as follows:

- Water Resources
  - Surface water
  - Groundwater
- Air Quality
  - Particulates
  - Hydrocarbons
  - Odor
- Biological Resources
  - Biodiversity
  - Wildlife
- Human Health and Safety
- Socio-Economic
- Cultural Resources
- Visual Aesthetics
- Noise
- Construction
- Beneficial Reuse

It is difficult and ill advised at this time to establish quantitative criteria for evaluation associated with these areas of concern since the elements in the proposed program are numerous, diverse and in need of further refinement. What will be established here is a set of topical areas of environmental concern and an indication of the important issues that must be addressed relative to each. The identified areas of concern should form the basis of an outline for more detailed environmental assessments that will be required for specific projects undertaken in the future.

The impact associated with each identified area of concern will be evaluated relative to the following factors: the extent of the area impacted, the number of people impacted, the special environmental value of the area impacted, the probability of an adverse impact, the duration of the adverse impact, the frequency of the adverse impact, and the reversibility of the adverse impact.

8.4 Evaluation of Water Projects

Positive Impacts

As discussed, the towns studied are in dire need of improved water service in the interest of the health and safety of the inhabitants of the towns. Studies show that water borne and water related diseases including cholera, typhoid, and dysentery are prevalent in the majority of the communities in Kenya. Statistically, water-born and water-related diseases are within the top five types of disease and causes of mortality in Kenya. Any improvement to water supply treatment would have a positive effect on the residents of the towns. In addition, improving the health of the residents would lead to increased economic productivity and a decreased burden on existing health facilities.

Women and children in particular would benefit from improvements to the water systems. Women carry a disproportionate share of the labor and health burdens within the towns in Kenya. Women are generally responsible for obtaining, carrying, and storing water supplies, washing and preparing food, doing the laundry, preparing bathing or showering facilities, and looking after the young and the elderly. Many of these activities involve water, which is often the source of disease. The implementation of water improvements would improve the quality of life for women in Kenya.

Infants and children generally suffer the brunt of poor health and premature mortality as a result of water-borne and water-related diseases and malnutrition. Infant and child mortality rates have decreases in the past decade in Kenya, however, health issues such as diarrhea, malaria, intestinal worms, and eye and skin infections and diseases are still prevalent. The implementation of water improvements would have a positive impact on the health, well-being, and quality of life of infants and children.

Socio-economically, the towns will also benefit significantly from improved water service. As the towns grow, more and better water supplies will be needed to meet the domestic and commercial need of the inhabitants. The Lake Victoria South area enjoys commercial potential in the form of tea, sugar and flower farming as well as fishing in Lake Victoria. These enterprises in conjunction with the agrarian nature of the area rely on water. An improved water management system is necessary to support the socio economic growth of the area.

Environmental Issues

Apart from construction impacts which will be separately addressed, the major area of concern in the development of water supplies to meet human needs is the impact on the non-human needs. Water diverted to human use is taken away from the remaining biological environment. The process of impounding or diverting surface waters for human consumption can significantly alter the character of the body of water and the flora and fauna that relies upon it. Table 8-1 provides a list of concerns as they relate to dams. As indicated, the issues are significant and it is important that they be addressed in implementing new dams and impoundments in the region as proposed. The same areas of concern exist to varying degrees in taking water from flowing streams without the use of dams. Issues of concern relative to accessing groundwater, which are not recommended in this study for future long-term water supplies, are less severe.

Table 8-1. The Chief Environmental Impacts of Dams

Impacts due to existence of dam and reservoir:

1) Imposition of a reservoir in place of a river valley (loss of habitat).
2) Changes in downstream morphology of riverbed, delta coastline due to altered sediment load.
3) Changes in downstream water quality: effects on river temperature, nutrient load, turbidity, dissolved gases, concentration of heavy metals and minerals.
4) Reduction of biodiversity due to blocking of movement of organisms (e.g. salmon) because of above changes.

Impacts due to pattern of dam operation:

1) Changes in downstream hydrology;
   a) Change in total flows;
   b) Change in seasonal flows (e.g. Spring flood becomes Winter flood.)
   c) Short-term fluctuation in flows (sometimes hourly);
   d) Change in extreme high and low flows.
2) Changes in downstream morphology caused by altered flow pattern.
3) Changes in downstream water quality caused by altered flow pattern.
4) Reduction in river/riparian/floodplain habitat diversity, especially because of elimination of floods.

Source: McCully (1996)

As indicated, the need for water is severe. New supply sources including at least one dam must be developed to meet the basic needs of people that live in the area. Impounding water and diverting stream flow must be done in a way that is sensitive to the environmental concerns identified.

Construction Impacts

As with construction of any kind, short term environmental impacts are to be expected. Construction typically includes noise, dust, soil erosion, traffic, and odor impacts. The significance of these impacts will vary with the physical constraints of the site, the accessibility of the site, the nature of the site (i.e. topography, soil material, wetlands etc.). The development of previously cleared sites can be expected to have less impact than development on sites with constraints that necessitate complex construction methods and extensive clearing. Proximity to dwellings and sensitive receptors (e.g. residential areas, schools, hospitals etc.) are also key factors relative to environmental impacts.

There is no doubt that the proposed improvements to the water system are worthy of enduring short term construction impacts. Impacts of this type should be minimized by employing normally accepted mitigation measures such as acceptable working hours, fugitive dust control, construction site access control, silt fences, etc.

Impact Summary

The intent of the discussion in this section was to present the major impacts that can be expected as a result of the implementation of the proposed water system improvement program for the towns studied. As previously indicated, detailed environmental impact assessments need to be prepared as required for individual program elements at a time proximate to their implementation. This presentation is meant to be an overview of significant environmental impact issues that can be expected from the work proposed. As indicated, in keeping with the purpose of this study, the human environment will be significantly improved as

a result of the proposed work. There will be associated construction impacts that will be relatively small as compared to the overall good of the improvements. The one area of significance relative to potential environmental impacts associated with the proposed improvements is water supply via impoundments and diversion of stream flows. Impacts associated with projects of this type must carefully consider environmental impacts and provide for the mitigation of severe impacts.

An overview of the impacts associated with the three major categories of project types proposed in the water sector; supply, treatment and distribution, is provided in Table 8-2. Areas of environmental concern are listed and an indication of whether positive, negative or neutral impacts can be anticipated is provided. An indication of duration, frequency and reversibility is also provided.

Table 8-2. Water Projects - Environmental Impact Summary

Sensitive Areas	Supply		Treatment		Distribution	
Water Resources						
Surface Water	-	lt/f/r	0		0	
Groundwater	-	lt/f/r	0		0	
Air Quality						
Particulates	NA		NA		NA	
Hydrocarbons	NA		-	lt/f/r	-	lt/f/r
Odors	NA		0		0	
Biological Resources						
Biodiversity	-	lt/f/r	0		0	
Wildlife	-	lt/f/r	0		0	
Human Health and Safety	++	lt/f/r	++	lt/f/r	++	lt/f/r
Socio Economic	++	lt/f/r	++	lt/f/r	++	lt/f/r
Cultural Resources	0		0		0	
Visual Aesthetics	0		0		0	
Noise	0		0		0	
Construction	-	st/f/r	-	st/f/r	-	st/f/r
Beneficial Reuse	NA		NA		NA	

Legend:

Potential Impacts	Characteristics
++ Significant positive Impact	st Short Term
+ Positive Impact	lt Long Term
0 Neutral	f Frequent
- Negative Impact	if Infrequent
-- Significant Negative Impact	r Reversible
	ir Irreversible
N/A Not applicable	

8.5 Evaluation of Wastewater Projects

Positive Impacts

The wastewater management situation in the towns studied is considerably worse than the water management situation. As previously indicated, it has been reported in 2002 by the Kenya Ministry of Environment and Natural Resources that access to sanitation in Kenya had declined over the past two decades and that about 42% of low income households do not have adequate sanitation. Where centralized wastewater systems do exist, connections to it are limited, the treatment works to which the wastewater is transported are poorly maintained, and the quality of the discharged effluent is poor. The consequence of this state of affairs is indiscriminate disposal of wastewater, polluted rivers and stream, and proliferation of disease vectors and disease. Clearly, this is a situation that must be addressed in the best interest of the health of the inhabitants of the study towns. In fact, the reach of the diseases that result from poor sanitation and pollution goes well beyond the limits of the towns studied and the impact of disease often falls hardest on the very young and the poorest members of society.

As is the case with water improvements, improvement to wastewater management would have a positive effect on the residents of the towns by improving their health. This would result in increased productivity and happiness. The aesthetics of the towns would be greatly enhanced by cleaner rivers and streams. Properly managed wastewater would also alleviate the current burdens of odors and unsightliness that characterize many existing wastewater disposal practices.

The socio-economic growth in the towns studied will rely on improved wastewater management provisions. Without improvements to the wastewater management system, the anticipated growth will exacerbate the health and aesthetic issues that currently characterize the wastewater management efforts. The wastewater improvements included in the plan will allow the towns in the study area to grow and prosper without being held back by wastewater management limitations.

Environmental Issues

In general, the environmental impacts of improved wastewater collection and treatment will be greatly positive. The most significant potential adverse impact that may be associated with broadening the nature and scope of the wastewater collection, treatment and disposal systems currently serving the study towns, is that the system accommodates and can in-fact promote growth. This is not always viewed in a positive light. Understanding cause and effect relationships in this regard in a way that will promote desirable growth is important. Wastewater systems can alter groundwater flow patterns and the systems can play a role in the inter basin transfer of water resources. While none of these issues is substantive as a deterrent to improving the wastewater management situation in the study towns, improvements should be made in consideration of these factors as applicable.

Construction Impacts

The impacts that can be expected with respect to wastewater construction are the same as for water construction. The discussion presented in section 8.4 under construction impacts applies here.

Impact Summary

The proposed wastewater management improvements are essential in the interest of human health, protecting the environment and natural resources, and accommodating the growth expectations of the towns studied. The human environment, the water environment, the flora, the fauna, wildlife, biodiversity will all benefit from better facilities and better managed wastewater facilities. While certain issues having to do with

managing growth and inter basin transfers of water resources might come into play, none are seen as issues that override the benefits of better health and a cleaner environment offered by the proposed improvements.

An overview of the impacts associated with the three major categories of project types proposed in the wastewater sector; collection, treatment and disposal, is provided in Table 8-3. Areas of environmental concern are listed and an indication of whether positive, negative or neutral impacts can be anticipated is provided. An indication of duration, frequency and reversibility is also provided.

Table 8-3. Wastewater Projects - Environmental Impact Summary

Sensitive Areas	Collection		Treatment		Disposal	
Water Resources						
Surface Water	++	lt/f/r	++	lt/f/r	++	lt/f/r
Groundwater	++	lt/f/r	++	lt/f/r	++	lt/f/r
Air Quality						
Particulates	NA		0		NA	
Hydrocarbons	-	lt/f/r	-	lt/f/r	NA	
Odors	+	lt/if/r	-	lt/if/r	-	lt/if/r
Biological Resources						
Biodiversity	++	lt/f/r	++	lt/f/r	++	lt/f/r
Wildlife	++	lt/f/r	++	lt/f/r	++	lt/f/r
Human Health and Safety	++	lt/f/r	++	lt/f/r	++	lt/f/r
Socio Economic	++	lt/f/r	++	lt/f/r	++	lt/f/r
Cultural Resources	0		0		0	
Visual Aesthetics	0		-	lt/f/r	-	lt/f/r
Noise	0		0		0	
Construction	-	st/if/r	-	st/if/r	-	st/if/r
Beneficial Reuse	NA		0		0	

Legend:

Potential Impacts	Characteristics
++ Significant positive Impact	st Short Term
+ Positive Impact	lt Long Term
0 Neutral	f Frequent
- Negative Impact	if Infrequent
-- Significant Negative Impact	r Reversible
	ir Irreversible
N/A Not applicable	

Sources:

Gordon, Sharon, Environmental Consultant Registered Lead NEMA-Kenya Expert Strategic Environmental Assessment (SEA) for 15 Towns in the Lake Victoria Basin In Kenya, Uganda & Tanzania. Final Report.

Republic of Kenya Ministry of Water and Irrigation Practical Manual for water Supply Services in Kenya. November, 2005.

9. FINANCING AND IMPLEMENTATION PLAN **9-1**

9.1 Overview **9-1**

9.2 Summary of Project Costs and Needs **9-1**

9.3 Financing **9-8**
9.3.1 Work Plan 9-8
9.3.2 Project Structure 9-9
9.3.3 Financing Sources 9-11
9.3.4 Financing Plan 9-13
9.3.5 Security Package 9-14
9.3.6 Financial Analysis 9-15
9.3.7 MIKUTRA (Migori) 9-19
9.3.7 (a) MIKUTRA Financial Modeling 9-19
9.3.7 (b) MIKUTRA CapEx Plan 9-20
9.3.7 (c) MIKUTRA Sensitivities 9-21
9.3.8 KEWASCO (Kericho) 9-23
9.3.8 (a) KEWASCO Financial Modeling 9-23
9.3.8 (b) KEWASCO CapEx Plan 9-24
9.3.8 (c) KEWASCO Sensitivities 9-25
9.3.9 GWASCO (Kisii) 9-27
9.3.9 (a) GWASCO Financial Modeling 9-27
9.3.9 (b) GWASCO CapEx Plan 9-28
9.3.9 (c) GWASCO Sensitivities 9-29
9.3.10 LVSWSB 9-30
9.3.10 (a) LVSWSB Financial Model 9-30
9.3.10 (b) LVSWSB CapEx Plan 9-32
9.3.10 (c) LVSWSB Sensitivities 9-36

9.4 Implementation Plan **9-37**

9. FINANCING AND IMPLEMENTATION PLAN

9.1 Overview

This Section reviews the following three topics:

- Summary of Project Costs and Needs
- Financing
- Implementation Plan

The following financial analyses confirm the initial hypothesis that it is possible establish viable, affordable, and self-sustaining water and wastewater utility service in the study towns while maintaining tariff rates around the Kenyan average. The next step is to immediately transition to successful implementation of the project. As described below, the Lake Victoria South Water Services Board's immediate efforts should be focused on securing funds for the first steps, which include technical and management tasks to begin the process of transforming existing service providers into bankable utilities, and securing btidge financing to implement the first phase of work.

9.2 Summary of Project Costs and Needs

The following pages contain figures and tables detailing existing service populations, service goals, and required major projects and cost estimates to meet the stated goals. The required projects range from detailed studies and a variety of management and operation and maintenance activities to the construction of dams and treatment facilities capable of providing water and sanitation for decades.

Key projects in the three communities include, but are not limited to, the following:

- Construction of water supply dams and intakes
- Upgrade, expansion, and construction of new water treatment, storage, and distribution systems
- Upgrade, expansion, and construction of new wastewater collection systems and treatment facilities
- Water metering and leak detection and repair
- Purchase of new laboratory and maintenance equipment
- Training programs for WSP staff and managers
- Asset management systems including mapping, computer hardware and software, master meters, preventative maintenance programs, etc.
- Watershed protection and public education programs
- Regionalization and local entrepreneurship programs

The phasing of projects will take place over an approximately 20-year period. It is expected that projects will occur as described below and in additional detail in the detailed matrices. The detailed matrices include a summary of the methodology used in deriving costs for each line item. A variety of sources of cost information was utilized including costs of recent similar projects, available detailed studies and design reports, available Kenyan and international guidelines, Kenya Civil Engineering Cost Indices, and engineering estimation. Phasing and project costs estimated in this report may require adjustment after more detailed analyses are carried out as part of the immediate projects.

Kisii Town - Water

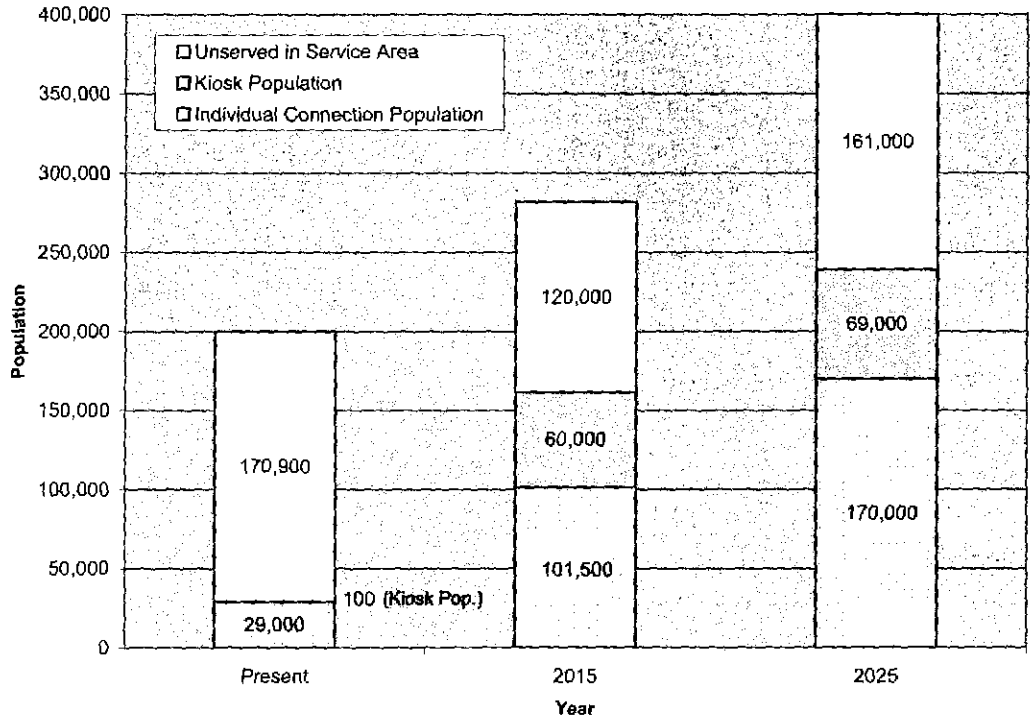

Figure 9-1. Kisii Town Existing Water Service Population and Future Service Goals

Table 9-1. Kisii Town Required Projects and Cost Estimates to Meet Water Service Goals

	Immediate *Within ~1 Year*	Short Term *By 2015*	Long Term *2016 - 2025*
Management	$ 870,000	$ 950,000	$ -
	Mapping, Bulk Metering, System Inventory, Asset Management Plan, Preventative Maintenance Plan, Water Audit, Watershed Protection, Illegal Connections, Training, Computers, Tariff Analysis, Staffing Study, Public Education, Equipment, Vehicles / New Offices, Consumer Meter Replacement, Land Purchase for Watershed Protection		
Source	$ 80,000	$ 2,680,000	$ 8,800,000
	Source Augmentation, Power Studies	*New Intake, Raw Water Main*	*Dam & Reservoir, Raw Water Main*
Treatment	$ 320,000	$ 4,440,000	$ 3,000,000
	WTP Upgrade Study, Sampling, Basic Lab and WTP Improvements	*New WTP, Existing WTP Upgrades*	*WTP Expansion*
Distribution	$ 660,000	$ 5,460,000	$ 8,760,000
	System Improvement Plans, Leak Detection & Repair, Kiosk Planning, Distribution System Upgrades	*System Expansion Plan, Distribution System Expansion, Water Kiosks, New Service Connections, Storage*	*Water Kiosks, New Service Connections, Storage*
TOTAL	**$ 1,930,000**	**$ 13,530,000**	**$ 20,560,000**
TOTAL WATER (ROUNDED)			**$ 36,000,000**

Kisii Town - Wastewater

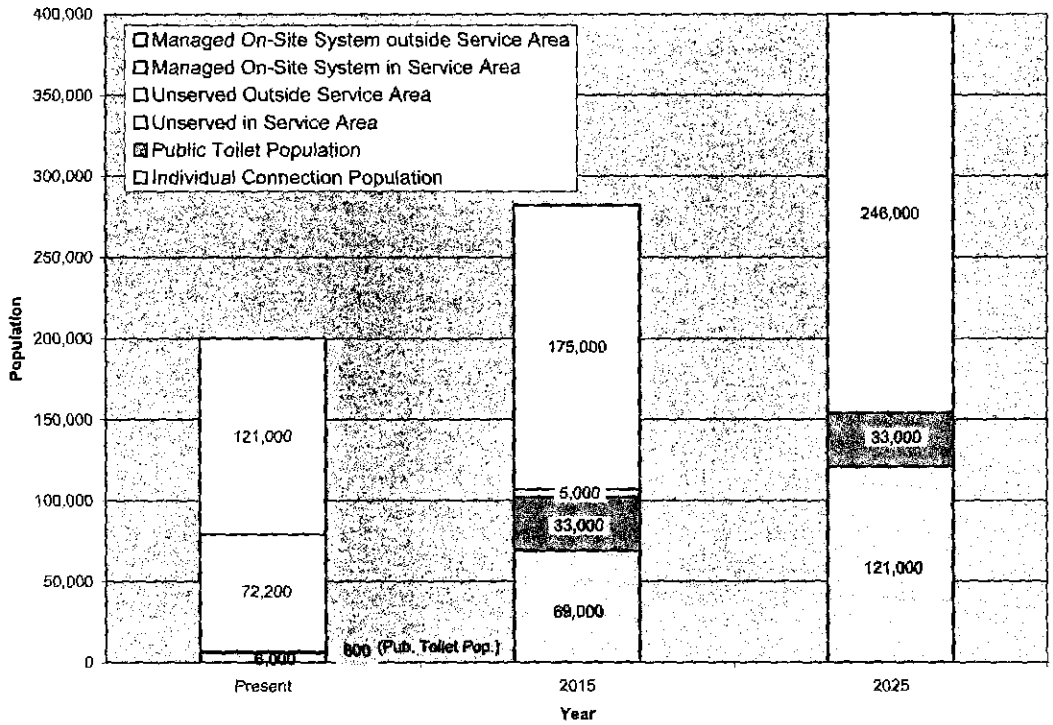

Figure 9-2. Kisii Town Existing Wastewater Service Population and Future Service Goals

Table 9-2. Kisii Town Required Projects and Cost Estimates to Meet Wastewater Service Goals

	Immediate *Within ~1 Year*	Short Term *By 2015*	Long Term *2016-2025*
Management	$ 60,000	$ -	$ -
	On-Site Wastewater Management Plan, Public Toilet/Latrine Plan, Infill Incentive Program		
Collection	$ 350,000	$ 3,640,000	$ 4,500,000
	Wastewater collection study, Infill Connections, Replace Manhole Covers, Buy Exhausters and Sewer Cleaning Equipment, Rehab & New Public Toilets	*Infill Connections, Public Toilets*	*Sewer Expansion, New and Infill Connections, Public Toilets*
Treatment	$ 30,000	$ 160,000	$ 220,000
	WWTF Upgrade & Expansion Planning, O&M / Sampling Improvements, Screening	*Laboratory equipment; Ugrades including Algae Baffles, Sludge Valves, Sludge Removal, Lagoon Covers, Composting; Reuse Study*	*Supplemental Aeration, Recirculation System, Constructed Wetland*
TOTAL	**$ 440,000**	**$ 3,800,000**	**$ 4,720,000**
TOTAL WASTEWATER (ROUNDED)			**$ 9,000,000**

Kericho Town - Water

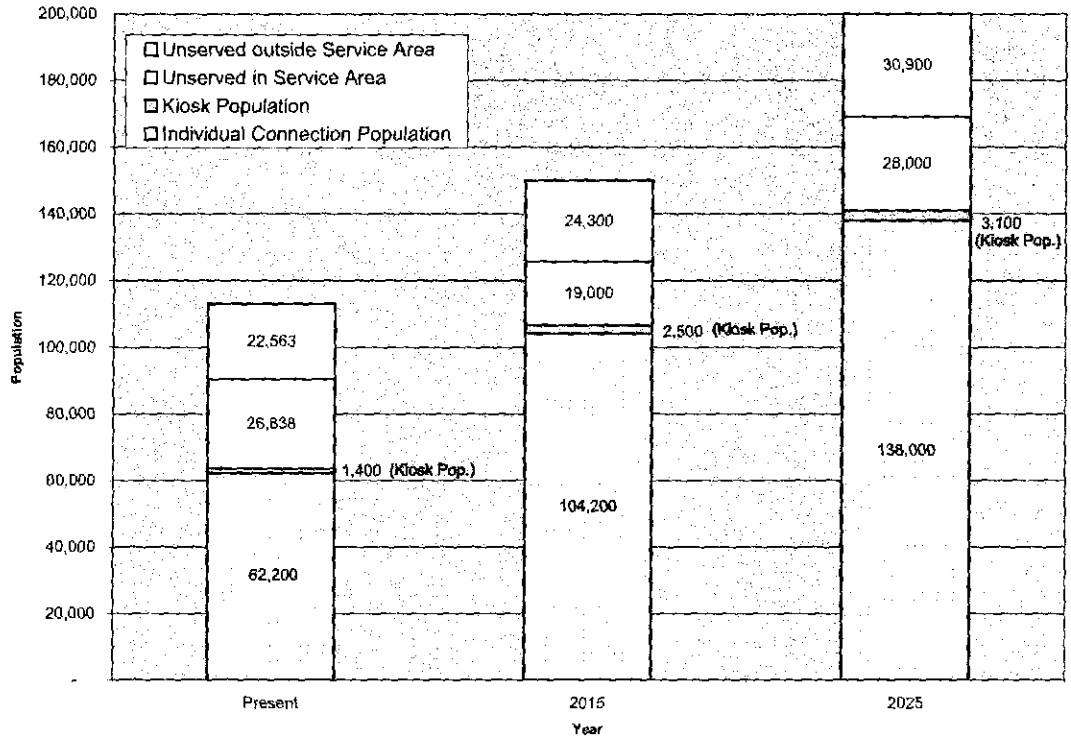

Figure 9-3. Kericho Town Existing Water Service Population and Future Service Goals

Table 9-3. Kericho Town Required Projects and Cost Estimates to Meet Water Service Goals

	Immediate *Within ~1 Year*	Short Term *By 2015*	Long Term *2016-2025*
Management	$ 800,000	$ 950,000	$ -
	Mapping, Bulk Metering, Consumer Meter Pilot, System Inventory, Asset Management Plan, Preventative Maintenance Plan, Water Audit, Watershed Protection, Illegal Connections, Training, Computers, Tariff Analysis, Staffing Study, Public Education, Equipment, Vehicles / New Offices, Consumer Meter Replacement, Land Purchase for Watershed Protection		
Source	$ 50,000	$ 8,260,000	$ -
	Source Augmentation Planning, Bulk Metering	*Dam & Reservoir, Raw Water Main*	
Treatment	$ 70,000	$ 1,960,000	$ 1,900,000
	WTP Upgrade / Expansion Planning; Laboratory Equipment	*Upgrade & Expand Timbilil WTP; Ugrade Kimugu WTP; New WTP and Raw Water Main Planning*	*New WTP*
Distribution	$ 180,000	$ 1,900,000	$ 3,400,000
	System Improvement Plans, Leak Detection & Repair, Kiosk Planning	*New Service Connections*	*System Expansion, New Service Connections*
TOTAL	**$ 1,100,000**	**$ 13,070,000**	**$ 5,300,000**
TOTAL WATER (ROUNDED)			**$ 19,500,000**

Kericho Town – Wastewater

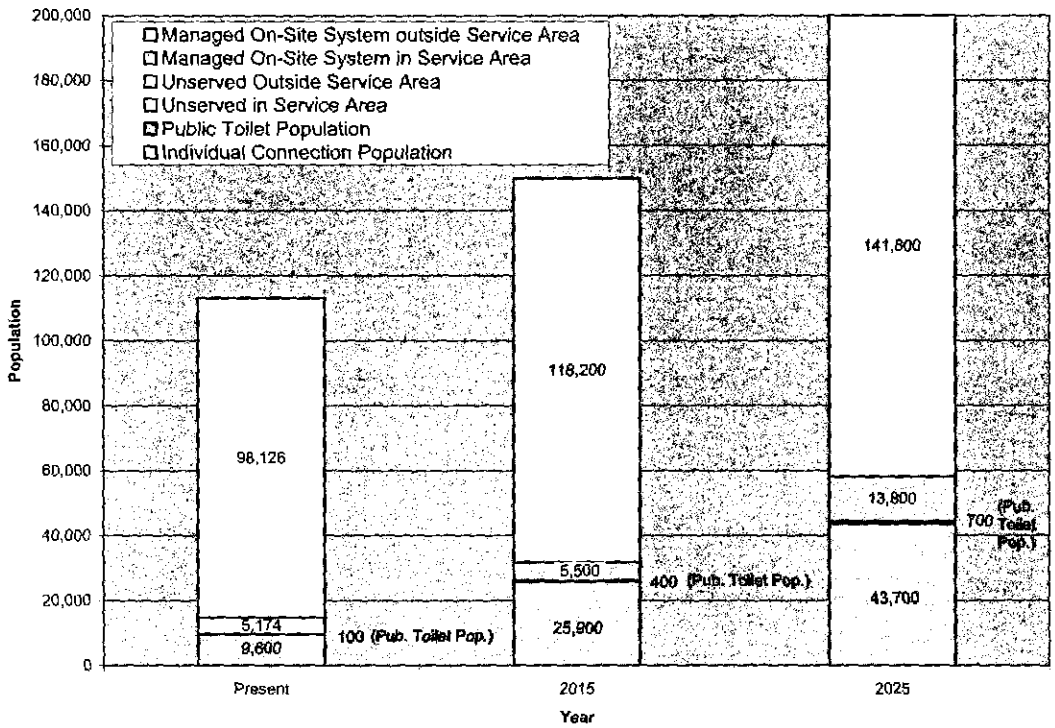

Figure 9-4. Kericho Town Existing Wastewater Service and Future Service Goals

Table 9-4. Kericho Town Projects and Cost Estimates Required to Meet Wastewater Service Goals

	Immediate *Within ~1 Year*	Short Term *By 2015*	Long Term *2016-2025*
Management	$ 20,000	$ -	$ -
	On-Site Wastewater Management Plan, Large User Discussions		
Collection	$ 160,000	$ 1,440,000	$ 3,400,000
	Wastewater collection planning, Infill Connections, Buy Exhauster and Sewer Cleaning Equipment, Rehab & New Public Toilets, I/I Evaluation	*New Pumping Station, Infill Connections, Public Toilets, Exhausters*	*Sewer Expansion, New and Infill Connections*
Treatment	$ 220,000	$ 600,000	$ 1,100,000
	WWTF Upgrade & Expansion Planning, WWTF Improvements i.e. Lab Upgrade, Pilot Aeration, etc.; Sludge Reuse / Septage Mgmt. Planning	*Digester Mixing, WWTF Expansion, Septage Receiving Improvements*	*New Central and Satellite WWTF*
TOTAL	**$ 400,000**	**$ 2,040,000**	**$ 4,500,000**
TOTAL WASTEWATER (ROUNDED)			**$ 7,000,000**

Migori Town – Water

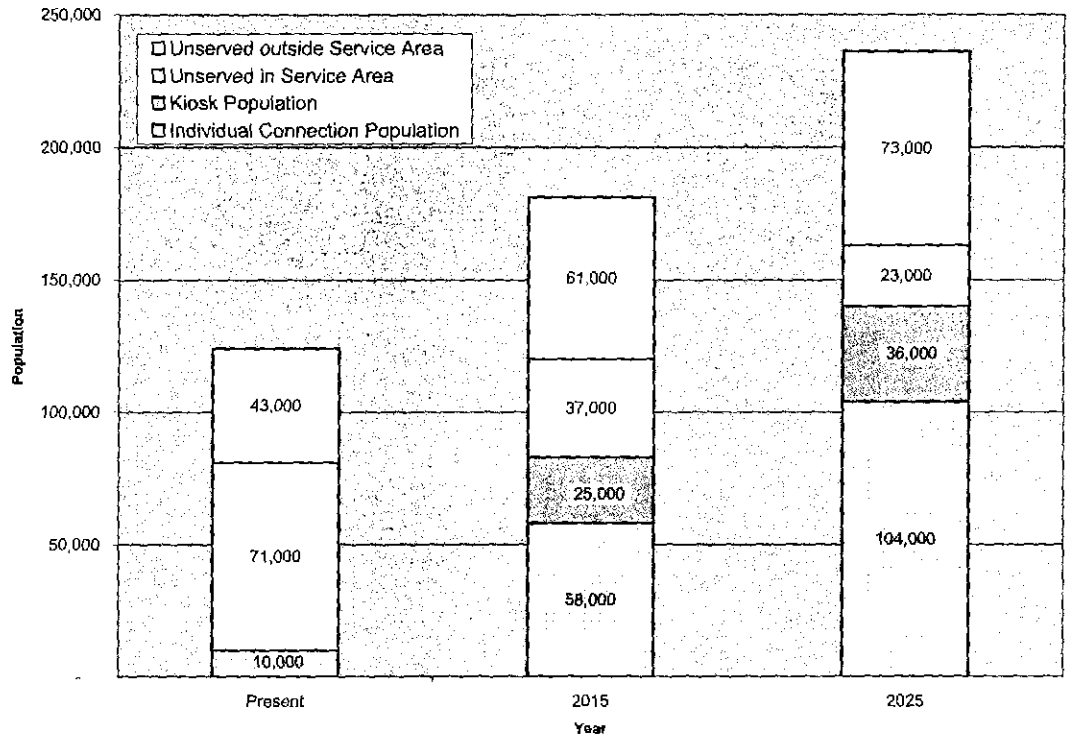

Figure 9-5. Migori Town Existing Water Service and Future Service Goals

Table 9-5. Migori Town Projects and Cost Estimates Required to Meet Water Service Goals

	Immediate *Within ~1 Year*	Short Term *By 2015*	Long Term *2016-2025*
Management	$ 670,000	$ 240,000	$ -
	Mapping, Bulk Metering, Consumer Meter Pilot, System Inventory, Asset Management Plan, Preventative Maintenance Plan, Water Audit, Watershed Protection, Illegal Connections, Training, Computers, Tariff Analysis, Staffing Study, Public Education, Equipment, Vehicles / Offices Expansion, Land Purchase for Watershed Protection		
Source	$ 610,000	$ 3,330,000	$ 2,230,000
	Source Augmentation Planning, Boreholes testing / rehab / aux. power	*Oyani R. Intake, pumping, pipeline, aux. power*	*Additional intake, pumping & raw water pipeline capacity*
Treatment	$ 300,000	$ 2,130,000	$ 1,470,000
	Add disinfection, pH control	*Treatment Study, New WTP*	*WTP Expansion*
Distribution	$ 140,000	$ 6,400,000	$ 3,470,000
	System Improvement & Expansion Plans, Leak Detection & Repair, Kiosk Planning & Pilot	*Kiosks, Distribution upgrade & expansion, new service connections, storage / pumping*	*Kiosks, Distribution expansion, new service connections, storage / pumping*
TOTAL	**$ 1,720,000**	**$ 12,100,000**	**$ 7,170,000**
TOTAL WATER (ROUNDED)			**$ 21,000,000**

Migori Town – Wastewater

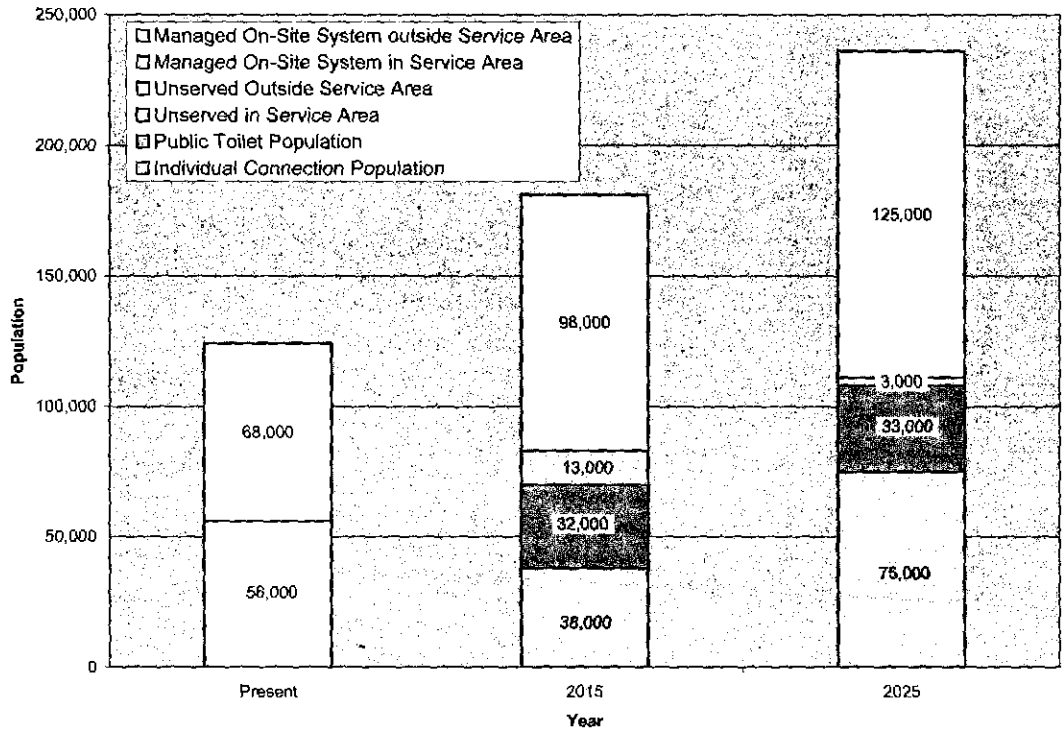

Figure 9-6. Migori Town Existing Wastewater Service and Future Service Goals

Table 9-6. Migori Town Projects and Cost Estimates Required to Meet Wastewater Service Goals

	Immediate *Within ~1 Year*	Short Term *By 2015*	Long Term *2016-2025*
Management	$ 30,000	$ -	$ -
	On-Site Wastewater Management Plan, Public Toilet Planning, Large User Discussions, St. Joseph's Lagoon discussions		
Collection	$ 80,000	$ 3,930,000	$ 2,590,000
	Wastewater collection planning, Public latrine rehab / commercialization plan & pilot program	*Public Latrines/Toilets; Exhauster purchase; Collection system & service connections*	*Sewer Expansion, New Connections*
Treatment	$ 70,000	$ 2,700,000	$ 500,000
	Municipal wastewater treatment study; St. Joseph's Lagoon feas. study, upgrades; septage discharge site assessment; Migori TTC septic upgrade	*Expand St. Joseph's Lagoons; Upgrade septage disposal site; Construct municipal WWTF*	*WWTF Expansion*
TOTAL	**$ 180,000**	**$ 6,630,000**	**$ 3,090,000**
TOTAL WASTEWATER (ROUNDED)			**$ 10,000,000**

Total Costs

The total estimated costs for all study recommendations are included in Table 9-7. Costs associated with large infrastructure projects may require refinement after more detailed studies are carried out as part of the Immediate Projects.

Table 9-7. Total Estimated Costs for Three Town WSPs and LVSWSB

	WATER	WASTEWATER	TOWN TOTAL
KERICHO	$ 19,470,000	$ 6,940,000	$ 26,410,000
KISII	$ 36,020,000	$ 8,960,000	$ 44,980,000
MIGORI	$ 20,990,000	$ 9,900,000	$ 30,890,000
TOATALS	$ 76,480,000	$ 25,800,000	$ 102,280,000

LAKE VICTORIA SOUTH WATER SERVICES BOARD	$ 700,000

GRAND TOTAL	**$ 103,000,000**

Note: These estimated costs exclude soft costs associated with financing

9.3 Financing

9.3.1 Work Plan

The Project Team's Finance related work was undertaken by the finance team members in close cooperation with the technical team members. Significant information was provided by the Water Services Board and the respective WSPs. In addition to financial statements, tariffs, the cost of various items and work performed by the WSPs and the Water Services Board within their districts, the Project Team analyzed the new Kenya Water Act and the resulting framework within which the new infrastructure investments would and could occur, examined any relevant precedents for funding Kenyan and neighboring country water sector projects, and developed an understanding of the available and more suitable financing sources for the LVSWSB projects.

As a more optimal type of financing plan emerged during the Study (based on a review of the appetite of various multilateral and regional development funding institutions), the Project Team analyzed financing issues, the project structure and the security package that would be available for financiers, the sources of revenue and the contractual agreement generating this revenue.

The Project Team developed financial modeling projections utilizing the findings of the Study, inclusive of capital costs, timing of expenditures, projected demand in water and waste water, tariffs, and financing terms. In order to generate an economic analysis of the LVSWSB projects, the Project Team created and worked with eight different financial spreadsheets or "models". Initially with a Detailed Assumptions Model for each community built with the data developed in the Study, these models then feeding into distinct Financial Models for each community, which in turn yielded results for the LVSWSB Financial Model. The latter is the required financial model for the Study's scope of work and the one which would be presented to prospective financiers. The Project Team ran sensitivities based on tariffs, financing terms, and demand.

Finally, the Project Team introduced the prospective project to various financial institutions both at the initial stage and latter stages of the Study. The initial discussions were based on assessing appetite, general terms, capacity, and learn about specific issues they may want to see addressed. The later stage discussions allowed

the Project Team to raise the specific needs of the project as identified in the Study, and determine how the Water Services Board could proceed and obtain a financing from these institutions. Among these discussions was a bridge financing concept with two regional banks. The latter expressed interest in exploring the concept further as a means to bridge the time it would take to secure the long term concessionary type financing which is available to such projects.

9.3.2 Project Structure

The Study concluded that the Water Services Board should essentially act as a "project sponsor" and owner of the new infrastructure recommended by the Study. This conclusion was reached based on various factors:

- The responsibility of funding and implementing the larger infrastructure needs in each community is left to the Water Services Board. The Kenya Water Act mandated the Water Services Board not only to finance but also construct, and provide major maintenance of the infrastructure within their territory.
- The WSPs must contract with the Water Services Board, who in turn monitors their performance, and assesses their respective financial and infrastructure requirements, among other requirements. The Board has the power to cause the WSPs to perform or replace them.
- The Water Services Board falls under the Ministry of Water and Irrigation, whereas the WSPs are private corporations, albeit still owned by the local municipality. For some years to come the WSPs will have smaller balance sheets and financial capacity, whereas the Water Services Board has the backing of the GOK, and already a larger balance sheet which will only increase as a result of the new infrastructure it must install. It is more creditworthy.
- The Water Services Board is a young entity yet it is responsible for new infrastructure investments and managing construction, and much of its personnel has years of experience in these capacities.
- For existing and new infrastructure, the WSPs must pay the Water Services Board a Lease payment and a royalty fee, covering at a minimum the Cost of Capital. The Lease payments for new infrastructure will be agreed to but will at a minimum include total capital cost recovery and some level of maintenance reserve. Thus the Water Services Board has a revenue structute that ensures it is financially solvent.
- The Water Services Board will expand with additional WSPs and more infrastructure investment requirements. It has a natural hedge of revenue sources arising from multiple WSPs, and hence more attractive to lenders than just a WSP.

As per the diagram below, the LVSWSB would secure funding, and carry out the investments in each community. The alternative of having multiple financings of smaller size at the level of each WSP is not a cost and time efficient structure.

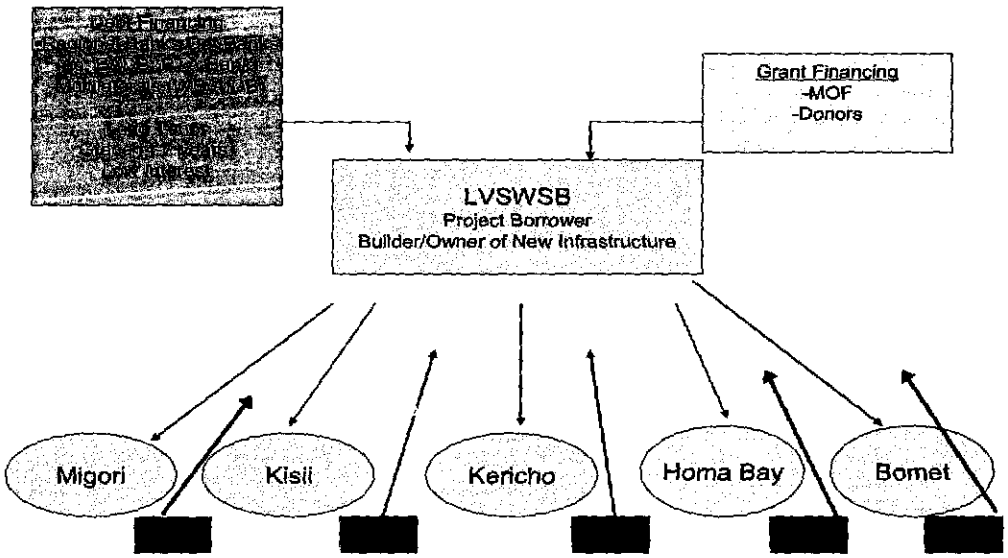

Figure 9-7. LVSWSB Financing Model

The contractual relationship between the WSPs for each community, or in the case of Kisii and Keroka which are covered by the same WSP (GWASCO), is a Service Provider Agreement (SPA). The revenue to the Water Services Board is determined by:

- A royalty on revenues of the WSP (revenues being the collections for water consumption, sewer charges, and other),
- The pass-through of meter rental fees, and
- For future capital investments an annual lease cost to be agreed and which will cover the cost of capital and more. The Water Services Board is keen on ensuring that it does not just cover the cost of capital but also allows for the build-up of expansion and major maintenance capital.

These SPAs are fully developed legal contracts, have been signed, and lay out the responsibilities of both the Water Services Board and the WSPs.

Per the diagram above, the new infrastructure would remain under ownership of the Water Services Board, allowing it to remove the WSP in the event of non-performance without requiring a transfer of infrastructure assets. This flexibility is viewed as an attractive structure from a financing perspective. The WSPs are new entities, with new management albeit while capturing much of the employees of its preceding municipal water group. The Water Act aims for these WSPs to be financially solvent as private entities and the SPA conditions provide the necessary incentives to achieve that.

The Kenyan water sector has essentially created a "public-private partnership" structure albeit with a transformation of the previous municipal water and wastewater division into a new private entity, and collapsing assets and staff from prior governmental water bodies into new Water Services Boards. A major difference from other countries where this sector has been privatized is that the main participants are indigenous, and in the case of the "concession" holder and sponsor, it is a new state-owned entity created specifically for this role. The Project Study Team believes that this results in operating cost savings and a reduction in capital return requirements. Any expertise not available within the staff can be, and has been, supplemented through consultancy arrangements with suitable experts. In the case of the revenue collectors and operator, the WSPs are newly created private sector companies using the pre-existing staff. As a private entity the staff can find new ways of becoming incentivized in the success of the business. While there is a learning curve involved which may not be the case with an established international water operator/sponsor,

upon reaching the required capability the country is able to proceed with a lower cost operator and pass those savings onto the consumer.

The option of privatizing the Water Services Board to the highest bidders remains available to the GOK but at a time in which these boards have been able to grow, and gained in value.

9.3.3 Financing Sources

Infrastructure projects in Africa are financed by an increasingly diverse source of financiers. There have been several new investment funds targeted to the market, as well as an increased liquidity at the level of commercial banks and other private debt providers, and some governments have launched new credit facilities available to certain African countries. The traditional "official sources" such as the Export Credit Agencies (ECAs), the global development banks (Overseas Private Investment Corporation, DEG, Development Bank of South Africa, etc.), and the multilaterals (World Bank, IFC, African Development Bank, KfW, etc.), are getting more competition from the private sector, but remain highly active and a reliable source of funding. Also worth mentioning are the regional development banks such as the East African Development Bank and the PTA Bank. While smaller, they are focused on fewer countries, have expanded their knowledge base and the types of projects they get involved with, and have gained credibility as a syndicator as well. These are good times for good African projects as the liquidity and number of financing sources are at the highest levels they have probably ever been.

However, not all projects have the luxury of meeting the criteria of all these sources, nor do the terms and conditions offered by some suit the needs of the projects. Hence, the financing sources focused on in the study are those meeting the needs of the LVSWSB.

The general view on Kenya by financiers is that it is a stable market from a political standpoint, it offers a solid legal system and precedents, and while a poor country it has good economic indicators. There are several successful companies, financings, and new business opportunities, strength in some core agricultural exports (cut flowers, coffee, and tea), and it is a popular tourism destination that contributes much to the economy. The government is close to meeting the Millennium Challenge Account's requirements involving graft and some social programs, and upon achieving those will be able to access grant funding from the Millennium Challenge Corporation. Kenya has improved considerably over the last five years.

The Project Study Team ruled out the participation of commercial banks, private investment funds, export credit agencies, and most global development banks given the needs and status of the LVSWSB projects. Some were ruled out because of the public ownership of the borrower (OPIC, IFC, etc.), others because of the limits on tenor of the loans they can extend, and any equity financing vehicles.

Given the government ownership of the Water Services Board, it can access extended tenor donor and government guaranteed financing (arising from Multilaterals/Donors) which would not be available to private sector sponsors. The LVSWSB, as with other Kenyan Water services boards, has demonstrated being capable to manage existing assets and to oversee the construction of new infrastructure. While lacking a significant balance sheet and financial capacity which an international private sector sponsor can provide, the Water Services Boards have the requirement to act as owners, and given the desperate need for low tariffs, they, not international sponsors, are uniquely positioned to obtain the lower cost financing as a parastatal entity.

Thus the finance plan considered by the Project Study Team focuses on the sovereign lenders, able to offer long tenors (20-30 yrs), long grace periods (5-7 years), low interest rates (3-5%) and coupled with a grant component from both donors and the Government of Kenya. Traditionally these financings have a GOK underlying guarantee. The level of grant to the overall financing requirement is estimated at 15-20%.

Meetings: Several meetings were held with multilateral lenders active in the Kenyan water sector, regional development banks, and other financiers. Aside from one-on-one meetings, the Project Team presented the project early on to a meeting of donors held at the Kenya School of Monetary Studies and presented a more defined project later in the Study period at the Corporate Council on Africa's First Infrastructure Conference, and at the New England Water Environment Association's Annual Conference. These discussions awarded the project with increased exposure to financiers, while allowing the Project Team to obtain valuable insights on the appetite, terms, and capacity of certain institutions. Applicable sources expressed interest in the LVSWSB requirements. The level of investment sought and the financing terms recommended in the Study were deemed in line with expectations and precedents.

The concern with securing the desired long term financing is the time required before a first disbursement could occur. Donors, the Ministry of Finance, LVSWSB, and the Ministry of Environment and Water, all concurred that one should expect 2 to possibly 3 years to achieve a first drawdown. This is a long period for the Water Services Board to wait before it can proceed with the Study's recommendation and solutions to shorten that time were explored.

The process by which the Water Services Board secures financing from the "donors" or multilaterals and the GOK, is for the Ministry of Water and Irrigation to submit the project costs identified in their overall budget presented to the Ministry of Finance. The Ministry of Finance will then coordinate with the Permanent Secretary of the MWI and approach the donor community to solicit their support. Typically one lender will take on the lead and attract others to join, but in other cases in the Kenyan water sector one lender has taken full financing responsibility for a particular water board. A new program has been established aiming to have the donors cooperate in the funding of the Kenyan water sector needs. The Ministry of Finance will typically be asked to support with a grant equivalent up to 10%, occasionally carrying a low interest rate. Upon obtaining financing commitments the funds will go to the Ministry of Finance first before being released to the Water Services Board. The Water Services Board is in the financing agreement and entrusted to repay the debt. The Ministry of Finance typically extends a sovereign guarantee for this sector.

The Project Team presented a concept of a bridge financing utilizing regional development banks and held preliminary discussions with these. The interest exists subject to certain conditions and reviewing information from the Study and proposed terms. A bridge financing would be sized to the capital requirements over the next 3 years, ensuring that the LVSWSB projects can begin their implementation per the Study's recommendations without losing two plus years of time. Once the long term debt financing is secured from the donor community, the bridge financing would be repaid and additional capital would be secured for the ensuing capital investments. A bridge financing amount would range between $25 and $35 million, depending on the timing of some of the new investments, the addition of other communities not in the Study, and the time to complete the long term concessionary financing.

An additional alternative to start the immediate recommendations from the Study ahead of completing the long term concessionary type finance is a Project Preparatory Facility (PPF). A PPF, an existing funding construct, would be defined and solicited by the LVSWSB/MWI/MoF which would cover, at a minimum, key aspects of the Immediate needs, the work related to documenting and obtaining larger financings, and possibly the feasibility study of the remaining communities. Typically such PPFs are viewed as an advance of the eventual long term concessionary type financing which the MoF will solicit from the donor community. It is unclear that such a PPF would allow for sufficient capital to allow the LVSWSB to implement the Study's recommendation until the "Larger Financing" is secured (or 2-3 years), and in such a case the MWI would be expected to request additional funds in their annual budgets to cover such shortfalls. An ideal situation would call for a PPF and the "bridge financing" as described above.

9.3.4 Financing Plan

The recommended capital expenditures plan spans over 15 years. At certain points in time the plan tequires a spike in investment (e.g. a waste treatment plant or dam) with respect to each community. Once aggregated at the level of the Water Services Board there still is a spike after the 5th year. Below is a figure with the annual capital requirements for the LVSWSB region as per the Study recommendations and with the addition of ancillary costs related to financing.

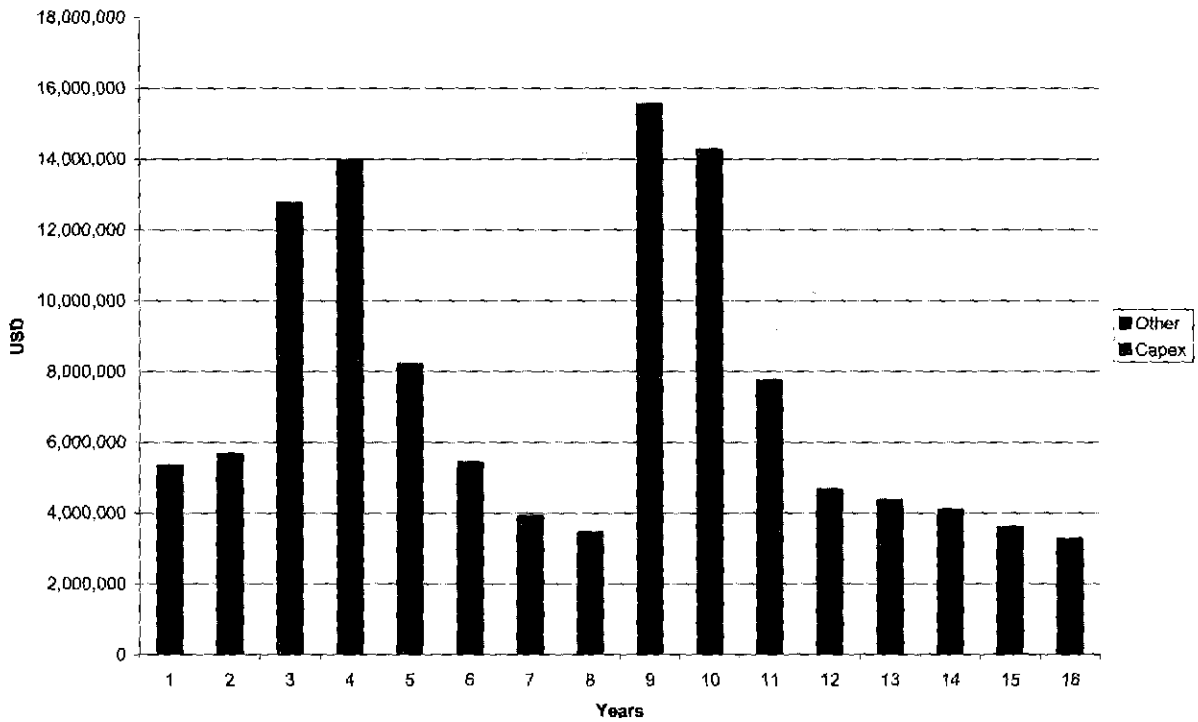

Figure 9-8. LVSWSB - CapEx

Despite new drinking water capacity, reduced losses of water in the system, and new waste treatment plants, the ramp up of customers still requires time before the LVSWSB (or WSPs) can be self-sufficient and generate cash flow for the ongoing and remaining investment plan (particularly with a goal of maintaining tariffs at or near the Kenyan average). On the other hand, financing sources are not interested in extending a debt financing which carries a 10-12 year construction period (extending the loan drawdown periods), or grace periods extending beyond 7 years (donors have provided 5-7 year grace, whereas commercial banks, and various development banks, typically stay at 4 years and under for grace on principal).

Thus the recommended financing plan considers that the LVSWSB will requite 2 to 3 separate financings to occur in 5 years intervals, complemented with a Grant amount equivalent to ~15-25% of total project costs. The capital cost requirements assume some over-borrowing in otder to satisfy the incremental interest until revenues can be ramped up. The Base Case assumes a 25% grant component.

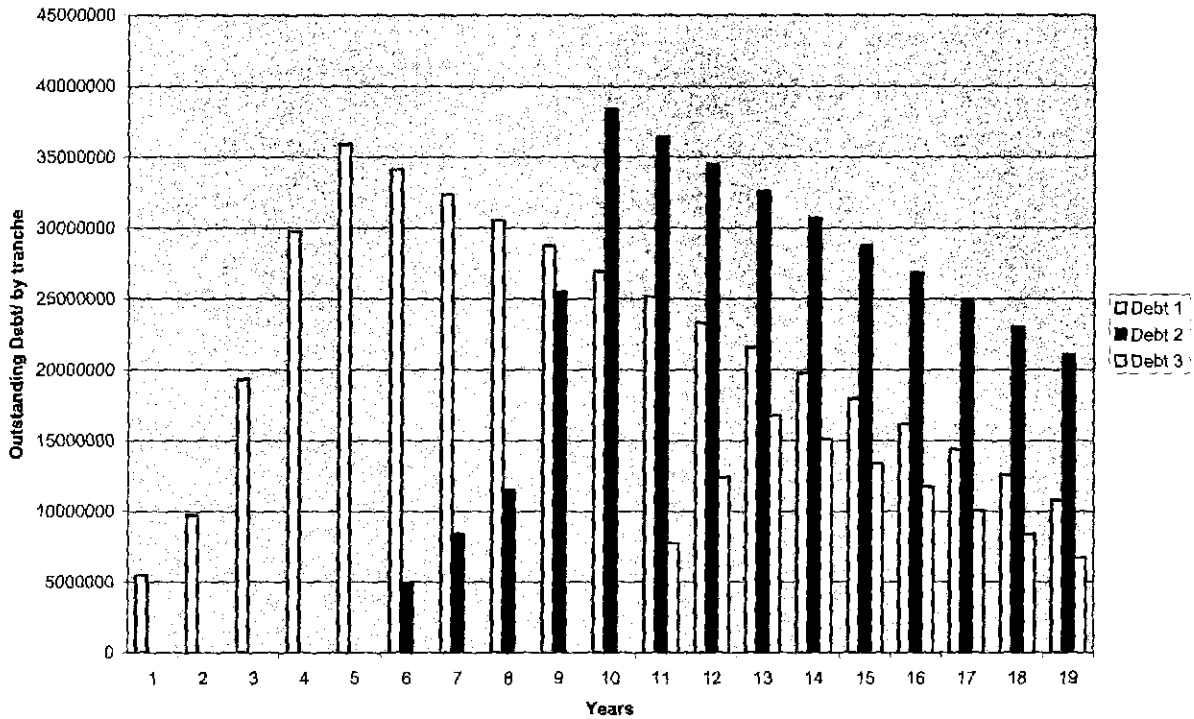

Figure 9-9. Scenario with Three Debt Tranches

As shown above, the LVSWSB would require:

1. A first debt facility of approximately $36 million to be drawn down over 5 years
2. A second facility starting in year 6 and reaching approximately $38 million,
3. Followed by a third in year 11 of about $17 million. A debt service reserve account (6 months of debt service) has been recommended and structured in the financial projections.

A grace period of 5 years, and a first financing tenor of 25 years all-in, using an interest rate of 5%, produces sustainable results. It is possible that the LVSWSB can extend its grace period beyond 5 years, while limiting the drawdown to 5 years, thus reducing the need to over-borrow to cover interest shortfalls, and placing less strain on the respective WSPs lease payments back to the LVSWSB.

It is not unfeasible to assume that a Donor based financing would not commit to the second debt facility and capital requirements at inception. Should that happen it will create some added flexibility to the LVSWSB as it may accelerate the program if warranted, and it would not need to worry about funding availability. On the other hand, after 4 years or so the LVSWSB will have been able to improve its financial position, demonstrated that the investments are generating intended results for revenues, profits, and the access to water and sanitation. The main benefit of staging is to minimize the costs, and to borrow only what you need which will be better for the government, the donors and the LVSWSB.

9.3.5 Security Package

We understand that in the case of the Kenyan water sector and the financings that have occurred in recent years, the GOK extends a government guarantee to the lenders. Whether it is for the Bridge Financing

construct, or the long term concessionary financing, to start things off the LVSWSB financing will require this sovereign guarantee. We could contemplate that in the 2nd or 3rd financing tranche that the need for a sovereign guarantee may be avoided, but instead we assumed a reduced grant amount.

We are recommending a 6 months debt service reserve fund, to be built up at the level of the LVSWSB. Within each WSP we recommend the creation of a "licensee fee" reserve fund equivalent to 6 months. Together, should there be a failure by the WSP to pay, the lenders would have comfort that the LVSWSB can pay the debt service for a period of 12 months out of these two reserve funds.

A pledge of shares of the Water Services Board is unlikely given its status.

The SPA offers an indirect security given the ability to replace the WSP, the penalties upon non-performance and payment, and other disincentives built into the contract.

We would expect that any turnkey contract or contractors executing the various infrastructure jobs would provide performance bonds, insurance and warranties as dictated by the market.

9.3.6 Financial Analysis

In order to determine the financial viability of the LVSWSB project, the Project Team first evaluated each community as a stand-alone to determine the financial viability of the capital expenditures (CapEx) program. The additional drinking water capacity and waste treatment generates new revenues, the timing of which being closely analyzed. Several assumptions were created by the technical team with respect to new capacity, capital and operating costs, completion time, and population growth. Each community required the creation of a Detailed Assumptions model which fed data into their respective Financial Model.

Excerpts from these Detailed Assumptions can be found in Appendix 9. Below is the Domestic Service Connections as an example of the data gathered, projected, and utilized for out analysis.

Table 9-8. Example of Detailed Assumptions Model (Part 1)

Part A. Domestic Service Connection Projections **Migori**

	2006		2007		2008		2009		2010		2011	
Population	**100%**	**124300**	**100%**	**129582.75**	**100%**	**135090.02**	**100%**	**140831.343**	**100%**	**146816.67**	**100%**	**153056.38**
High/Medium Income	**53%**	**65879**	**53%**	**68,679**	**53%**	**71,598**	**53%**	**74,641**	**53%**	**77,813**	**53%**	**81,120**
IWC	15%	9881.85	17%	11,487	19%	13,352	21%	15,520	23%	18,040	26%	20,970
NWC, ISA	64%	42162.56	61%	41,757	58%	41,355	55%	40,957	52%	40,563	50%	40,172
NWC, NISA*	21%	13834.59	22%	15,436	24%	16,891	24%	18,164	25%	19,210	25%	19,978
ISC	0%	0	10%	6,868	11%	8,019	13%	9,363	14%	10,932	16%	12,764
NSC, ISA	50%	32939.5	46%	31,764	43%	30,630	40%	29,537	37%	28,483	34%	27,467
NSC, NISA**	50%	32939.5	44%	30,047	46%	32,948	48%	35,740	49%	38,398	50%	40,889
Low Income	**47%**	**58421**	**47.00%**	**60,904**	**47.00%**	**63,492**	**47.00%**	**66,191**	**47.00%**	**69,004**	**47.00%**	**71,937**
IWC	0%	0	8%	4,568	8%	5,333	9%	6,227	11%	7,271	12%	8,490
NWC, ISA	50%	29210.5	47%	28,625	44%	28,051	42%	27,488	39%	26,937	37%	26,397
NWC, NISA*	50%	29210.5	46%	27,711	47%	30,108	49%	32,475	50%	34,796	52%	37,050
ISC	0%	0	5%	3,045	6%	3,810	8%	5,295	9%	6,210	11%	7,913
NSC, ISA	40%	23368.4	35%	21,316	34%	21,587	32%	21,181	31%	21,391	29%	20,862
NSC, NISA**	60%	35052.6	60%	36,542	60%	38,095	60%	39,714	60%	41,402	60%	43,162
		0		-		-		-		-		-
TOTALS FOR ALL INCOME GROUPS												
IWC	8%	9881.85	12%	16,054	14%	18,685	15%	21,747	17%	25,311	19%	29,459
NWC, IWSA	57%	71373.06	54%	70,382	51%	69,406	49%	68,445	46%	67,500	43%	66,569
NWC, NISA	35%	43045.09	33%	43,147	35%	46,999	36%	50,639	37%	54,006	37%	57,028
ISC	0%	0	8%	9,913	9%	11,828	10%	14,658	12%	17,142	14%	20,677
NSC, ISA	45%	56307.9	41%	53,080	39%	52,218	36%	50,718	34%	49,874	32%	48,328
NSC, NISA	55%	67992.1	51%	66,589	53%	71,044	54%	75,455	54%	79,800	55%	84,051
Pop. in Water Service Area*	65%	81254.91	67%	86,436	65%	88,091	64%	90,192	63%	92,811	63%	96,029
Pop. in Wastewater Service A	45%	56307.9	49%	62,993	47%	64,046	46%	65,376	46%	67,017	45%	69,006

NOTES:

IWC	Individual Water Connection	ISC	Individual Wastewater Connection
NWC, ISA	No Water Connection, In Water Ser	NSC, ISA	No Wastewater Connection, In Wastewater Service Area
NWC, NISA	No Water Connection, Not in Water	NSC, NISA	No Wastewater Connection, Not in Wastewater Service Area

Considering the WSPs as a stand-alone absorbing the new capital investments is only a theoretical perspective as the Water Services Board will make these investments and retain ownership of those assets. The SPA will stipulate that the WSP will pay back the Water Services Board the cost of its capital for new investments. Yet, should the WSP not have a sustainable business with the new investment it will not be able to make those lease payments. Hence the needs for the Project Team to first review each WSP and its respective investment requirements as a stand-alone.

This stand-alone analysis provided the Project Study Team with reference points as to levels of tariff to be charged, timing of new capital expenditures, ramping up of new customers, and guidance as to the level of grant financing.

Below is an excerpt of the Detailed Assumptions model for Migori. This focuses on the revenue assumptions which are then fed into both the Migori Financial Model and to a lesser extent directly into the LVSWSB Financial Model.

Table 9-9. Example of Detailed Assumptions Model (Part 2)

REVENUE

Meter Rent (Kshs / meter / day)	$ 1.67	$ 1.67	$ 1.67	*Assume current meter rent of 50 KSh/month for up to 20 mm meter, increasing at annual percentage below.*
Water Kiosk Tariff (Kshs / 20 L)	$ 2.00	$ 2.00	$ 2.00	*Assume current standard kiosk tariff, increasing at annual percentage below.*
Public Toilet Tariff (Kshs / use)	$ 0.50	$ 0.50	$ 0.50	*Assume current 0.5 Kshs/use, increasing at annual percentage below.*
Avg. Individual Connection Water Tariff (Kshs/m3)*	30	36	44	*w/ww tariffs dependent on usage volume block. Avg. values shown. 2005 water tariffs shown based on 2005 reported total water billings / total 2005 water sold. Future wastewater tariffs assumed to be ~85% of water tariffs. Does not take into account revenues from connection fees - assume in 'additional revenue' below. Assume annual increase by percentage below.*
Avg. Wastewater Tariff (Kshs/m3)	0	31	38	
Total Avg. W/WW Tariff	30	67	82	
				2.0%

** Note here*

Updated Year 2000 WHO Reported Avg Kenya W/WW Tariff	45			*WHO: 33 / m3 water, 9 /m3 sewer = 42; assumed 1% inc. annually from 2000-2006 to derive current value.*
Expected W/WW Tariff in C&C Proposal	34	38	41	*Assumed start @ 34, inc. ~1% annually.*
Payment Ratio	70%	95%	99%	*Current payment ratio from MIKUTRA. Future assumed.*
NOTE: Revenues shown below are for middle year of period, and assumes linear increase in revenue throughout period.				
Water Kiosk Revenue (Kshs/year)	-	8,345,492	13,654,665	*Assumes people using kiosks obtain one 20-l jerrycan every other day (assumes drinking water from kiosks, cleaning water from other sources). Assume not all persons with access to kiosks use them regularly. Assume operator profits included in operational expenses.*
Public Toilet Revenue (Kshs/year)	-	10,314,692	11,844,524	*Assumes people using public toilets use them twice per day. Assume not all persons with access to public toilets use them regularly. Assume operator profits included in operational expenses.*
Water Meter Rent Revenue (Kshs/year)	-	2,317,014	6,389,512	*=Avg. Rent * number of meters*
Individual Water Connection Tariff Revenue (Kshs/year)	1,753,349	106,676,536	222,127,039	*=Avg. Tariff * Total Volume Treated*
Wastewater Tariff Revenue (Kshs)	-	57,605,329	97,851,723	*=Avg. Tariff * Total Volume Treated*
Revenue Generated from Tariffs (Kshs)	**1,753,349**	**185,259,063**	**351,867,453**	

Tariffs: The Kenyan average tariff varies according to the source as depicted in Table 9-10. The Study identified an average tariff of 33 KShs/m^3 in 2000, anticipated to be 38 KShs by 2007, and for wastewater a tariff of 9 KShs/m^3, reaching 11 KShs in 2007. The Study communities' average tariff is actually lower than the Kenyan average as shown in Table 9-10. The existing tariff within most Kenyan water boards has not been changed for several years. Recently WSPs have been able to assess their new cost structure and needs, and are submitting requests for tariff augmentation. KEWASCO has submitted such a request and their "effective tariff", which is different from the Average Tariff which ignores the weighting by customer type, is higher than the Average Tariff. In our analysis an assumption of 1-2% annual escalation is made although what is likely to occur is an adjustment to the tariff every few years. We believe the 1-2% escalation achieves the same result.

Table 9-10. Analysis of Kenyan Average Water and Wastewater Tariffs

	Reported Tariff	2007 Tariff (Assume 2% ann. increase[1])
W.H.O.[2] (2000)	**Kshs / m^3**	**Kshs / m^3**
Kenyan Avg. Piped Water Tariff	32.8	38
Kenyan Avg. Sewer Tariff	9.2	11
INT. INSTITUTE FOR ENVIRONMENT AND DEVELOPMENT [2] (2001)		
Kenyan Avg. Piped Water Tariff	33.5	38
KENYAN AVERAGE	Kshs / m^3	Kshs / m^3
Average piped water tariff	**33**	**38**
Average wastewater tariff	**9**	**11**

[1] Average Kenyan inflation rate from 2000-2006 was ~7%. Lowest inflation during that period was 2%. Current inflation ~15%.

[2] World Health Organization. Water Supply & Sanitation Sector Assessment 2000. Part II. Country Profiles - Kenya.

[3] International Institute for Environment and Development. 2001. Drawers of Water II: 30 Years of Change in Domestic Water Use & Environmental Health in East Africa. Nottingham: Russell Press. Page 64-70.

Table 9-11. Tariffs in Study Towns and Kenyan Averages

	2007 Tariff
KENYAN AVERAGE	Kshs / m^3
Average piped water tariff	**38**
Average wastewater tariff	**11**
MIKUTRA	Kshs / m^3
Average piped water tariff	30
Average wastewater tariff	N/A
KEWASCO	Kshs / m^3
Average piped water tariff	27
Recently Requested Rate	43
Average wastewater tariff	21
GUSII	Kshs / m^3
Average piped water tariff	30
Average wastewater tariff	2.5

What is interesting to note in the above Tariffs is the variance in the wastewater services. Ultimately MIKUTRA and GWASCO WSPs will be able to increase these tariffs as currently they have limited infrastructure for wastewater, if any. The base case water tariff for GWASCO and MIKUTRA is 30 KShs which is well below the Kenyan average.

The next pages will show the results of the WSP Financial Models and discuss the findings. Full financial statements are included in the Appendix 9.

9.3.7 MIKUTRA (Migori)

9.3.7 (a) MIKUTRA Financial Modeling

Table 9-12. MIKUTRA "Standalone" Financial Model Summary Key Results

LVSWSB - Migori USD	2007	2008	2009	2010	2011	2012	2013	2014	2015
	Construction								
Revenues									
Water Kiosk Revenue	9,175	20,997	26,841	34,410	44,116	56,561	72,519	92,982	119,221
Public Toilet Revenue	15,307	31,197	38,853	48,445	60,248	75,010	93,862	117,882	147,353
Water Meter Rent Revenue	3,177	7,342	9,424	11,922	14,939	18,555	22,571	27,398	33,100
Individual Water Connection Tariff Revenue	30,797	43,331	59,618	228,052	459,181	607,957	798,805	1,043,124	1,351,056
Total Water Revenues	58,455	102,806	134,735	322,831	578,485	758,083	987,857	1,281,186	1,650,731
Wastewater Tariff Revenue	85,662	188,792	219,244	256,633	299,327	351,690	412,535	485,758	572,229
Additional Revenue	28,823	58,320	70,796	115,693	175,662	221,955	280,078	353,389	444,592
Expenses	(183,052)	(234,581)	(362,533)	(427,920)	(389,286)	(433,377)	(462,929)	(524,569)	(659,677)
EBITDA	(10,112)	115,336	62,143	266,237	663,088	898,351	1,218,450	1,595,764	2,007,874
Cash	1,161,902	1,347,047	1,388,460	1,184,794	922,432	724,170	822,452	625,212	1,017,132
Debt Service Reserve Account (Cash)	67,297	133,036	186,727	253,345	622,791	685,293	692,171	749,068	807,035

In the MIKUTRA standalone model (as with the other WSPs) the Project Team is able to treat the WSP as the owner of the new infrastructure, and borrower of the financing required. Given the terms of the Service Performance Agreement in theory the LVSWSB is always covered for the investments it makes in the WSP service area, and hence running sensitivities for tariff drops, reductions in water demand and the like at the LVSWSB Financial Model will not affect the LVSWSB projections much, or tell us about the viability of the WSP. As stated earlier, it is important to determine how these sensitivities affect the WSPs ability to remain solvent and hence service its financial obligations to the LVSWSB, which can in turn service its debt burden.

The capital expenditure plan for MIKUTRA is determined from the Project Team's technical findings and recommendations, which have been incorporated in each community's Detailed Assumptions model. The investments occur over time and have an impact on the WSPs ability to ramp up new customers both in drinking water and wastewater connections.

9.3.7 (b) MIKUTRA CapEx Plan

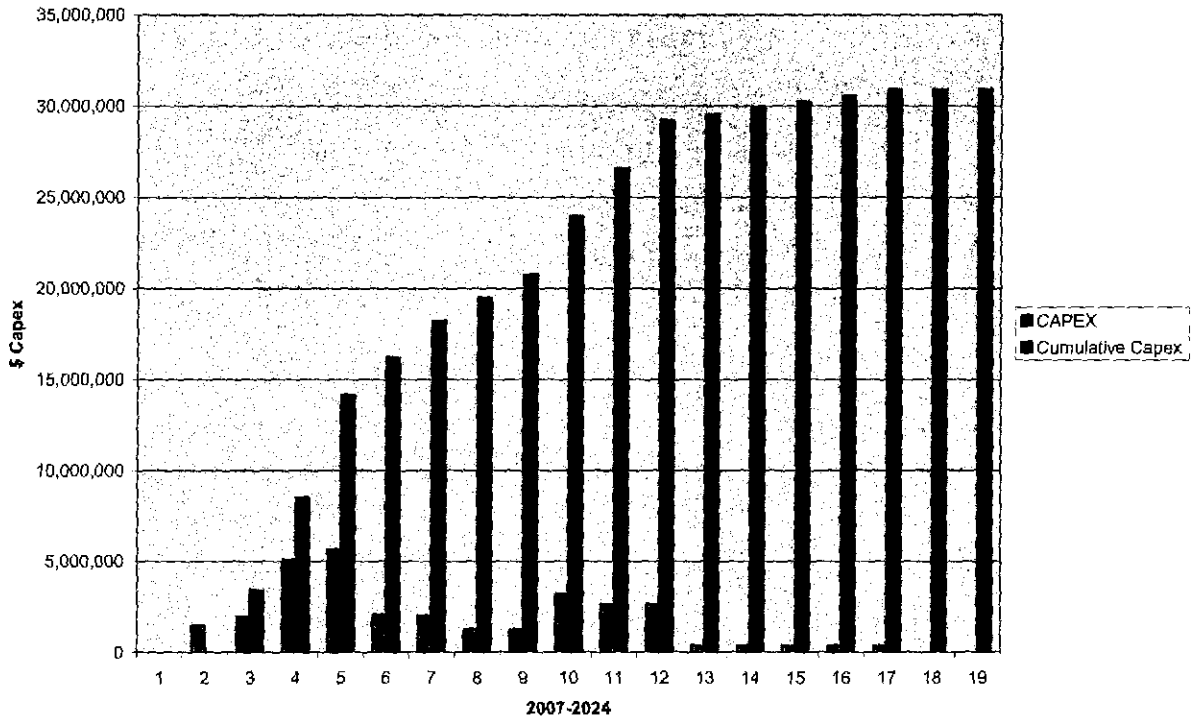

Figure 9-10. MIKUTRA CapEx

The Migori community will require approximately $33 million in capital expenditures during the course of the Study period. This capital expenditure is spread out mostly over the first 12 years, albeit with a greater concentration during the first five years.

MIKUTRA has a below Kenyan average Tariff of 30 KShs. We expect that they will request an increase in this tariff as new investments are made by the LVSWSB, and we have modeled a 1.5% annual increase in tariff. It is more likely that the Tariff increases will occur in a step-up fashion every few years. These increases will occur in most Kenyan water boards and can be safely assumed for purposes of this Study.

As with the LVSWSB financing plan, the financing plan for the WSPs is broken out into three stages. A first financing will carry a drawdown period of 5 years (equivalent to its Grace on Principal period) and a total tenor of 25 years. This will be followed by a 2nd financing also with a 5 year drawdown but a 20 year tenor, and finally a 10 year financing around 2016 at a higher interest rate as it is assumed it will not be concessionary financing and will not carry a sovereign guaranty.

9.3.7 (c) MIKUTRA Sensitivities

The variables used for the sensitivities of all the WSPs analyzed included:

- Tariff reductions
- Reduction in Tariff escalation %
- Changes in Grant funding amount
- Water Demand reduction of 10%

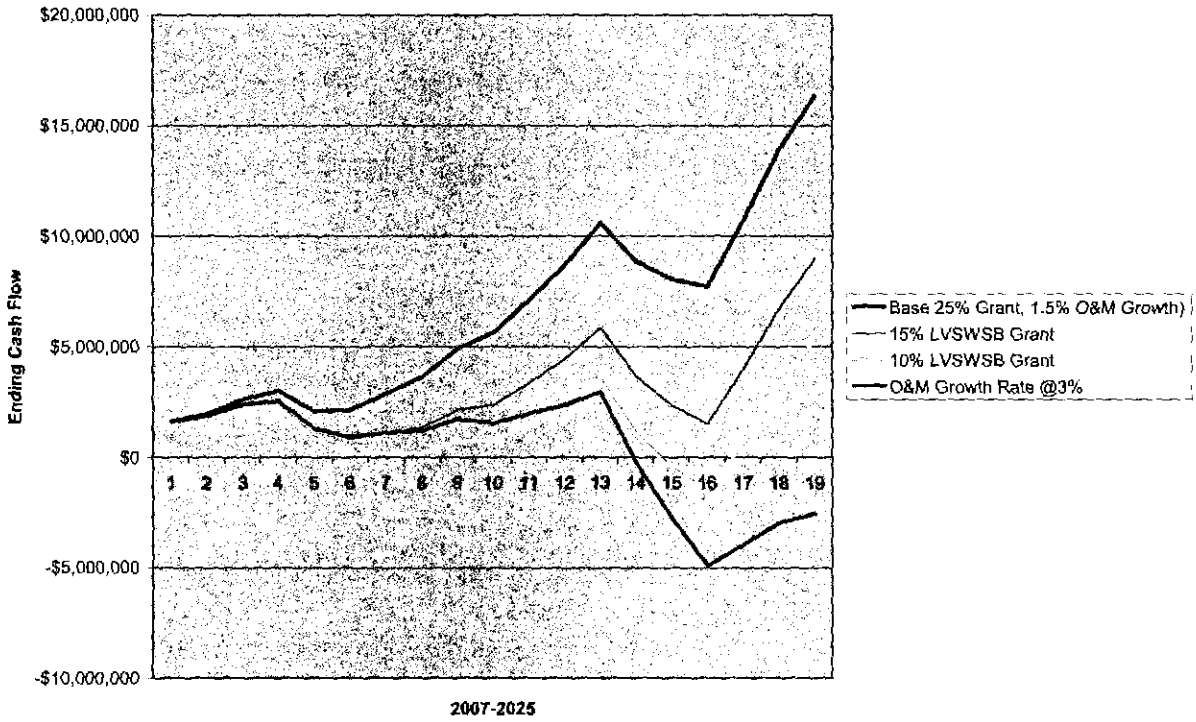

Figure 9-11. MIKUTRA Sensitivities

The sensitivity analysis shows that in the case of MIKUTRA it is most affected by a drop in Grant funding from the base case's 25% to 10%. It is also sensitive to the Tariff reduction and will not be cash flow positive for a period of 5 years at the 26 KShs base tariff. In the Base Case it remains cash flow positive, and gets thin at the time in which it is adding on the second debt tranche and has begun paying principal of the first debt tranche. Thereafter the increased capacity of its system allows it to increase revenues and build up cash reserves.

FIRR and EIRR

Financial IRR (2008-2025)	2008	2009	2010	2011	2012
Annual Investment (External)	(3,129,920)	(2,229,893)	(5,398,860)	(5,632,727)	(2,061,672)
Cumulative First Financing	(3,129,920)	(5,359,813)	(10,758,673)	(16,391,400)	(18,453,072)
Cumulative 2nd Financing					
Cumulative 3rd Financing					
Less Grant Component	(782,480)	(557,473)	(1,349,715)	(1,408,182)	(515,418)
Annual Financed Amount	(2,347,440)	(1,672,420)	(4,049,145)	(4,224,545)	(1,546,254)
Base Case Revenues less O&M	(2,465)	124,341	76,782	282,581	676,785
Base Case FIRR Cash Flow	(2,349,905)	(1,548,079)	(3,972,363)	(3,941,964)	(869,469)
Base Case FIRR	**3%**				
Tariff 35 FIRR	**5%**				
	227				

EIRR	2008	2009	2010	2011	2012
Incremental Water	-	81	179	299	2,628
Health Benefits	-	12,676	28,132	46,934	412,911
Base Case EIRR Cash Flow	(2,349,905)	(1,535,403)	(3,944,231)	(3,895,030)	(456,559)
Base Case EIRR	**9%**				
Tariff 35 EIRR	**11%**				

The above table considers the Base Case and the Tariff at 35 KShs for the FIRR and EIRR analysis. The Health Benefits applied were drawn from another Kenyan water study (Rift Valley) and consider 11,000 KShs per incremental cubic meters of water. The analysis is run over the 20 years.

9.3.8 KEWASCO (Kericho)

9.3.8 (a) KEWASCO Financial Modeling

Table 9-13. Kericho "Standalone" Financial Model Summary Key Results

LVSWSB - Kericho USD	2007	2008	2009	2010	2011	2012	2013	2014	2015
	Construction								
Revenues									
Water Kiosk Revenue	7,365	7,835	8,670	9,586	10,599	11,719	12,959	14,332	15,934
Public Toilet Revenue	273	617	984	1,152	1,323	1,549	1,779	2,085	2,404
Water Meter Rent Revenue	14,160	15,183	17,081	19,276	21,755	24,556	27,719	31,293	35,510
Individual Water Connection Tariff Revenue	802,594	877,573	1,015,929	1,165,645	1,327,683	1,503,085	1,692,981	1,898,595	2,121,258
Total Water Revenues	824,392	901,207	1,042,665	1,195,659	1,361,360	1,540,909	1,735,438	1,946,305	2,175,106
Wastewater Tariff Revenue	52,085	85,961	125,085	136,341	148,758	162,542	177,780	194,727	214,160
Additional Revenue	175,295	197,434	233,550	266,400	302,024	340,690	382,643	428,206	477,853
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
Expenses	(899,803)	(944,396)	(1,000,512)	(1,102,884)	(1,157,428)	(1,211,879)	(1,157,473)	(1,218,512)	(1,290,338)
EBITDA	151,969	240,206	400,788	495,416	654,715	832,263	1,138,388	1,350,727	1,576,782
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
Cash	786,367	1,115,335	1,525,076	1,639,707	1,483,888	1,393,183	1,299,969	1,402,435	1,686,019
Debt Service Reserve Account (Cash)	61,169	114,118	153,436	210,063	577,226	597,812	597,017	620,821	659,660
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The rationale for the Kericho standalone financial model is the same as for MIKUTRA/Migori. While Kericho is a more established system and has more limited growth possibilities, the key summary results above demonstrate that Kericho will maintain a healthy cash flow. KEWASCO has an increase in tariff request to the Ministry resulting in an "effective" tariff of 43 KShs. In the Project Team's projections a tariff of 42 KShs and an escalation of 2% is used.

The financing plan applied in this financial model is also assuming three distinct financings occurring in sequence. The only financing to require a grant is the first one resulting in 25% of the overall project financing amounts, or $4.2 million against a senior debt of $12.8 million.

9.3.8 (b) KEWASCO CapEx Plan

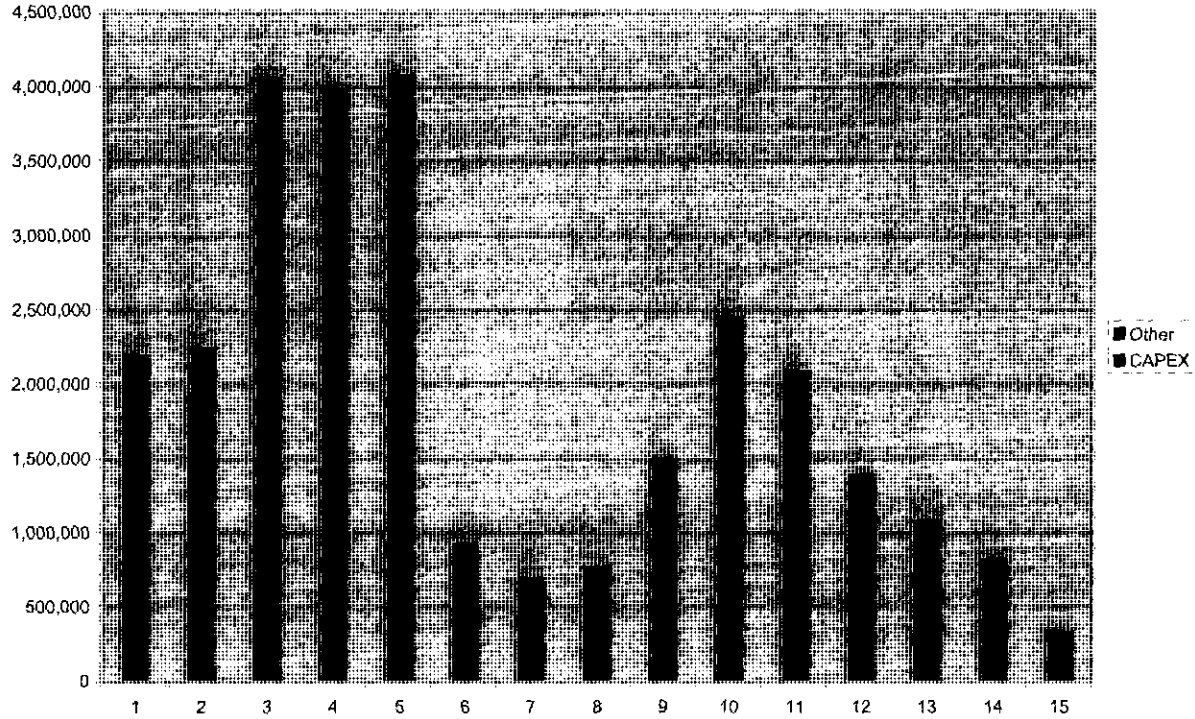

Figure 9-12. KEWASCO CapEx

Kericho's capital expenditure requirements are greater on the wastewater aspects and early in the period.

9.3.8 (c) KEWASCO Sensitivities

The variables used for the sensitivities of all the WSPs analyzed included

- Tariff reductions
- Reduction in Tariff escalation %
- Changes in Grant funding amount
- Water Demand reduction of 10%

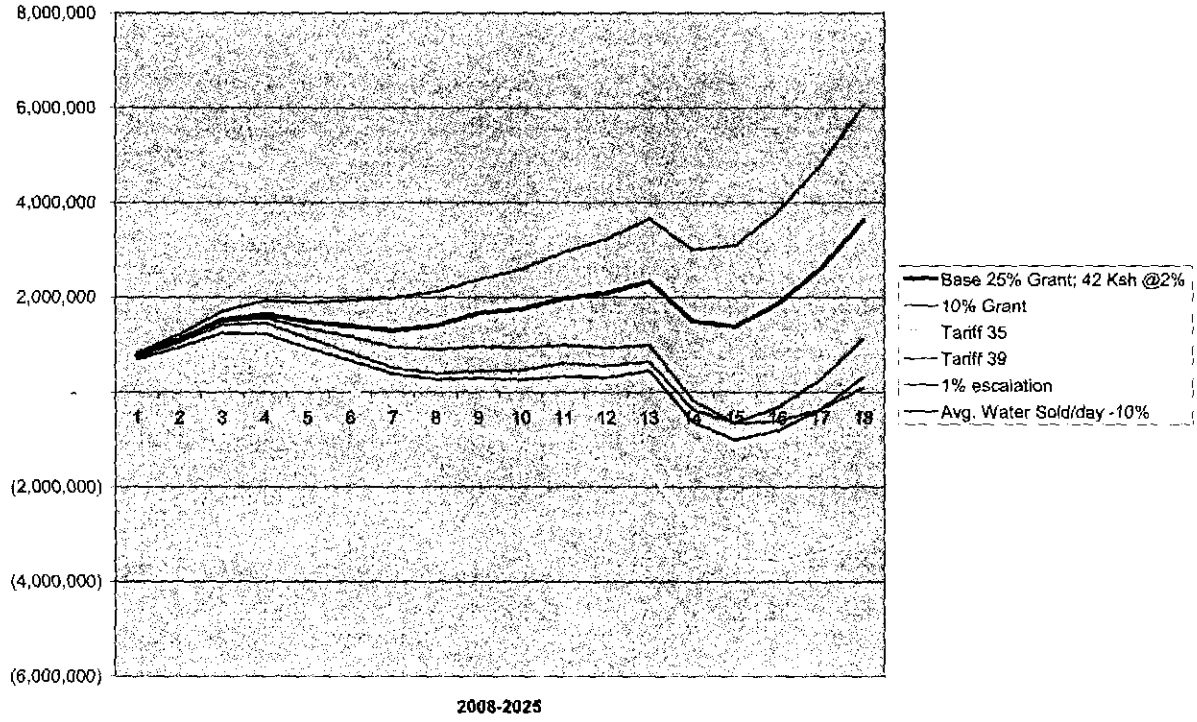

Figure 9-13. KEWASCO Sensitivities

The above sensitivity graph demonstrates why KEWASCO has requested a tariff increase. The 35 KShs tariff sensitivity or a drop of 7 KShs and more in line where they have been, is clearly not a viable option. It can support a smaller reduction in tariff, although it negates its ability to build up cash for future expenditures, growth and dividends. The Base Case shows an growth organization able to become self-sufficient and bankable over time.

FIRR and EIRR

Financial IRR (2008-2025)	2008	2009	2010	2011	2012
Annual Investment (External)	(2,710,000)	(2,248,700)	(4,075,633)	(3,982,333)	(4,086,333)
Cumulative First Financing	(2,710,000)	(4,958,700)	(9,034,333)	(13,016,667)	(17,103,000)
Cumulative 2nd Financing					
Cumulative 3rd Financing					
Less Grant Component	(677,500)	(562,175)	(1,018,908)	(995,583)	(1,021,583)
Annual Financed Amount	(2,032,500)	(1,686,525)	(3,056,725)	(2,986,750)	(3,064,750)
Base Case Revenues less O&M	188,306	278,071	440,809	539,847	701,230
Base Case FIRR Cash Flow	(1,844,194)	(1,408,454)	(2,615,916)	(2,446,903)	(2,363,520)
Base Case FIRR	**5.00%**				
Tariff 45 FIRR	**7.02%**				

Economic IRR	2008	2009	2010	2011	2012
Incremental Water	-	531	1,085	1,664	2,271
Health Benefits	-	83,384	170,481	261,548	356,859
Base Case EIRR Cash Flow	(1,844,194)	(1,325,070)	(2,445,435)	(2,185,354)	(2,006,661)
Base Case EIRR	**12%**				
Tariff 45 EIRR	**13%**				

The above table considers the Base Case and the Tariff at 45 KShs for the FIRR and EIRR analysis. The Health Benefits applied were drawn from another Kenyan water study (Rift Valley) and consider 11,000 KShs per incremental cubic meters of water.

9.3.9 GWASCO (Kisii)

9.3.9 (a) GWASCO Financial Modeling

LVSWSB - Kisii USD	2008	2009	2010	2011	2012	2013	2014	2015
	0							
Revenues								
Water Kiosk Revenue	22,148	52,598	71,904	98,583	133,324	179,108	241,006	322,408
Public Toilet Revenue	20,318	42,442	54,215	68,980	87,354	109,997	137,569	170,625
Water Meter Rent Revenue	8,256	15,935	21,862	28,824	37,017	46,682	58,115	71,687
Individual Water Connection Tariff Revenue	211,437	283,214	374,553	568,959	819,010	1,056,266	1,354,546	1,728,737
Total Water Revenues	262,159	394,189	522,534	765,346	1,076,705	1,392,053	1,791,236	2,293,457
Wastewater Tariff Revenue	90,496	108,617	132,271	159,454	198,492	244,713	299,664	365,260
Additional Revenue	70,531	100,561	130,961	184,960	255,039	327,353	418,180	531,747
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Expenses	(383,884)	(317,823)	(489,803)	(580,378)	(594,752)	(672,057)	(778,154)	(876,627)
EBITDA	39,503	285,544	295,963	529,383	935,484	1,292,062	1,730,925	2,313,857
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Cash	1,152,210	1,541,468	1,899,492	2,192,182	2,482,708	2,436,811	2,760,586	3,305,567
Debt Service Reserve Account (Cash)	32,236	62,675	89,602	126,877	365,338	699,448	706,767	856,755
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[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

Figure 9-14. Kisii "Standalone" Financial Model Summary Key Results

Kisii's capex plan is benefited by an overlapping initiative by the UNDP which the Project Team assumes will contribute $3 million towards the Study's recommended investments. However, Kisii, or the GWASCO WSP as it comprises other cities, will need to make a significant investment in the 9th and 10th year for a new dam, followed by important water main and distribution investments. This will cause a significant debt repayment burden which around the 11th and 12th years ahead of having been able to ramp up enough customer base for a comfortable financial situation.

9.3.9 (b) GWASCO CapEx Plan

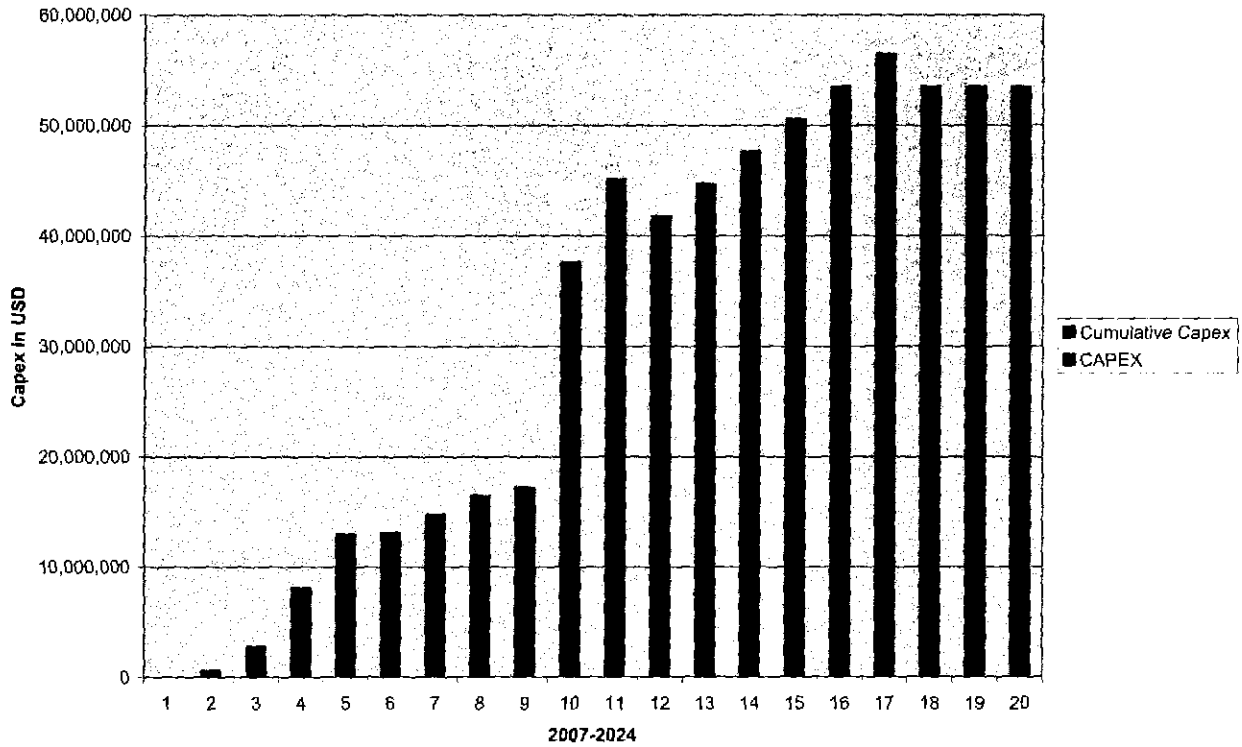


Figure 9-15. GWASCO CapEx Plan

As shown in the Capex Plan chart, an important investment is made around the 10th and 11th year, and thereafter for 6 years an important annual investment to bring the new capacity to new customers. It is possible that a tariff increase occurs around that time to address this spike in investment and takes pressure off the financials. As for Migori, we would expect that Kisii/GWASCO WSP request a tariff increase for added comfort. Our model escalates their tariff at a higher rate than Migori and Kericho, using 3% instead of 2%.

The financing plan assumed in this model is also over three stages and three distinct financings. In the case of Kisii, the second debt financing is assumed to include a smaller grant component of 15%.

9.3.9 (c) GWASCO Sensitivities

The variables used for the sensitivities of all the WSPs analyzed included

- Tariff reductions
- Reduction in Tariff escalation %
- Changes in Grant funding amount
- Water Demand reduction of 10%

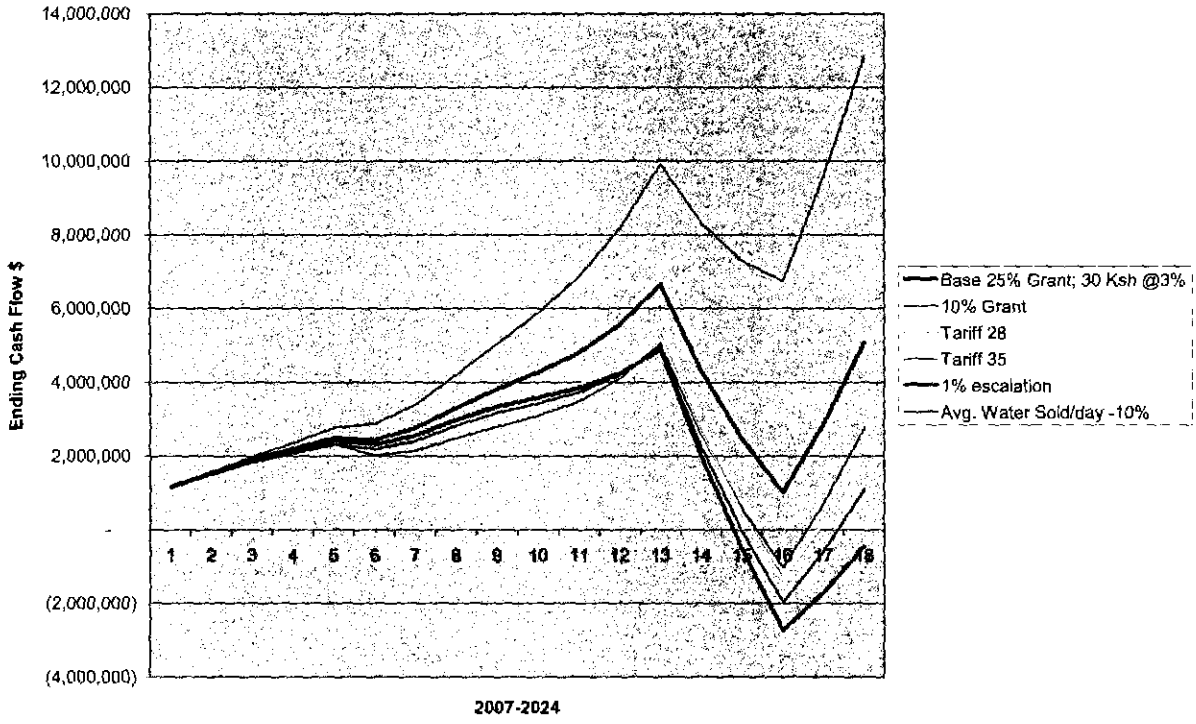


Figure 9-16. GWASCO Sensitivities

The effects of the capital expenditures in the 11th year, and the start of repayment of all three debt facilities' principal, causes an drop-off in ending cash flow in 13th to 16th year. As per the above graph, Kisii is most sensitive to a tariff drop in the form of a reduced escalation from 2% to 1%. This is followed by a reduction in water sold. The effects of any of the above sensitivities is to become cash flow negative around the 14th to the 17th year. Hence this WSP will need to ensure it can maintain escalation on its tariff, or increase its tariff closer to the Kenyan average, and develop a strategy to ramp up its new connections quickly upon completing the new dam project.

The Base Case shows that GWASCO/Kisii can meet its financial obligations.

FIRR and EIRR

Financial IRR (2008-2025)	2008	2009	2010	2011	2012
Annual Investment (External)	(2,088,080)	(1,277,811)	(3,392,651)	(4,020,145)	(2,065,910)
Cumulative First Financing	(2,088,080)	(3,365,891)	(6,758,543)	(10,778,688)	(12,844,598)
Cumulative 2nd Financing					
Cumulative 3rd Financing					
Less Grant Component	(522,020)	(319,453)	(848,163)	(1,005,036)	(516,478)
Annual Financed Amount	(1,566,060)	(958,359)	(2,544,489)	(3,015,109)	(1,549,433)
Base Case Revenues less O&M	56,766	305,775	321,917	559,455	966,493
Base Case FIRR Cash Flow	(1,509,294)	(652,583)	(2,222,572)	(2,455,653)	(582,939)
Base Case FIRR	**10%**				
Tariff 35 EIRR	**14%**				

Economic IRR	2008	2009	2010	2011	2012
Incremental Water	0	402	899	1,513	3,279
Health Benefits	-	63,136	141,262	237,693	515,273
Base Case EIRR Cash Flow	(1,509,294)	(589,447)	(2,081,310)	(2,217,960)	(67,666)
Base Case EIRR	**20%**				
Tariff 35 EIRR	**24%**				

The above table considers the Base Case and the Tariff at 35 KShs for the FIRR and EIRR analysis. The Health Benefits applied were drawn from another Kenyan water study (Rift Valley) and consider 11,000 KShs per incremental cubic meters of water.

9.3.10 LVSWSB

9.3.10 (a) LVSWSB Financial Model

The creation of the three separate Financial Models for the WSPs in the Study allowed for the creation of the LVSWSB Financial Model/projections. Per the excerpt below, the respective WSPs pay the LVSWSB a licensee fee and water meter rent. In this financial model the LVSWSB is the borrower and its balance sheet grows in proportion to the new capital expenditures made within its service area. Following are the key summary results.

LVSWSB USD	2008	2009	2010	2011	2012	2013	2014	2015
	June 30 yr end							
Revenues								
Kisii Licensee Fees	$ 21,159	$ 30,168	$ 39,288	$ 55,488	$ 76,512	$ 98,208	$ 125,454	$ 159,524
Migori Licensee Fees	$ 22,482	$ 45,489	$ 55,221	$ 84,708	$ 102,669	$ 116,586	$ 134,024	$ 156,017
Kericho Licensee Fees	$ 136,730	$ 149,230	$ 160,065	$ 169,920	$ 180,607	$ 192,207	$ 204,793	$ 218,462
Water Meter Rent Revenue	$ 26,616	$ 40,358	$ 50,563	$ 62,502	$ 76,513	$ 92,956	$ 111,979	$ 134,598
New Lease Fees (Cost of Capital for New WSP Investments)	$ 146,268	$ 321,404	$ 619,658	$ 859,529	$ 1,180,569	$ 3,775,625	$ 3,945,105	$ 3,991,910
Existing LVS Revenue (less License Fees year 1, grow @3%)	$ 4,622,209	$ 4,760,875	$ 4,903,701	$ 5,050,812	$ 5,202,337	$ 5,358,407	$ 5,519,159	$ 5,684,734
Maintenance Fund From WSPs (percentage of cost of capital)	$ 182,550	$ 247,820	$ 603,357	$ 681,760	$ 410,696	$ 226,362	$ 187,973	$ 165,483
Expenses	(5,060,104)	(5,136,006)	(5,213,945)	(5,291,242)	(5,370,610)	(5,451,169)	(5,532,937)	(5,615,931)
EBITDA	(101,169)	238,626	990,565	1,427,653	1,611,879	4,160,156	4,444,891	4,642,476
Cash	1,613,524	1,941,570	2,620,305	3,008,180	2,088,101	2,137,188	2,884,006	3,628,451
Debt Service Reserve Account (Cash)	201,918	399,057	561,227	781,346	1,796,275	1,924,793	1,935,349	2,153,535

Figure 9-17. Summary LVSWSB Financial Model Results

In the LVSWSB Financial Model the WSPs are paying a Licensee fee to the LVSWSB which is a royalty on revenues. In addition, where the LVSWSB still owns the water meters that income is a pass-through from the WSP to the LVSWSB. The New Lease Fees consists of the charge to the WSP so as to recover the cost of capital incurred due to the new investments in each WSP. It is understood in the SPA that the WSP will cover that cost, and more to be derived from any excess cash flow at the WSP level. The additional amounts will be utilized by the LVSWSB as a major maintenance reserve and future expansion. A debt service reserve is incorporated in the Financial Model equivalent to 6 months of debt service. As can be seen from the above, the LVSWSB's asset base increases steadily and will enhance its bankability over time.

9.3.10 (b) LVSWSB CapEx Plan

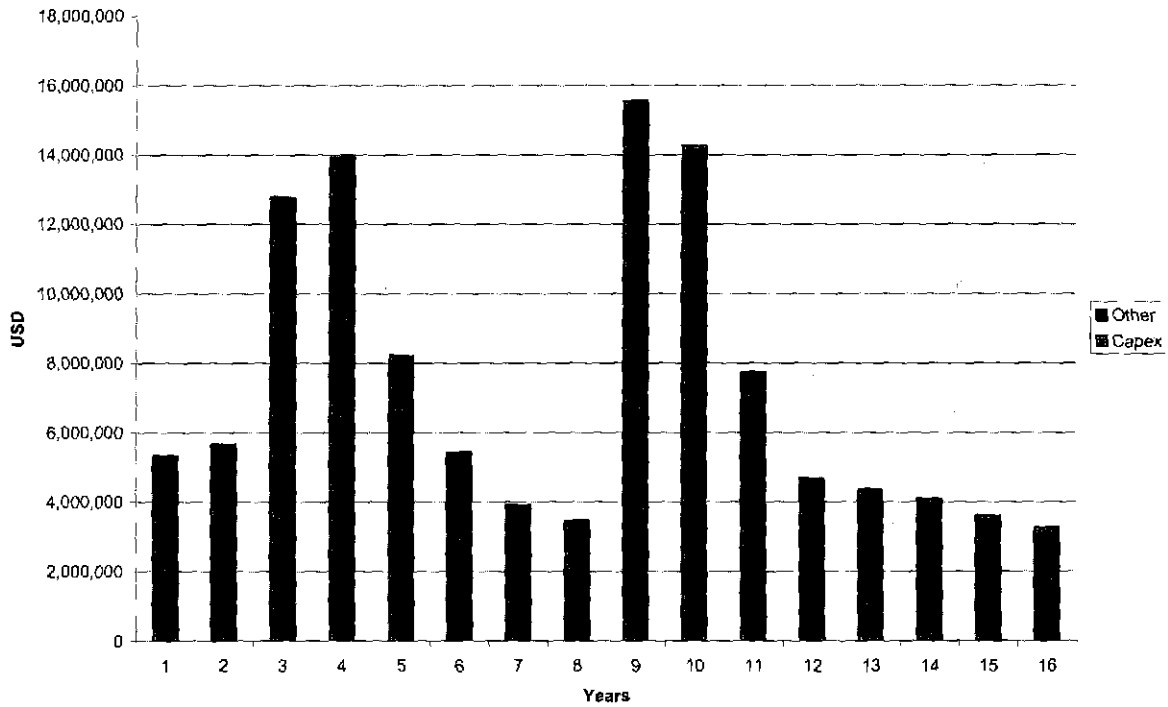


Figure 9-18. LVSWSB CapEx

The Capex chart depicts the two more significant stages of investment. The Other costs relate to soft costs over and above the infrastructure capital expenditures.

The financing is recommended to be staged in three 5 year phases. The first debt financing assumes a Sources and Uses as follows:

FINANCING 1 - LVSWSB

USES	US Dollars	KS ('000s)
Project Costs		
CAPEX	**42,525,670**	2,976,797
Working Cap (start opex...)	1,200,000	84,000
Interest	1,200,000	84,000
Legal and Financial Advisory (Development and close)	300,000	21,000
Financing costs and other	675,000	47,250
Contingency	2,000,000	140,000
Total Project Costs	**47,900,670**	**3,353,047**

SOURCES	US Dollars	KS ('000s)	Grant
GRANT (MOF and Other)	11,975,167	838,262	25%
Senior Debt 1	**35,925,502**	2,514,785	75%
Total Project Financing	**47,900,670**	**3,353,047**	**100%**

Financal Assumptions:			
Interest		5.0%	
Loan Re-Paymnet Period		25	Don't Change
Grace (loan re-payment)		5	Don't Change
Total Loan Period From Initial Drawdown		25	
Receivables		45	
Inventory	N/A		
Payables		30	
Tax Rate		0%	
Depreciation period		30	

The Working Capital is funding to the WSPs and for the LVSWSB who will need additional capital to expand their staff, and meet the greater obligations that new infrastructure investment will cause. Interest will need to be paid currently and as the revenue potential for the WSPs will lag several months it is prudent to capitalize a level of interest as part of project costs. Under the assumption of a Bridge Finance there would be additional costs to the sponsor. The Contingency amount of $2 million is drawn the first year and is used by LVSWSB on an as needed basis. This reserve allows the LVSWSB to maintain a healthy cash balance through the slower early years.

On the Sources side a recommendation for 25% grant is presented. There are precedents for 30% and for less than 25%, and while the sensitivities show that the LVSWSB can support a higher debt component, it is more prudent to increase the grant amount.

The Second and Third financings are assumed to be as follows in the LVSWSB Financial Model:

FINANCING 2

Long Term Requirements		
Capex	**41,410,571**	
Other	1200000	
LT extended	0	
Grant	4261057	10%
Senior Debt 2	38,349,514	90%
TOTAL PROJECT COSTS	**42,610,571**	
Tenor	20	
Rate	5%	
Grace	5	

The second financing would occur 5 years after the first, also carry a 5 year grace period and drawdown, but with a shorter tenor to 20 years. This funding will also be concessionary or donor type funding. A smaller grant amount is required in consideration of Kisii's needs.

FINANCING 3

Long Term Requirements		
Capex	**16,757,567**	
Other	300000	
LT extended	0	
Grant	0	0%
Senior Debt 2	17,057,567	100%
TOTAL PROJECT COSTS	**17,057,567**	
Tenor	10	
Rate	8%	
Grace	3	

The third financing is assumed to occur at a time in which the LVSWSB will not require a sovereign guarantee, or concessionary donor type financing. A higher interest rate is assumed, a shorter tenor, and a shorter drawdown period. This debt financing would occur in the 11th year.

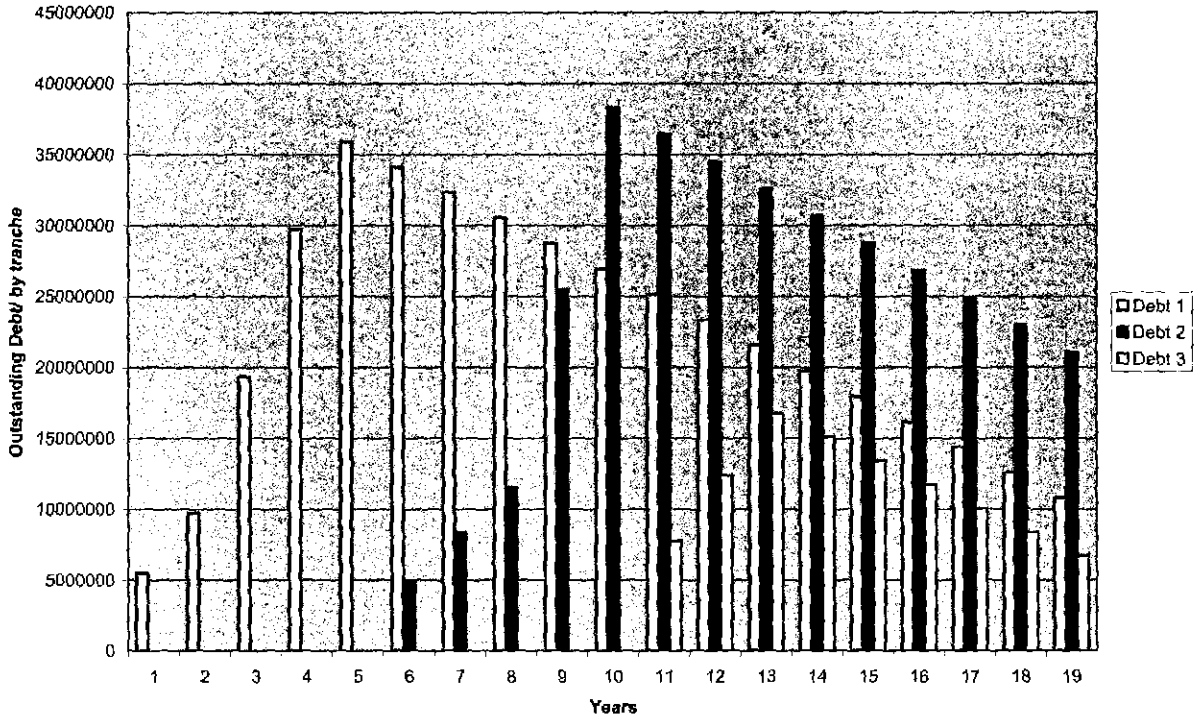


Figure 9-19. LVSWSB Debt Financings

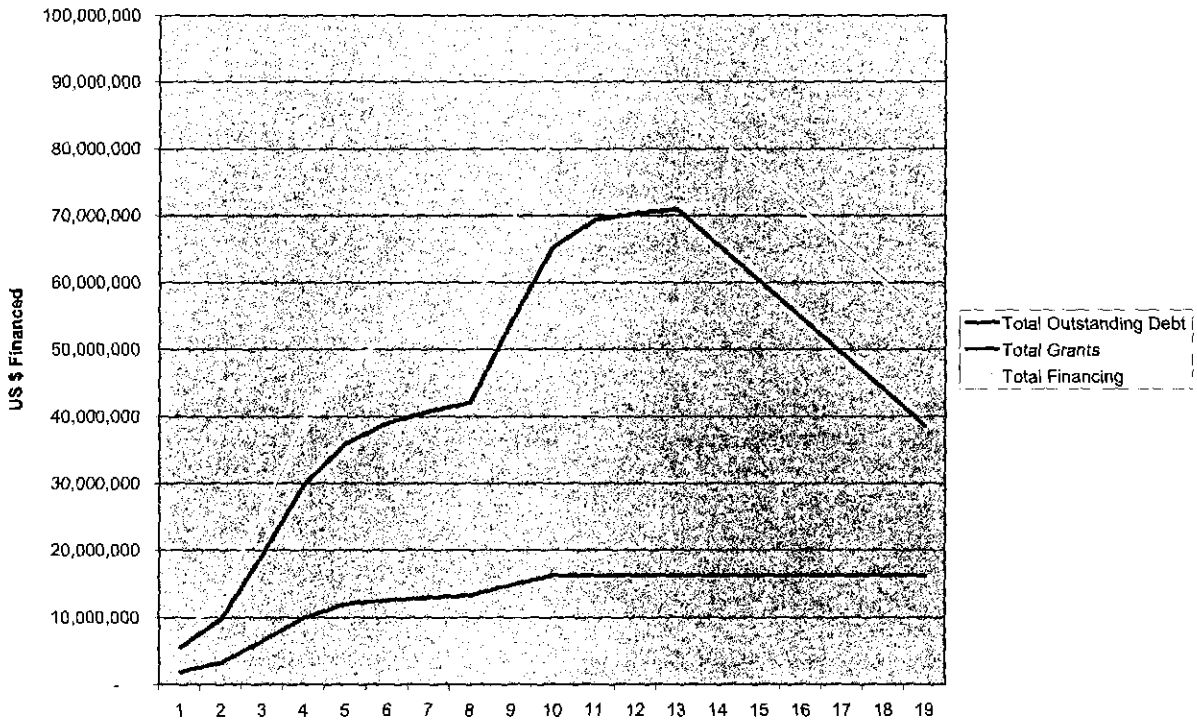


Figure 9-20. LVSWSB Total Financing

9.3.10 (c) LVSWSB Sensitivities

The sensitivities for the LVSWSB focused on the Grant amount, and the O&M expense escalation. Tariff and water demand sensitivities were addressed in the WSP financial models.

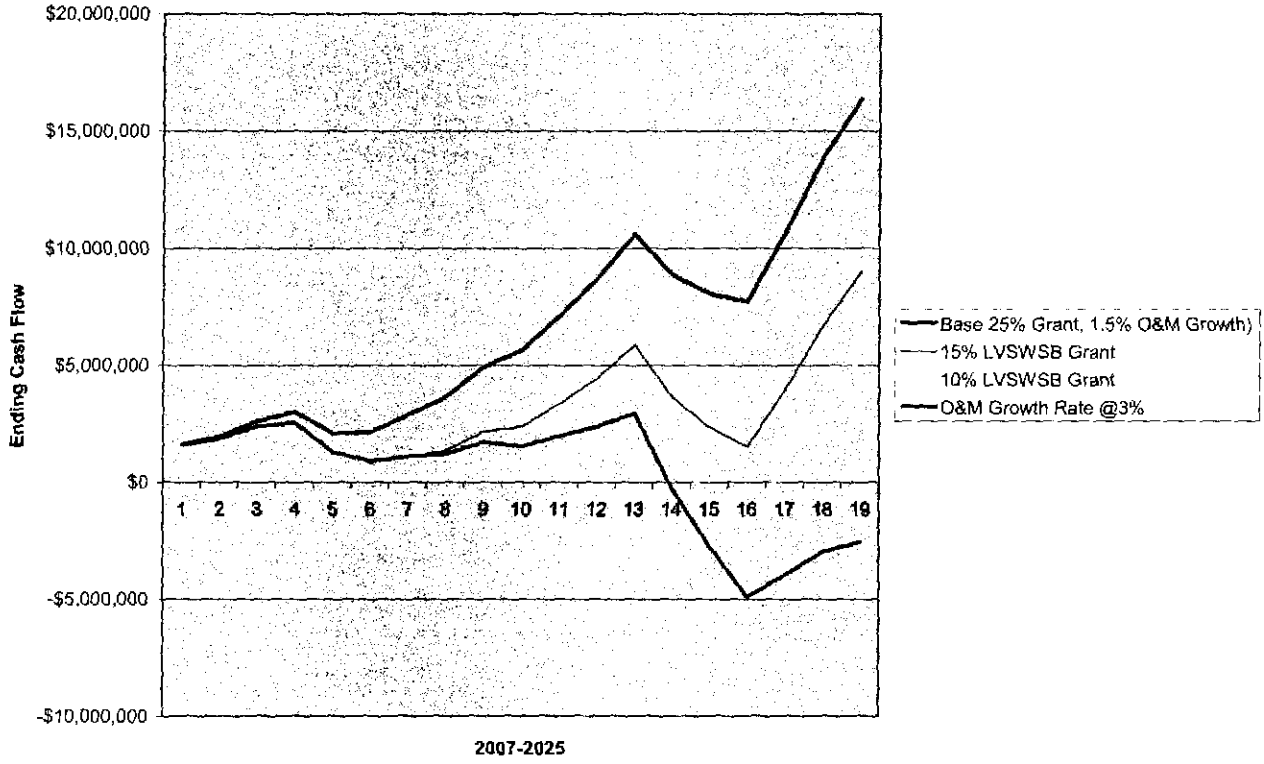


Figure 9-21. LVSWSB Sensitivities

The LVSWSB financial projections are sensitive to a drop in Grant amount, although as stated earlier it could withstand a 15% grant. To create more margin for error it is prudent to remain in the 20-25% grant amount. The O&M escalation change would create a cash flow problem in the years 13 and beyond. The LVSWB will need to be prudent on its cost structure as it expands. The reason for the increase in ending cash flow in the Base Case, which is very strong, is that the LVSWSB intends to maintain a royalty on WSP revenues.

While the initial years have negative net income (incurred in part due to the significant depreciation charges), the ending cash balance remains healthy and grows over the years creating reserve capacity for future investment requirements. Not shown in these results is a share of the surplus cash flow generated at the level of each WSP which, according to the SPA, will need to be distributed amongst the WSP and Water Services Board, the latter's justification being major maintenance and new capital expenditures to expand and upgrade the system.

An area of improvement for LVSWSB will be to control O&M expenditures as they expand.

The Project Team's opinion of the project, using these assumptions and the recommendations made in the Study, is that it can successfully borrow these funds, deploy them, and generate income to repay the debt. What is also important is that it can be done maintaining the tariffs at or near their existing ones, with minimal escalation. This was a goal set-out at the beginning of the Study, and decisions on the technical

implementation, the timing of the investments, and other, only needed to be slightly adjusted to meet the tariff goal. It is worth noting that surveys indicate that customers would be open to higher tariffs in exchange for more reliable services.

FIRR and EIRR

Financial IRR Cash Flow (2008-2025)	2008	2009	2010	2011	2012
Annual Investment (External)	(7,328,000)	(5,656,405)	(12,767,145)	(13,935,205)	(8,213,916)
Cumulative First Financing	(7,328,000)	(12,984,405)	(25,751,550)	(39,686,754)	(47,900,670)
Cumulative 2nd Financing	-	-	-	-	-
Cumulative 3rd Financing	-	-	-	-	-
Less Grant Component	(1,832,000)	(1,414,101)	(3,191,786)	(3,483,801)	(2,053,479)
Annual Financed Amount	(5,496,000)	(4,242,304)	(9,575,359)	(10,451,404)	(6,160,437)
Base Case Revenues less O&M	(101,169)	238,626	990,565	1,427,653	1,611,879
Base Case FIRR Cash Flow	(5,597,169)	(4,003,678)	(8,584,794)	(9,023,751)	(4,548,557)
Base Case FIRR	**4.8%**	-	-	-	-

Economic IRR	2008	2009	2010	2011	2012
Incremental Water	0	1013	2163	3476	8178
Health Benefit		159,197	339,875	546,176	1,285,043
Base Case EIRR Cash Flow	(5,597,169)	(3,844,481)	(8,244,919)	(8,477,575)	(3,263,515)
Base Case EIRR	**14%**				

Health Benefits derived from ADB Rift Valley Study - 2004; 11,000Ksh/cubic meter of incremental water

Figure 9-22. Financial and Economic IRR Analysis

To determine the investment basis the Grant component is removed and the investment becomes tied to the amount of third party debt financing. The EIRR's health benefits component was derived from the basis used in the Rift Valley water supply project study. While the FIRR is not very high, the business model of the LVSWSB calls for third parties (the WSPs) to always cover its cost of funds and more. The higher O&M costs of the LVSWSB and the limits on growth, account for a lower FIRR. The Base Case EIRR is at 14% which is understandably not very high considering the new projects are required to meet water and sanitation goals in this area of Kenya.

9.4 Implementation Plan

This study demonstrates that viable water and wastewater utilities in the Lake Victoria South service area can be developed and principally financed with user tariffs set near or below the Kenyan average. From its inception, a central focus of the project has been on ensuring that the study recommendations are implemented. The Lake Victoria South Water Services Board, still in its infancy, is at a pivotal juncture for this project and the development of the region. It is crucial that the current project momentum be maintained and immediately translated into project implementation.

The focus of initial implementation efforts should be on securing funds required for technical assistance to start immediate projects and on seeking bridge financing required for implementation of the Immediate and Short Term Projects. Securing limited funds for the first steps is crucial to maintaining the project momentum. The Water Services Board will continue its activities and do what it can to advance on the Study's recommendations, but it will require third party assistance for advice and additional resources.

Figure 9-23 summarizes the proposed implementation schedule, broken down into Technical and Financing tasks. As indicated, immediate financing will be required in the first nine months of the project to provide technical assistance and secure the bridge financing required to fully implement the Immediate Projects and

begin the Short Term Projects. Securing the concessionary-type financing required for implementing larger projects may require more than two years.

If bridge financing is secured by the end of Year 1, then LVSWSB and the WSPs will be able to implement the Immediate Projects and some Short Term Projects extending though the first part of Year 3. During this period, work will continue to secure the long-term concessionary financing required for projects from Year 3 through the Short Term. As described previously, it is expected that a second and possibly third tranche of financing will be required by 2015 to fund the remaining projects throughout the study period.

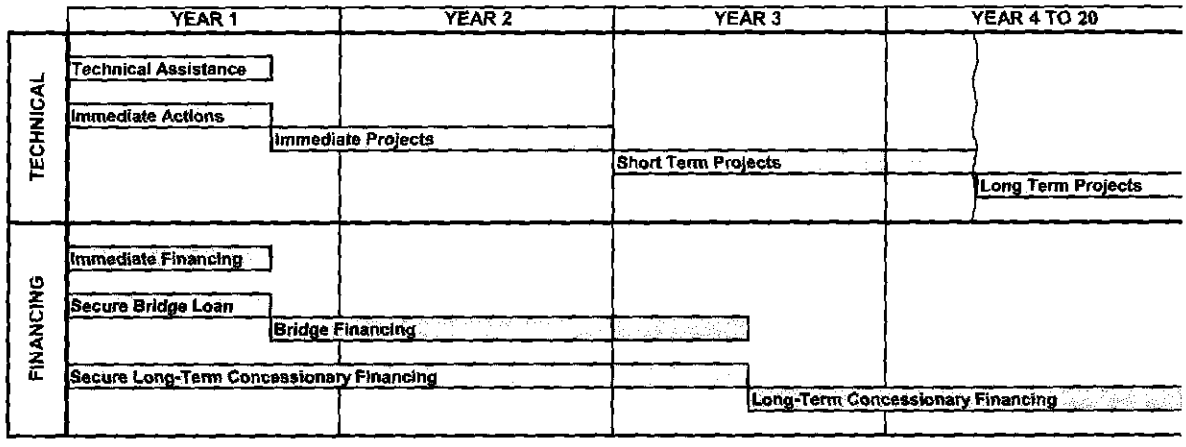


Figure 9-23. Proposed Project Implementation Timeline

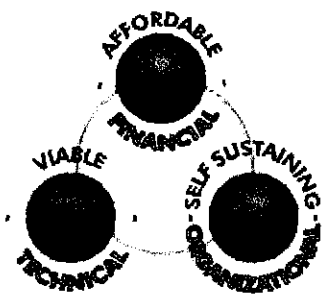
The recommended financing and technical assistance projects to be undertaken in the first nine months are outlined in Table 9-14. Approximately $550,000 will be required in this period to provide technical assistance and move the bridge financing process forward to the level of a preliminary term sheet. In addition to the tasks identified in Table 9-14, there are technical projects (requiring additional budget) which are identified in the Study that can be implemented during this nine month period and which will help the WSPs boost production and revenue in the shortest amount of time for the least cost.

By implementing these technical projects, the LVSWSB will be able to demonstrate to potential donors and lenders that the WSPs have taken important steps toward becoming bankable utilities and that they are prepared to move immediately into full implementation once bridge financing is made available. The financing efforts included will move the bridge financing process forward to the level of a preliminary term sheet.

Table 9-14 . Estimated Costs for Immediate Technical Assistance and Financing Needs

SUMMARY TITLE	LVSWSB	KISII	KERICHO	MIGORI	EST. COST
FINANCING					
Seek Bridge Financing Preliminary Term Sheet	X				$ 100,000
WATER & WASTEWATER ACTIVITIES					
Mapping	X	X	X	X	$ 160,000
Asset Management Planning	X	X	X	X	$ 55,000
WATER MANAGEMENT					
Bulk Water Meter Planning		X	X	X	$ 15,000
Consumer Water Meter & Pilot Planning		X	X	X	$ 25,000
Illegal Connections Elimination Planning	X	X	X	X	$ 15,000
WATER SOURCE & TREATMENT					
Auxillary Power Analysis		X		X	$ 40,000
Well Rehabilitation Assistance				X	$ 25,000
WATER DISTRIBUTION					
Leak Detection and Repair Assistance	X	X	X	X	$ 25,000
Distribution System Re-activation Plan		X			$ 15,000
WASTEWATER COLLECTION					
Sewer Infill Connections Program		X	X		$ 20,000
I/I Sewer System Evaluation Program			X		$ 20,000
WASTEWATER TREATMENT					
Pilot Aeration Project Assistance			X	X	$ 20,000
Hospital Lagoons Capacity Analysis				X	$ 15,000
TOTAL					$ 550,000

Conclusion



The Lake Victoria South Water Services Board area is rich in human and natural resources. This vibrant region has the potential to become one of East Africa's most productive and prosperous areas. However, the region's economic development and public health are significantly weakened by inadequate and deteriorating water and wastewater infrastructure.

This study demonstrates that viable water and wastewater utilities can be developed and principally financed with user tariffs set near the Kenyan average. The 2002 Water Act reforms have been systematically implemented over the past five years to bring about a new era where self-sustaining water and wastewater utilities can take hold in Kenya. The Lake Victoria South Water Services Board is positioned to take advantage of the opportunities afforded by this new regulatory environment. This study lays out the technical, financial, and organizational requirements for moving forward and creating viable, affordable, and self-sustaining utilities. The resultant provision of affordable and high quality water and sanitation services to hundreds of thousands of Kenyans will have far-reaching public health benefits and unlock the region's economic potential.

10. DEVELOPMENT IMPACT 1

10. DEVELOPMENT IMPACT

Provision of viable water and wastewater services in the Lake Victoria South Region will produce numerous positive developmental impacts ranging from health benefits to economic growth. Kenya has set forth national priorities for development in the water sector. Most notably, the National Policy on Water Resources, finalized in 1999, has set a goal of providing all Kenyans with access to clean water by the year 2010[1]. Current national access levels are estimated to be approximately 65%.

Kenyan President Kibaki recently unveiled a plan to turn the Lake Victoria South Region into a business hub for the East and Central Africa region.[2] He noted that the plan would include an expansion of the airport in Kisumu and the construction of a highway around Lake Victoria to link Kenya with its East Africa Corporation partners. A viable water and wastewater infrastructure will be crucial to the successful implementation of an economic transformation of this magnitude.

Developmental impacts expected to result from the proposed project are summarized below. They include the four principal areas noted in Clause H of Contract Annex II (*Infrastructure/Industry*, *Market-Oriented Reforms*, *Human Capacity Building*, and *Technology Transfer and Productivity Enhancement*) as well as three additional areas (*Health Impacts - AIDS*, *Environmental Impacts & Tourism*, and *Opportunities for Related Industries*).

Infrastructure/Industry:

- Unreliable and nonexistent water provision in Kenya is often cited as a significant obstacle to development and economic productivity.
- It is the Government of Kenya's stated objective to expand rural and new urban industrialization and attract manufacturing to these areas. This goal cannot be achieved without the availability of reliable and clean water to operate factories and encourage business activity. For example, the Coca-Cola bottling facility relies on its own groundwater supplies but would like to utilize municipal water and avoid the expense and uncertainty of maintaining its own supply.
- Lack of wastewater treatment hampers industrial development because discharges contaminate local surface and groundwater supplies for downstream users and impair fisheries. For example, in Migori the construction of multi-story buildings is currently prohibited due to a lack of sewers, despite a burgeoning commercial/industrial base centered around trade with Tanzania and the food processing industry.
- The establishment of viable, reliable water and wastewater management systems will allow local industries and businesses to grow, while avoiding the potentially devastating losses that water shortages can cause.

Market-Oriented Reforms:

- The recommendations of the study include the abandonment of national standard water and wastewater tariffs which do not ensure cost-recovery and result in Water Service Providers (WSPs) operating at a financial loss. The recommended tariff toolkit will allow WSPs to implement a standardized approach to tariff-setting based on real data and expected future expenditures, thereby accurately pricing water while simultaneously incorporating pro-poor tariff structures. WSPs would be required to utilize the toolkit when submitting tariff rate increases, thereby simplifying the review process and ensuring tariff increases are based on verifiable data.
- Among the principal recommendations of the study is the development of a business-minded approach to management among Water Service Providers. This includes provisions for transitioning to a 100% metered system and becoming customer-focused utilities with emphasis on public relations, communication with customers, and responsiveness.

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[1] Allen, Nick and Julius Ngonga, p 1.

[2] Mburu, Samuel. "Kibaki's gift for Kisumu city" The East African Standard. 28 March 2004. Online. Accessed March 29, 2004. Available at: http://www.eastandard.net/archives/March/sun28032004/headlines/news28030411.htm

- The current lack of asset management systems causes equipment to fall into disrepair and increases life cycle costs of infrastructure. The asset management systems recommended in the study will ensure WSPs maximize the longevity of their assets and include their depreciated value in accounting systems.

Human Capacity Building:

- Time spent searching for water is time unavailable for more productive activities. In many parts of the Lake Victoria South Region, economic productivity is significantly hampered because women and children spend hours each day searching for and collecting water, reducing time available for more productive work or schooling.
- A sick population is not working. The lack of a reliable clean water source increases the percentage of the workforce that is unavailable for productive work due to water borne illness. Such illness affects all sectors of the workforce, from rural farming to office work.
- Water borne diseases tend to have a larger impact on children and the young, putting a great strain on the public health and hospital system. These lost children are Kenya's potential political and business leaders, educators, and innovators of the future.
- The project recommendations include a variety of training programs for WSP staff and managers to develop skills needed to create and maintain viable utilities. Among the three towns studied and LVSWSB, over one hundred employees are expected to receive training. A structured program for training, testing, and certification of operators will be created and administered at the LVSWSB level. Requiring certification of water and wastewater facilities operators and continuing education will develop competency of local staff, ensure operator safety, and enable LVSWSB to reap maximum benefits from its infrastructure investments. Local managers and staff will be trained in various areas including leak detection and repair, computer use, billing and collections management, handling illegal connections, public relations, on-site wastewater management, and kiosk and public toilet management. Training will also include "soft" subjects such as maintaining professional appearance, customer relations, etc.
- The project recommendations also include development of local entrepreneurship opportunities, including training and certification programs. Such enterprises will reduce burdens on WSPs and develop local income-generating opportunities and employment such as management of water kiosks and public toilets, septage hauling, and other activities. Local entrepreneurs will also be trained and certified.
- Hundreds of workers, from laborers to engineers, will be required for construction of the proposed infrastructure projects.

Technology Transfer and Productivity Enhancement:

- The project recommendations also include a variety of technologies which will improve employee productivity and the number of people served with water and sanitation.
    - *New dams, intakes, and water and wastewater treatment facilities* will reduce the number of citizens without access to water and sanitation by 50% by 2015. This will increase the number of available working and education hours by several hundred thousand per day as a result of reductions in time required for fetching water and recovery from water related illnesses.
    - *Bulk and Consumer Water Meters and Leak Detection Equipment* will reduce water losses from present levels of more than 50% to as low as 15% and increase WSP revenues. Automatic meter reading technology will similarly reduce time required for meter reading.
    - *Mapping Information including Satellite Imagery, GPS Equipment, GIS software and hardware* will drastically improve the accuracy of planning activities and time spent by technicians in the field trying to locate assets.
    - *Billing and Asset Management Software/Systems* will improve billing accuracy, reduce time required for billing activities, and maximize the lifespan of WSP assets.
    - *Solar Aeration and other Treatment Facility Improvements* are expected to increase capacity and efficiency of existing facilities by as much as 50%.

Health Impacts - AIDS

- The present HIV/AIDS epidemic in Kenya is significantly exacerbated by the lack of adequate water and sanitation infrastructure. HIV/AIDS affects the immune system and the body's resistance to disease, so people with HIV/AIDS are more vulnerable to water borne disease. Many formerly non-lethal water borne diseases are now lethal for AIDS sufferers.
- According to USAID, "Largely due to AIDS, life expectancy in Kenya dropped from 60 years in 1990 to 45.5 years in 2002". [3] It is estimated that 15% of Kenya's working population is infected with HIV. Kenya is one of only four "high-priority" countries identified by USAID to receive more resources for HIV/AIDS programming. The prevalence of AIDS puts a major strain on Kenya's health care system.
- HIV/AIDS is predicted to be a significant hindrance to the development of the Kenyan economy, principally due to high health care costs and lost income due to people being ill. Kenya's gross domestic product was projected to be 14.5 percent higher in 2005 in the absence of AIDS.

Environmental Impacts, Tourism

- The purpose of the proposed project is to improve and expand the water and wastewater infrastructure currently serving the Lake Victoria South Region. Surface and ground water quality will be improved because of the project. Improvements in the environmental health of lakes, streams, and groundwater in the Lake Victoria South Region will be realized. Lake Victoria's eutrophication and the explosion of water hyacinth has resulted in devastating impacts to the region's fishing, shipping, and tourism industries.
- Improvements to the environment and the availability of clean drinking water and sanitation will result in improving tourism in the area, which is adjacent to Maasai Mara, one of the world's most popular safari destinations.

Opportunities for Related Industries

- In addition to products and services directly related to the provision of water and wastewater services, a variety of other products and services will be required for project implementation and present additional opportunities for U.S. firms:
  - *Mapping Information Systems including Satellite Imagery, GPS, and GIS* - One of the principal recommendations of the study is for the development of mapping information to be used for virtually all planning activities. The availability of high quality satellite imagery, Geographic Positioning System (GPS) and Geographic Information Systems (GIS) can result in the rapid development of detailed mapping.
  - *Computer Hardware and Software* – Management of complex water and wastewater systems as proposed in this study will be drastically simplified and made more efficient through the use of microcomputers and software.
  - *Auxiliary Power* – The lack of reliable power in the region necessitates that auxiliary power sources such as diesel or gas-fired generators be installed at major treatment facilities and pumping stations.
  - *Alternative Energy (Wind, Hydropower, Biomass)* – Although a reliable electrical power supply and distribution network does not exist in the region, abundant potential sources of alternative energy exist including wind, hydropower, and biomass.

[3] USAID Country Profile, HIV/AIDS, Kenya 2003.

In summary, implementing a well planned, economically viable program for water and wastewater infrastructure development will result in the following developmental improvements for the Lake Victoria South Region:

- Decreased incidence of waterborne disease
- Decreased time wasted searching for water
- Improved children's health and time available for education
- Increased human productivity
- Increased industrial productivity
- Improved water quality in Lake Victoria (impacts on navigation, fisheries, tourism)
- Improved tourism due to availability of potable water and sanitation
- Increased industrial development in rural areas
- Increased availability of human capital
- Decreased incidence of mortality from HIV/AIDS
- Increased gross domestic product

A list of U.S. Suppliers of equipment and services required for implementation of the project recommendations is included in Appendix 10-1.

APPENDIX 1-1

Project Team Letter to Grantee containing Draft Work Plan and Draft Community Selection Criteria (1/10/2006)

COLER & COLANTONIO INC

ENGINEERS AND SCIENTISTS

January 10, 2006

Eng. R.N. Gakubia, Director of Water
Ministry of Water and Irrigation
Maji House, Ngong Road
P.O. Box 49720, Nairobi
KENYA

RE: Lake Victoria South Water and Wastewater Feasibility Study

Dear Eng. Gakubia:

We are very pleased to have established the dates (January 23 through February 2, 2006) of our first trip to Kenya associated with the above-referenced project. I have attached four documents as described below:

1) **Draft Itinerary** for our upcoming visit. Please review and comment. Mr. Wanday of CapeConsult is working with Eng. Ombogo to arrange the meetings in Nairobi, Kisumu, and each of the proposed study communities, as well as ground transportation.
2) **Draft Work Plan**. This document details our proposed schedule and responsibility for all project tasks in agreement with our contract. Please review and comment. We will finalize this Work Plan during our initial meeting in Nairobi on Monday January 23.
3) **Draft Community Selection Criteria.** Our proposed criteria to be used in selecting which three communities will be chosen for detailed study. Please review and comment. We will finalize these criteria during our initial meeting in Nairobi on Monday January 23.
4) **Advance Payment Invoice.** This is our initial invoice in accordance with our contract. We require these funds for our initial work, including our first trip to Kenya. We ask that P.S. Maalim please sign the invoice before our January 23 meeting. We will retrieve the signed invoice during the visit.

As you are aware, USTDA is providing funding for this project. The invoicing protocol they have asked us to use is as follows:

1) Contractor (Coler & Colantonio) sends invoice to Client (Ministry of Water and Irrigation)
2) Client approves, signs and dates invoice and returns to Contractor by e-mail or fax.
3) Contractor sends invoice to USTDA
4) USTDA releases funds to Contractor

We look forward to meeting with you on January 23 and to working with you on this exciting project.

Sincerely,
COLER & COLANTONIO, INC.

Mark J. Devine, P.E.
Water and Wastewater Division Manager

cc: Eng. Mahboub M. Maalim, Permanent Secretary, Ministry of Water and Irrigation
Eng. Patrick Ombogo, CEO, Lake Victoria South Water Services Board
Mr. Humphrey Lilech, Senior Commercial Specialist, U.S. Embassy Nairobi

101 Accord Park Drive
Norwell, MA 02061-1685

781 982-5400
Fax: 781 982-5490

recycled paper

LAKE VICTORIA SOUTH WATER AND WASTEWATER FEASIBILITY STUDY

ITINERARY

January/February 2006 Coler & Colantonio Project Team Visit

Project Team for visit includes the following seven (7) individuals:
James Colantonio, Mark Devine, David Favazza, Jerry Okoko, M. Ilyas Bhatti, Chris Lundstrom, Peter Wanday

Monday – January 23, 2005

09:00 Meeting with Project Team, Humphrey Lilech (U.S. Embassy), Eng. Mahboub M. Maalim (P.S., Ministry of Water and Irrigation), Eng. R.N. Gakubia (Director of Water, Ministry of Water and Irrigation), Eng. Patrick Ombogo (CEO, Lake Victoria South Water Services Board), and other Ministry Staff (?).

- Presentation by Project Team
- Review Agenda, Schedule for Trip
- Discuss / Establish Communication, Invoicing Protocols
- Review / Discuss / Finalize Work Plan
- Review / Discuss / Finalize Criteria for Community Selection
- Review / Discuss Existing Communities and Available Information
- Review / Discuss W.Q. Requirements / Criteria
- Review / Discuss Financing

p.m. Additional meetings with Ministry of Water, U.S. Embassy, Chamber of Commerce, others – T.B.D.

Tuesday – January 24, 2005

08:00 Fly from Nairobi to Kisumu
09:00 Arrive Kisumu
10:00 Meetings at LVSWSB Offices with CEO Ombogo and LVSWSB Staff
12:00 Drive to **Kericho** (1 1/4 hr. drive). Lunch at Tea Hotel.
14:00 Meet local water/wastewater/municipal staff, visit water/wastewater facilities as time permits.

Wednesday – January 25, 2005

All Day Continue **Kericho** visit. Continue visiting all water/wastewater facilities, tour community.
p.m. M. Devine, D. Favazza remain in Kericho.
Rest of Project Team returns to Kisumu.

Thursday – January 26, 2005

All Day M. Devine, D. Favazza visit **Bomet and Keroka (if two visits in one day possible).** Meet local water/wastewater/municipal staff; visit all water/wastewater facilities, tour community.

p.m M. Devine, D. Favazza return to Kericho.

Friday – January 27, 2005

All Day Visit **Kisii or Keroka (Keroka only if not already visited).** Meet local water/wastewater/municipal staff, visit all water / wastewater facilities, tour community.
Eve. Return to Kericho

Saturday – January 28, 2005

All Day Visit **Kisii or Keroka (whichever not already visited, if either).** Meet local water/wastewater/municipal staff, visit all water/wastewater facilities, tour community.

Eve. Return to Kericho

Sunday – January 29, 2005

Rest – visit Tea Plantation

Review Notes, Prepare for upcoming meetings

Monday – January 30, 2005

All Day Visit **Migori** (long drive from Kericho). Meet local water/wastewater/municipal staff, visit all water/ wastewater facilities, tour community.

Eve. Drive to Kisii.

Tuesday – January 31, 2005

All Day Visit **Homa Bay**. Meet local water/wastewater/municipal staff, visit all water/wastewater facilities, tour community.

Eve. Drive to Kisumu (if visits complete) or Kisii (if not complete)

(**Note**: If it is not possible to arrange a Saturday visit or two visits on one day, it may be necessary to stay in Kisii this night and visit last community on Wednesday)

Wednesday – February 1, 2005

OPEN DAY – Fly back to Nairobi if visits complete OR
Additional visits / meetings in LVSWSB area as needed

Thursday – February 2, 2005

a.m. Fly from Kisumu to Nairobi

p.m. Wrap-up Meeting with M. Devine, D. Favazza, CapeConsult, M. Maalim, R.N. Gakubia, Eng. P. Ombogo, other Ministry Staff.

- Review Notes from Site Visits
- Discuss Communities with respect to Selection Criteria
- Make Community Selection Recommendations, Finalize Communities (if possible)
- Establish W.Q. Requirements (if possible)
- Review Next Steps, Schedule Next Trip

Eve. Return flight to U.S.

DRAFT WORK PLAN BY PAYMENT

LAKE VICTORIA SOUTH WATER AND WASTEWATER PROJECT

KENYA

5-Dec-05

PAYMENT/TASKS	RESPONSIBLE ENTITY 1	2	3
PAYMENT 1 - MOBILIZATION			
PAYMENT 2			
1.1.1 Develop Draft Work Plan	C&C	All	
1.1.2 Document Draft Work Plan	C&C		
1.2.1 Profile Candidate Communities	C&C	Cape	
1.2.2 Develop Criteria for Selection of Communities	C&C	Cape	All
1.2.3 Develop Recommendations of Communities	C&C	Cape	All
1.2.4 Recommend Communities to Grantee	C&C	Cape	All
1.3.1,2 Meet with Grantee re Work Plan and Selected Communities	C&C	All	
1.3.3,4 Finalize/Document Work Plan	C&C	All	
2.1.1 Identify Available Information	Cape	C&C	
2.1.2 (a) Collect Information (Initiate)	Cape	C&C	
2.2.1 Identify Water Uses	C&C	Cape	
2.2.2 Identify W.Q. Requirements/Criteria	C&C	Cape	Bhatti
5.1.1 (a) Develop Financial Model (Initiate data gathering and research)	Tusk	Bab	Bhatti
PAYMENT 3			
2.1.2 (b) Collect Information (Complete)	Cape	C&C	
2.1.3 Catalog and File Information	Cape	C&C	
2.2.3 Establish Final W.Q. Objectives/Criteria	C&C	Cape	Bhatti
2.2.4 Document W.Q. Objectives/Criteria	C&C	Cape	Bhatti
2.3.1 Define Base Map Needs	C&C	Cape	
2.3.2 (a) Develop Service Area Base Maps (Initiate)	C&C	Cape	
2.4.1 Population, Domestic Water Use	C&C	Cape	Bhatti
2.4.2 Ag., Comm., Ind. Water use	C&C	Cape	Bhatti
4.1.1 Define Current Mgmt. Arrangements	Bhatti	C&C	Cape
4.1.2 Legislative and Regulatory Limitations	Bhatti	C&C	Cape
PAYMENT 4			
2.3.2 (b) Develop Service Area Base Maps (Complete)	C&C	Cape	
2.3.3 Develop Treatment Plant Base Maps	C&C	Cape	
2.4.3 Distribute Pop./Land Use	C&C	Cape	Bhatti
2.4.4 Project Water Demand/W.W.	C&C	Cape	Bhatti
2.5.1 (a) Evaluate Sources and Intakes (Initiate)	C&C	Cape	Bhatti
2.5.2 (a) Evaluate Water Treatment Facilities (Initiate)	C&C	Cape	Bhatti
2.5.3 (a) Evaluate Water Distribution Systems (Initiate)	C&C	Cape	Bhatti
2.5.4 (a) Evaluate Water System Management (Initiate)	Bhatti	C&C	Cape
2.6.1 (a) Evaluate W.W. Collection Systems (Initiate)	C&C	Cape	Bhatti
2.6.2 (a) Evaluate W.W. Treatment Facilities (Initiate)	C&C	Cape	Bhatti
2.6.3 (a) Evaluate W.W. Disposal Provisions (Initiate)	C&C	Cape	Bhatti
2.6.4 (a) Evaluate Sludge Provisions (Initiate)	C&C	Cape	Bhatti
2.6.5 (a) Evaluate W.W. System Management (Initiate)	Bhatti	C&C	Cape
4.1.3 Review Innovative Mgmt. Models In-Place	Bhatti	C&C	Cape

PAYMENT/TASKS	RESPONSIBLE ENTITY 1	2	3
5.1.1 (b) Develop Financial Model (Continue data gathering, initiate model development)	Tusk	Bab	Bhatti
PAYMENT 5			
2.4.5 Document Projections Findings	C&C	Cape	Bhatti
2.4.6 Finalize Projections Findings w/Grantee	C&C	Cape	Bhatti
2.5.1 (b) Evaluate Sources and Intakes (Complete)	C&C	Cape	Bhatti
2.5.2 (a) Evaluate Water Treatment Facilities (Complete)	C&C	Cape	Bhatti
2.5.3 (b) Evaluate Water Distribution Systems (Complete)	C&C	Cape	Bhatti
2.5.4 (b) Evaluate Water System Management (Complete)	Bhatti	C&C	Cape
2.6.1 (b) Evaluate W.W. Collection Systems (Complete)	C&C	Cape	Bhatti
2.6.2 (b) Evaluate W.W. Treatment Facilities (Complete)	C&C	Cape	Bhatti
2.6.3 (b) Evaluate W.W. Disposal Provisions (Complete)	C&C	Cape	Bhatti
2.6.4 (b) Evaluate Sludge Provisions (Complete)	C&C	Cape	Bhatti
2.6.5 (b) Evaluate W.W. System Management (Complete)	Bhatti	C&C	Cape
2.7.1 (a) Options for Water Treatment (Initiate)	C&C	Cape	Bhatti
2.7.2 (a) Options for Wastewater Treatment (Initiate)	C&C	Cape	Bhatti
3.1.1 Evaluate Current O&M	C&C	Cape	
3.1.2 Summarize Current O&M	C&C	Cape	
4.1.4 (a) Identify Mgmt. Options (Initiate)	Bhatti	C&C	Cape
PAYMENT 6			
2.5.5 Identify Water Infrastructure Needs	C&C	Cape	Bhatti
2.6.6 Identify W.W. Infrastructure Needs	C&C	Cape	Bhatti
6.1.1 Develop Evaluation Criteria	C&C	Cape	
PAYMENT 7			
2.5.6 Document Water Inf. Findings	C&C	Cape	Bhatti
2.6.7 Document W.W. Inf. Findings	C&C	Cape	Bhatti
2.7.1 (b) Options for Water Treatment (Complete)	C&C	Cape	Bhatti
2.7.2 (b) Options for Wastewater Treatment (Initiate)	C&C	Cape	Bhatti
3.1.3 Develop O&M Improvement Options	C&C	Cape	
4.1.4 (b) Identify Mgmt. Options (Complete)	Bhatti	C&C	Cape
4.1.5 Comparative Analysis of Mgmt. Options	Bhatti	C&C	Cape
5.1.1 (c) Develop Financial Model (Create preliminary financial model)	Tusk	Bab	Bhatti
5.1.2 Summary Worksheet	Tusk	Bab	Bhatti
6.1.2 Conduct Impact Evaluations	C&C	Cape	
PAYMENT 8			
2.7.3 Present W/WW Inf. Options/Rec.	C&C	Cape	Bhatti
3.1.4 Comparative Analysis of O&M Options	C&C	Cape	
3.1.5 (a) Present O&M Options/Recommendation	C&C	Cape	
4.1.6 Present Mgmt. Options/Recommendation	Bhatti	C&C	Cape
5.1.3 Input Additional Detailed Information into Financial Model	Tusk	Bab	Bhatti
5.1.4 Calculate User Fees, Fin. Structure Charges	Tusk	Bab	Bhatti
6.1.3 Recommend Mitigation Measures	C&C	Cape	
6.1.4 Discuss Analyses with Grantee	C&C	Cape	
6.1.5 Document Mitigation Measures	C&C	Cape	
PAYMENT 9			
5.2.1 Run Sensitivities	Tusk	Bab	Bhatti
5.2.2 Sensitiviites Report	Tusk	Bab	Bhatti

PAYMENT/TASKS	RESPONSIBLE ENTITY 1	2	3
7.1.1 Recommended Imp. Plan, Final Rpt. (Initiate)	C&C	All	
PAYMENT 10			
2.7.4 Select W/WW Inf. Option with Grantee	C&C	Cape	Bhatti
3.1.5 (b) Select Agreed-to O&M program, Mgmt. Arrangments	C&C	Cape	
3.1.6 Document Selected O&M Option	C&C	Cape	
5.3.1 Prepare Financing Plan	Tusk	Bab	Bhatti
5.3.2 Present Plan, Review, Finalize	Tusk	Bab	Bhatti
7.1.2 Discuss Recommendations with Grantee	C&C		
7.1.3 Structure Selected Plan	C&C		
PAYMENT 11			
2.7.5 Document Selected W/WW Inf. Option	C&C	Cape	Bhatti
4.1.7 Document Selected Mgmt. Option	Bhatti	C&C	Cape
7.1.4 Recommended Imp. Plan, Final Rpt. (Complete)	C&C	All	

LAKE VICTORIA SOUTH WATER AND WASTEWATER FEASIBILITY STUDY

DRAFT COMMUNITY SELECTION CRITERIA

6-Jan-06

	Kericho	Kisii	Migori	Homa Bay	Keroka	Bomet
2005 Population						
2025 Population (Projected)						

6 = strongly agree, 1= stongly disagree

TECHNICAL CRITERIA

General	Kericho	Kisii	Migori	Homa Bay	Keroka	Bomet
Reliable Topographic Maps Available						
Reliable Water / WW System Maps Available						
Reliable Street Maps Available						
Population distribution favorable (not highly dispersed)						
Topography favorable for distribution / collection						
Geology / soils favorable for construction						
Roadways in good condition						
Reliable power available						
Potential for renewable energy available						
Construction materials / equipment available locally						
Representative of other communities in region						
Overall Need for Public Health and Economic Improvement						

Water	Kericho	Kisii	Migori	Homa Bay	Keroka	Bomet
Supply Proximate to Demands						
Supply Capable of Meeting Present Demand						
Supply Capable of Meeting Future Demand w/o Dam/Reservoir construction						
Supply of Adequate Quality						
High (relative) percentage of existing population served						
Low (relative) unaccounted-for-water						
Water Treatment infrastructure capable of rehab/expansion						
Water Distribution infrastructure capable of rehab/expansion						
Government owned land available for new facilities						
Land available for new facilities						

Wastewater	Kericho	Kisii	Migori	Homa Bay	Keroka	Bomet
W.W. Treatment infrastructure capable of rehab/expansion						
W.W. Collection infrastructure capable of rehab/expansion						
Sufficient Land Available for Treatment/Disposal						
Favorable soils for subsurface discharge						
Surface water discharge feasible						
Little Commercial/Industrial Inputs or Pretreatment Exists						
High potential for local biosolids reuse						
Community interest in water reuse						

MANAGEMENT CRITERIA	Kericho	Kisii	Migori	Homa Bay	Keroka	Bomet
Strong local support for w/w.w. improvements						
Local government staff committed to support data needs of project						
Managerial Capacity in Place for O&M/Billing/Mgmt.						
Established water system staff exists						
Establishted wastewater system staff exists						
Established billing system exists						
Reliable population data available						
Clear House Numbers, Street Names, etc.. Exist						
Skilled labor / operators available						

FINANCIAL CRITERIA	Kericho	Kisii	Migori	Homa Bay	Keroka	Bomet
Systems in place for locally funding projects						
Projects often funded town government level (not national, international)						
Recent successful large infrastructure projects financed						
Local Household income relatively high						
Present fees for w/ww high						
Water/WW Payment Ratio Relatively Favorable						
Reasonable rate structure in place						
System Revenues Invested in System						
Revenues Pay for O&M, Mgmt.						
Revenues Pay for O&M, Mgmt., Cap. Improvements						
Local Economic Growth Potential						
General Creditworthiness						

Contractor and Subcontractor Contact Information

Lake Victoria South Water and Wastewater Feasibility Study

CONTRACTOR

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SUBCONTRACTORS

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Lake Victoria South Water and Wastewater Feasibility Study

APPENDIX 1-3

Community Pre-Visit Survey and Data Request Results

LAKE VICTORIA SOUTH WATER AND WASTE WATER FEASIBILITY STUDY

PRE-VISIT SURVEY AND DATA REQUEST

(Please complete survey and prepare documents prior to Coler & Colantonio visit Jan 25 – Feb 1)

COMMUNITY NAME:	**MIGORI WATER SUPPLY**
NAME/TILE OF RESPONDENT:	**DISTRICT WATER OFFICER**
TELEPHONE NUMBER:	**057-20031**
DATE:	**20TH JANUARY 2006**

GENERAL

What is present (2005) Population?	54322
What is 2025 Population (Projected)?	96224
Is a reliable street map available?	IF YES, PLEASE COPY
Are Reliable Water and Wastewater System Maps Available?	IF YES, PLEASE COPY
Are reliable local topographic maps available?	IF YES, PLEASE COPY
Is soil/geology data or maps available?	IF YES, PLEASE COPY
How often do power blackouts occur? (Daily? Weekly? Monthly?)	DAILY - HOURLY

WATER

What is design capacity of present water system (m^3/day)?	No specific design available – depend on borehole
What is actual daily production of present water system (m^3/day)?	570m^3/day
What % of population is served by the water system?	27% most parts (Ragana/Oruba) not served
What is the present fee for water (Kshs/m^3 or Kshs/10m^3)?	20/= per m^3
What is water source(s) (Stream, Lake, Borehole etc)?	2No. Boreholes
What treatment processes are required for current water source (filtration, chlorination etc)?	Chlorination by Batching
Is the existing water supply capable of meeting present demands?	No. present demand is 2987m^3/day
Is the existing water supply capable of meeting future demands without building a new dam/ reservoir/borehole?	No.
Is the existing water supply capable of meeting future demands if a new dam/reservoir/borehole is built?	Yes – Gravity system be put in Place
What % of water is unaccounted (lost to leaks, stolen etc)?	67%
Is Government owned land available for new facilities?	Yes

WASTE WATER

What is the design capacity of existing waste water treatment system (m^3/day)?	None Exists
What is the actual daily volume of waste water currently treated (m^3/day)?	N/A
What %	
What is the present fee for waste water (if separate form water)?	None
Is land available for treatment and disposal?	Yes – Municipal Council to provide
What kinds of industries are present in town?	Fish factory
Do industries discharge to the wastewater system?	Disposal ponds
Is there potential for sludge treated sludge for local agriculture?	If sensitized
Would the town consider re-using highly treated waste water for non-drinking purposes?	If sensitized.

MANAGEMENT AND FINANCE

Does the town have an established water/waste water billing system?	Domestic water billing by DWO – Revenue section
What percentage of people pay their bills?	70 – 80%
Is the community strongly in support of investing in water and sanitation systems?	Yes- Willing to pay but discouraged by irregular supply
Would people be willing to pay for improved water and sanitation service?	Very much
What is the average annual household income?	28,800/= Per annum
Is billing revenue re-invested into the system?	Yes by way of A.I.A
Does billing revenue pay for all operation and maintenance?	No
Does billing revenue pay for new capital projects?	No
Does the town have a water system administrative staff? How many people?	Yes – DWO
Does the town have a waste water system administrative staff? How many people?	N/A
Does the town have an established water system operation and maintenance staff? How many people?	Yes – DWO 65No. Including 6No. from WRMA
Does the town have an established waste water system operation and maintenance Staff? How many people	N/A
Is available population data reliable?	Yes – From district statistics office
Is a clear system of house numbers in place?	No
What percentage of people live in unplanned settlements?	80% proper town planning is a new initiative
Are skilled labour/operators available locally?	Yes
Are projects usually funded at the town, regional, or national level?	National level
What recent, infrastructure projects have been successfully financed?	Only rehabilitation of Migori and Rongo Water Supplies have been partly financed.

LAKE VICTORIA SOUTH WATER AND WASTE WATER FEASIBILITY STUDY

PRE-VISIT SURVEY AND DATA REQUEST

(Please complete survey and prepare documents prior to Coler & Colantonio visit Jan 25 – Feb 1)

COMMUNITY NAME:	**KISII WATER SUPPLY**
NAME/TILE OF RESPONDENT:	**DISTRICT WATER OFFICER**
TELEPHONE NUMBER:	**0722-877361**
DATE:	**19TH JANUARY 2006**

GENERAL

What is present (2005) Population?	About 200,000 service area, about 82,000 within Municipal
What is 2025 Population (Projected)?	360,000 Service area, about 147,000 within Municipality
Is a reliable street map available?	Yes
Are Reliable Water and Wastewater System Maps Available?	Yes
Are reliable local topographic maps available?	Yes
Is soil/geology data or maps available?	Yes
How often do power blackouts occur? (Daily? Weekly? Monthly?)	Daily

WATER

What is design capacity of present water system (m^3/day)?	Kegati & Nyakomisaro (6,000 +1,000)7,000m3 /day
What is actual daily production of present water system (m^3/day)?	2500m^3/day
What % of population is served by the water system?	40% of the Municipal
What is the present fee for water (Kshs/m^3 or Kshs/10m^3)?	20/= per m^3 or 200/= per 10m^3
What is water source(s) (Stream, Lake, Borehole etc)?	Stream
What treatment processes are required for current water source (filtration, chlorination etc)?	Full treatment (Coagulation, filtration/Chlorination)
Is the existing water supply capable of meeting present demands?	No
Is the existing water supply capable of meeting future demands without building a new dam/ reservoir/borehole?	No
Is the existing water supply capable of meeting future demands if a new dam/reservoir/borehole is built?	No
What % of water is unaccounted (lost to leaks, stolen etc)?	55%
Is Government owned land available for new facilities?	yes

WASTE WATER

What is the design capacity of existing waste water treatment system (m^3/day)?	8,600m^3/day
What is the actual daily volume of waste water currently treated (m^3/day)?	
What %	
What is the present fee for waste water (if separate form water)?	2.50 per m^3
Is land available for treatment and disposal?	Yes
What kinds of industries are present in town?	Soft Drinks
Do industries discharge to the wastewater system?	Yes e.g. light industries
Is there potential for sludge treated sludge for local agriculture?	Yes
Would the town consider re-using highly treated waste water for non-drinking purposes?	No

MANAGEMENT AND FINANCE

Does the town have an established water/waste water billing system?	Yes
What percentage of people pay their bills?	75%
Is the community strongly in support of investing in water and sanitation systems?	Yes
Would people be willing to pay for improved water and sanitation service?	Yes
What is the average annual household income?	
Is billing revenue re-invested into the system?	No
Does billing revenue pay for all operation and maintenance?	No
Does billing revenue pay for new capital projects?	No
Does the town have a water system administrative staff? How many people?	
Does the town have a waste water system administrative staff? How many people?	Yes (but inadequate – 1No)
Does the town have an established water system operation and maintenance staff? How many people?	39
Does the town have an established waste water system operation and maintenance Staff? How many people	7
Is available population data reliable?	Yes
Is a clear system of house numbers in place?	No
What percentage of people live in unplanned settlements?	About 5%
Are skilled labour/operators available locally?	Yes
Are projects usually funded at the town, regional, or national level?	National
What recent, infrastructure projects have been successfully financed?	None

LAKE VICTORIA SOUTH WATER AND WASTE WATER FEASIBILITY STUDY

PRE-VISIT SURVEY AND DATA REQUEST

(Please complete survey and prepare documents prior to Coler & Colantonio visit Jan 25 – Feb 1)

COMMUNITY NAME:	**KEROKA WATER SUPPLY**
NAME/TILE OF RESPONDENT:	**INSPECTOR WATER – TOM ONGORO**
TELEPHONE NUMBER:	**0734-625517**
DATE:	**18TH JANUARY 2006**

GENERAL

What is present (2005) Population?	28,000
What is 2025 Population (Projected)?	54,648 (GROWTH RATE 3.4%)
Is a reliable street map available?	No
Are Reliable Water and Wastewater System Maps Available?	No
Are reliable local topographic maps available?	No
Is soil/geology data or maps available?	No
How often do power blackouts occur? (Daily? Weekly? Monthly?)	At least twice a week

WATER

What is design capacity of present water system (m^3/day)?	600m^3/day
What is actual daily production of present water system (m^3/day)?	300m^3/day
What % of population is served by the water system?	40%
What is the present fee for water (Kshs/m3 or Kshs/10m^3)?	200/=
What is water source(s) (Stream, Lake, Borehole etc)?	Stream
What treatment processes are required for current water source (filtration, chlorination etc)?	Coagulation, Filtration & chlorination
Is the existing water supply capable of meeting present demands?	No. (needs improvement)
Is the existing water supply capable of meeting future demands without building a new dam/ reservoir/borehole?	No (Damming required)
Is the existing water supply capable of meeting future demands if a new dam/reservoir/borehole is built?	Yes
What % of water is unaccounted (lost to leaks, stolen etc)?	Always over 50%
Is Government owned land available for new facilities?	Yes

WASTE WATER

What is the design capacity of existing waste water treatment system (m^3/day)?	None is available (urgently required)
What is the actual daily volume of waste water currently treated (m^3/day)?	None (not known)
What %	
What is the present fee for waste water (if separate form water)?	None
Is land available for treatment and disposal?	No but council can avail
What kinds of industries are present in town?	None
Do industries discharge to the wastewater system?	None (only oils from garages)
Is there potential for sludge treated sludge for local agriculture?	Yes
Would the town consider re-using highly treated waste water for non-drinking purposes?	Not known (this is new idea)

MANAGEMENT AND FINANCE

Does the town have an established water/waste water billing system?	No (billing done from DWOs office)
What percentage of people pay their bills?	28%
Is the community strongly in support of investing in water and sanitation systems?	Yes
Would people be willing to pay for improved water and sanitation service?	Yes
What is the average annual household income?	Kshs. 30,000/=
Is billing revenue re-invested into the system?	Yes
Does billing revenue pay for all operation and maintenance?	No
Does billing revenue pay for new capital projects?	No
Does the town have a water system administrative staff? How many people?	2No
Does the town have a waste water system administrative staff? How many people?	No
Does the town have an established water system operation and maintenance staff? How many people?	15No
Does the town have an established waste water system operation and maintenance Staff? How many people	None
Is available population data reliable?	Yes (from Population & statistics)
Is a clear system of house numbers in place?	No
What percentage of people live in unplanned settlements?	58%
Are skilled labour/operators available locally?	Yes
Are projects usually funded at the town, regional, or national level?	National
What recent, infrastructure projects have been successfully financed?	None

LAKE VICTORIA SOUTH WATER AND WASTE WATER FEASIBILITY STUDY

PRE-VISIT SURVEY AND DATA REQUEST

(Please complete survey and prepare documents prior to Coler & Colantonio visit Jan 25 – Feb 1)

COMMUNITY NAME:	**KERICHO WATER & SEWERAGE**
NAME/TILE OF RESPONDENT:	**MANAGING DIRECTOR**
TELEPHONE NUMBER:	**052-20602**
DATE:	**19TH JANUARY 2006**

GENERAL

What is present (2005) Population?	110,145
What is 2025 Population (Projected)?	179,376
Is a reliable street map available?	Yes
Are Reliable Water and Wastewater System Maps Available?	Yes but too many to copy
Are reliable local topographic maps available?	No
Is soil/geology data or maps available?	No
How often do power blackouts occur? (Daily? Weekly? Monthly?)	Weekly

WATER

What is design capacity of present water system (m^3/day)?	8,640m^3/day
What is actual daily production of present water system (m^3/day)?	7500m^3/day
What % of population is served by the water system?	75%
What is the present fee for water (Kshs/m^3 or Kshs/10m^3)?	Average Kshs. 26/50 per m^3
What is water source(s) (Stream, Lake, Borehole etc)?	River (stream)
What treatment processes are required for current water source (filtration, chlorination etc)?	Full treatment (Sedimentation, Filtration, Chlorination)
Is the existing water supply capable of meeting present demands?	No. (due to uncovered areas)
Is the existing water supply capable of meeting future demands without building a new dam/ reservoir/borehole?	No. (Dam is necessary)
Is the existing water supply capable of meeting future demands if a new dam/reservoir/borehole is built?	No. (other infrastructure to be expanded)
What % of water is unaccounted (lost to leaks, stolen etc)?	48%
Is Government owned land available for new facilities?	Yes

WASTE WATER

What is the design capacity of existing waste water treatment system (m^3/day)?	990m^3/day
What is the actual daily volume of waste water currently treated (m^3/day)?	500m^3/day
What %	40%
What is the present fee for waste water (if separate form water)?	Kshs. 19.00 per m^3 (average)
Is land available for treatment and disposal?	Yes
What kinds of industries are present in town?	Bakery & Dairy plant only
Do industries discharge to the wastewater system?	No
Is there potential for sludge treated sludge for local agriculture?	Yes if well packaged
Would the town consider re-using highly treated waste water for non-drinking purposes?	No. (slim chances)

MANAGEMENT AND FINANCE

Does the town have an established water/waste water billing system?	Yes
What percentage of people pay their bills?	100%
Is the community strongly in support of investing in water and sanitation systems?	Yes
Would people be willing to pay for improved water and sanitation service?	yes
What is the average annual household income?	Estimate of Kshs. 7000/=
Is billing revenue re-invested into the system?	No
Does billing revenue pay for all operation and maintenance?	Yes
Does billing revenue pay for new capital projects?	No (Unless Reviewed)
Does the town have a water system administrative staff? How many people?	76
Does the town have a waste water system administrative staff? How many people?	
Does the town have an established water system operation and maintenance staff? How many people?	66
Does the town have an established waste water system operation and maintenance Staff? How many people	27
Is available population data reliable?	Yes
Is a clear system of house numbers in place?	No
What percentage of people live in unplanned settlements?	20%
Are skilled labour/operators available locally?	Yes
Are projects usually funded at the town, regional, or national level?	National
What recent, infrastructure projects have been successfully financed?	Kericho

LAKE VICTORIA SOUTH WATER AND WASTE WATER FEASIBILITY STUDY

PRE-VISIT SURVEY AND DATA REQUEST

(Please complete survey and prepare documents prior to Coler & Colantonio visit Jan 25 – Feb 1)

COMMUNITY NAME:	**HOMABAY WATER SUPPLY & SEWER WORKS**
NAME/TILE OF RESPONDENT:	**DISTRICT WATER OFFICER**
TELEPHONE NUMBER:	**057-22314**
DATE:	**18TH JANUARY 2006**

GENERAL

What is present (2005) Population?	Arujo, Town & Asego) 40,000
What is 2025 Population (Projected)?	61,300
Is a reliable street map available?	No
Are Reliable Water and Wastewater System Maps Available?	Yes
Are reliable local topographic maps available?	Yes
Is soil/geology data or maps available?	Yes
How often do power blackouts occur? (Daily? Weekly? Monthly?)	Daily

WATER

What is design capacity of present water system (m^3/day)?	3,000M^3/DAY
What is actual daily production of present water system (m^3/day)?	1,800M^3/DAY
What % of population is served by the water system?	50%
What is the present fee for water (Kshs/m^3 or Kshs/10m^3)?	Kshs. 200/= for the first 10m^3
What is water source(s) (Stream, Lake, Borehole etc)?	Lake Victoria
What treatment processes are required for current water source (filtration, chlorination etc)?	Full treatment (filtration & Chlorination)
Is the existing water supply capable of meeting present demands?	Yes (if rehabilitation is completed)
Is the existing water supply capable of meeting future demands without building a new dam/ reservoir/borehole?	No (A new intake is required)
Is the existing water supply capable of meeting future demands if a new dam/reservoir/borehole is built?	Yes (if a new intake is put in place
What % of water is unaccounted (lost to leaks, stolen etc)?	65%
Is Government owned land available for new facilities?	yes

WASTE WATER

What is the design capacity of existing waste water treatment system (m^3/day)?	750m^3/day
What is the actual daily volume of waste water currently treated (m^3/day)?	
What %	22% connected
What is the present fee for waste water (if separate form water)?	20% of total water billed
Is land available for treatment and disposal?	
What kinds of industries are present in town?	Fish processing & Jua Kali fabricators, car washing
Do industries discharge to the wastewater system?	Few
Is there potential for sludge treated sludge for local agriculture?	Yes
Would the town consider re-using highly treated waste water for non-drinking purposes?	Yes

MANAGEMENT AND FINANCE

Does the town have an established water/waste water billing system?	Yes
What percentage of people pay their bills?	50%
Is the community strongly in support of investing in water and sanitation systems?	Yes (through their elected representations)
Would people be willing to pay for improved water and sanitation service?	Yes
What is the average annual household income?	21,990/=
Is billing revenue re-invested into the system?	Yes
Does billing revenue pay for all operation and maintenance?	No
Does billing revenue pay for new capital projects?	No
Does the town have a water system administrative staff? How many people?	Yes
Does the town have a waste water system administrative staff? How many people?	Yes (10)
Does the town have an established water system operation and maintenance staff? How many people?	Yes (31)
Does the town have an established waste water system operation and maintenance Staff? How many people	Yes
Is available population data reliable?	Yes
Is a clear system of house numbers in place?	No
What percentage of people live in unplanned settlements?	70%
Are skilled labour/operators available locally?	Yes
Are projects usually funded at the town, regional, or national level?	Both
What recent, infrastructure projects have been successfully financed?	Rehabilitation of sewer, (i) Sewer treatment works (ii) Homabay water supply

LAKE VICTORIA SOUTH WATER AND WASTE WATER FEASIBILITY STUDY

PRE-VISIT SURVEY AND DATA REQUEST

(Please complete survey and prepare documents prior to Coler & Colantonio visit Jan 25 – Feb 1)

COMMUNITY NAME:	**BOMET WATER SUPPLY**
NAME/TILE OF RESPONDENT:	**DISTRICT WATER OFFICER**
TELEPHONE NUMBER:	**052-22057**
DATE:	**19TH JANUARY 2006**

GENERAL

What is present (2005) Population?	5,000
What is 2025 Population (Projected)?	9,031
Is a reliable street map available?	No
Are Reliable Water and Wastewater System Maps Available?	No
Are reliable local topographic maps available?	Yes
Is soil/geology data or maps available?	No
How often do power blackouts occur? (Daily? Weekly? Monthly?)	Weekly

WATER

What is design capacity of present water system (m^3/day)?	800m^3/day
What is actual daily production of present water system (m^3/day)?	360m^3
What % of population is served by the water system?	50%
What is the present fee for water (Kshs/m^3 or Kshs/10m^3)?	Kshs. 250/= for 10m^3
What is water source(s) (Stream, Lake, Borehole etc)?	River
What treatment processes are required for current water source (filtration, chlorination etc)?	Full treatment
Is the existing water supply capable of meeting present demands?	No
Is the existing water supply capable of meeting future demands without building a new dam/ reservoir/borehole?	No
Is the existing water supply capable of meeting future demands if a new dam/reservoir/borehole is built?	Yes
What % of water is unaccounted (lost to leaks, stolen etc)?	40%
Is Government owned land available for new facilities?	Yes

WASTE WATER

What is the design capacity of existing waste water treatment system (m^3/day)?	None
What is the actual daily volume of waste water currently treated (m^3/day)?	None
What %	
What is the present fee for waste water (if separate form water)?	None
Is land available for treatment and disposal?	No
What kinds of industries are present in town?	None
Do industries discharge to the wastewater system?	None
Is there potential for sludge treated sludge for local agriculture?	Yes
Would the town consider re-using highly treated waste water for non-drinking purposes?	Yes

MANAGEMENT AND FINANCE

Does the town have an established water/waste water billing system?	Yes
What percentage of people pay their bills?	60%
Is the community strongly in support of investing in water and sanitation systems?	Yes
Would people be willing to pay for improved water and sanitation service?	Yes
What is the average annual household income?	Kshs. 72,000
Is billing revenue re-invested into the system?	Yes
Does billing revenue pay for all operation and maintenance?	No
Does billing revenue pay for new capital projects?	No
Does the town have a water system administrative staff? How many people?	Yes
Does the town have a waste water system administrative staff? How many people?	No – 5 Persons
Does the town have an established water system operation and maintenance staff? How many people?	Yes – 3 Persons
Does the town have an established waste water system operation and maintenance Staff? How many people	No
Is available population data reliable?	Yes
Is a clear system of house numbers in place?	No
What percentage of people live in unplanned settlements?	60%
Are skilled labour/operators available locally?	Yes
Are projects usually funded at the town, regional, or national level?	National level
What recent, infrastructure projects have been successfully financed?	Road – Narok Bomet Road

APPENDIX 1-4

LVSWSB Letter to Ministry of Water and Irrigation stating community selections and including completed Community Selection Criteria Forms (1/31/2006)

LAKE VICTORIA SOUTH WATER SERVICES BOARD

P. O. Box 3325 Kisumu
Telephone: 057 – 2025127/8

Ref: LVSWSB/ASS/USTDA/5/24/VOL I/(21)

Date: 31st January 2006

Eng. Mahboub. M. Maalim CBS,
Permanent Secretary,
Ministry of Water & Irrigation,
P. O. Box 49720,
NAIROBI.

Dear

RE: LAKE VICTORIA SOUTH REGION WATER AND WASTE WATER FEASIBILITY STUDY (USTDA SUPPORTED)

==========

In line with the plans of works, the project team for the Lake Victoria South Region Water and Waste Water Feasibility study conducted the initial data collection phase between 24th January 2006 and 31st January 2006. The towns that were covered were Kisii, Kericho, Bomet, Migori, Homabay and Keroka.

An evaluation was thereafter carried out in line with the study technical, management and financial criteria (attached herewith) from which it was recommended that Kericho, Kisii and Migori be considered for further study.

Migori was chosen instead of Homabay because UN Habitat has already made commitment to support Homabay. The Board is in agreement with the prioritized towns as they deserve the proposed investment.

Yours

ENG. P. L. OMBOGO
CHIEF EXECUTIVE OFFICER

Encls.

cc Coler& Colantonio Inc
101 Accord Park Drive
Norwell, MA 02061

LAKE VICTORIA SOUTH WATER AND WASTEWATER FEASIBILITY STUDY

DRAFT COMMUNITY SELECTION CRITERIA

6-Jan-06

	Kericho	Kisii	Migori	Homa Bay	Keroka	Bomet
2005 Population	110,145	200,000	54,322	40000	28,000	103,000
2025 Population	179,376	360,000	98,224	61,300	54,648	150,000

6 = strongly agree, 1= strongly disagree

TECHNICAL CRITERIA

General	Kericho	Kisii	Migori	Homa Bay	Keroka	Bomet
Reliable Topographic Maps Available	√	√	√	√	√	√
Reliable Water / WW System Maps Available	6	5	1	4	1	1
Reliable Street Maps Available	-	-	-	-	-	-
Population distribution favorable (not highly dispersed)	6	5	4	2	1	3
Topography favorable for distribution / collection	6	5	4	2	1	3
Geology / soils favorable for construction	-	-	-	-	-	-
Roadways in good condition	6	5	4	1	3	2
Reliable power available	6	3	1	2	4	5
Potential for renewable energy available	6	2	5	3	4	1
Construction materials / equipment available locally	-	-	-	-	-	-
Representative of other communities in region	1	2	6	4	3	5
Overall Need for Public Health and Economic Improvement	1	2	6	3	4	5
Total	**38**	**29**	**31**	**21**	**21**	**25**

Water	Kericho	Kisii	Migori	Homa Bay	Keroka	Bomet
Supply Proximate to Demands	2	4	1	6	5	3
Supply Capable of Meeting Present Demand	5	3	1	6	4	2
Supply Capable of Meeting Future Demand w/o Dam/Reservoir construction	-	-	-	-	-	-
Supply of Adequate Quality	6	5	5	5	5	5
High (relative) percentage of existing population served	6	4	3	5	4	5
Low (relative) unaccounted-for-water	5	4	1	2	3	6
Water Treatment Infrastructure capable of rehab/expansion	6	5	1	4	3	2
Water Distribution infrastructure capable of rehab/expansion	-	-	-	-	-	-
Government owned land available for new facilities	2	2	1	-	2	2
Land available for new facilities	-	-	-	-	-	
Total	**32**	**27**	**13**	**28**	**26**	**25**

Wastewater	Kericho	Kisii	Migori	Homa Bay	Keroka	Bomet
W.W. Treatment infrastructure capable of rehab/expansion	4	6	1	5	1	1
W.W. Collection infrastructure capable of rehab/expansion	3	3	1	3	1	1
Sufficient Land Available for Treatment/Disposal	4	6	2	5	1	3
Favorable soils for subsurface discharge	-	-	-	-	-	-
Surface water discharge feasible	-	-	-	-	-	-
Little Commercial/Industrial Inputs or Pretreatment Exists	1	2	1	2	1	1
High potential for local biosolids reuse	1	1	1	3	1	1
Community interest in water reuse	-	-	-	-	-	-
Total	**13**	**18**	**6**	**18**	**5**	**7**

MANAGEMENT CRITERIA	Kericho	Kisii	Migori	Homa Bay	Keroka	Bomet
Strong local support for w/w.w. improvements	6	4	5	2	1	3
Local government staff committed to support data needs of project	6	4	5	3	1	2
Managerial Capacity in Place for O&M/Billing/Mgmt	6	5	4	3	1	2
Established water system staff exists	6	5	5	5	4	4
Established wastewater system staff exists	5	3	1	3	1	1
Established billing system exists	6	5	6	5	5	5
Reliable population data available	-	-	-	-	-	-
Clear House Numbers, Street Names, etc.. Exist	-	-	-	-	-	-
Skilled labor / operators available	6	5	3	4	2	1
Total	**41**	**31**	**29**	**26**	**15**	**18**

FINANCIAL CRITERIA	Kericho	Kisii	Migori	Homa Bay	Keroka	Bomet
Systems in place for locally funding projects	6	3	4	3	3	5
Projects often funded town government level (not national, international)	-		-	-	-	-
Recent successful large infrastructure projects financed	4	5	3	6	1	3
Local Household income relatively high	5	4	3	2	3	2
Present fees for w/w.w. high	6	5	4	5	4	4
Water/WW Payment Ratio Relatively Favorable	6	5	4	2	1	3
Reasonable rate structure in place	-	-	-	-	-	-
System Revenues Invested in System	-	-	-	-	-	-
Revenues Pay for O&M, Mgmt.	6	5	4	4	1	1
Revenues Pay for O&M, Mgmt., Cap. Improvements	-	-	-	-	-	-
Local Economic Growth Potential	4	5	6	3	2	1
General Creditworthiness	6	5	4	3	2	1
Total	**43**	**37**	**32**	**28**	**17**	**20**

APPENDIX 1-5

Project Team Letter to Grantee containing Final Work Plan (2/26/2006)

COLER & COLANTONIO INC

ENGINEERS AND SCIENTISTS

February 23, 2006

Eng. Mahboub M. Maalim, Permanent Secretary
Ministry of Water and Irrigation
Maji House, Ngong Road
P.O. Box 49720, Nairobi
Kenya

Re: January/February 2006 Visit Summary; Final Invoicing Protocol and Work Plan

Dear Secretary Maalim:

Thank you very much for the generous support we received from you and your staff during our recent visit to Kenya (23rd January – 2nd February, 2006). Our trip was very successful and we are pleased to inform you that the project is moving forward on schedule.

After our meetings with the Ministry in Nairobi on 23rd January, we met with the Lake Victoria South Water Services Board on 24th January and spent the following week visiting the potential study communities (Kericho, Keroka, Bomet, Kisii, Migori, Homa Bay). We were met graciously everywhere we went. We met local officials and toured each community; identified available information, water uses, and water quality requirements; and began data collection. Working closely with the Lake Victoria South Water Services Board, we applied our Community Selection Criteria after visiting all six communities and chose to perform our detailed study on **Kericho**, **Kisii**, and ***Migori***, as described in the 31st January 2006 letter to you from LVSWSB. At the conclusion of our trip on 2nd February we gave a presentation at the GoK/Development Partner Water Sector Coordination Meeting held at the Kenya School of Monetary Studies in Nairobi. We thank you for the opportunity to present at this event where we were able to introduce our project to additional members of the donor community.

During our working meeting at the Ministry on 23rd January 2006, it was resolved that the invoicing protocol for the project would be as follows:

1) Coler & Colantonio, Inc. emails invoice to Eng. Ombogo for review and approval
2) Eng. Ombogo provides invoice to Eng. Mangiti, who provides to P.S. Maalim for signature
3) Ministry provides copy of signed invoice to Eng. Wanday (CAPEconsult), who sends to Coler & Colantonio, Inc.
4) Ministry provides original invoice to Ministry of Finance
5) Coler & Colantonio, Inc. sends signed invoice to USTDA
6) USTDA releases funds to Coler & Colantonio, Inc.

Thank you for approving our Advance Payment Invoice (Payment 1). We have completed the tasks associated with Payment 2 and will soon send our second invoice to Eng. Ombogo in accordance with above protocol.

101 Accord Park Drive
Norwell, MA 02061-1685

781 982-5400
Fax: 781 982-5490

recycled paper

We finalized our Work Plan during our recent visit. The Ministry and Lake Victoria South Water Services Board had no comments on the Draft Work Plan provided to the Ministry and LVSWSB. The Final Work Plan is attached.

We are working diligently on the next phase of the project and will soon begin preparations for our next trip, which we expect to take place in April. We will be in touch soon regarding details of the next trip.

Sincerely,

COLER & COLANTONIO, INC.

Mark J. Devine, P.E.
Water & Wastewater Division Manager

Attachments: Final Work Plan

cc: Eng. Patrick Ombogo, CEO, Lake Victoria South Water Services Board
Eng. R.N. Gakubia, Director of Water, Ministry of Water and Irrigation
Eng. Peter Mangiti, Deputy Director for Donor Coordination, Ministry of Water and Irrigation
Eng. Peter Wanday, CAPEconsult

recycled paper

FINAL WORK PLAN BY PAYMENT

LAKE VICTORIA SOUTH WATER AND WASTEWATER PROJECT

KENYA

13-Feb-06

PAYMENT/TASKS	RESPONSIBLE ENTITY 1	2	3
PAYMENT 1 - MOBILIZATION			
PAYMENT 2			
1.1.1 Develop Draft Work Plan	C&C	All	
1.1.2 Document Draft Work Plan	C&C		
1.2.1 Profile Candidate Communities	C&C	Cape	
1.2.2 Develop Criteria for Selection of Communities	C&C	Cape	All
1.2.3 Develop Recommendations of Communities	C&C	Cape	All
1.2.4 Recommend Communities to Grantee	C&C	Cape	All
1.3.1,2 Meet with Grantee re Work Plan and Selected Communities	C&C	All	
1.3.3,4 Finalize/Document Work Plan	C&C	All	
2.1.1 Identify Available Information	Cape	C&C	
2.1.2 (a) Collect Information (Initiate)	Cape	C&C	
2.2.1 Identify Water Uses	C&C	Cape	
2.2.2 Identify W.Q. Requirements/Criteria	C&C	Cape	Bhatti
5.1.1 (a) Develop Financial Model (Initiate data gathering and research)	Tusk	Bab	Bhatti
PAYMENT 3			
2.1.2 (b) Collect Information (Complete)	Cape	C&C	
2.1.3 Catalog and File Information	Cape	C&C	
2.2.3 Establish Final W.Q. Objectives/Criteria	C&C	Cape	Bhatti
2.2.4 Document W.Q. Objectives/Criteria	C&C	Cape	Bhatti
2.3.1 Define Base Map Needs	C&C	Cape	
2.3.2 (a) Develop Service Area Base Maps (Initiate)	C&C	Cape	
2.4.1 Population, Domestic Water Use	C&C	Cape	Bhatti
2.4.2 Ag., Comm., Ind. Water use	C&C	Cape	Bhatti
4.1.1 Define Current Mgmt. Arrangements	Bhatti	C&C	Cape
4.1.2 Legislative and Regulatory Limitations	Bhatti	C&C	Cape
PAYMENT 4			
2.3.2 (b) Develop Service Area Base Maps (Complete)	C&C	Cape	
2.3.3 Develop Treatment Plant Base Maps	C&C	Cape	
2.4.3 Distribute Pop./Land Use	C&C	Cape	Bhatti
2.4.4 Project Water Demand/W.W.	C&C	Cape	Bhatti
2.5.1 (a) Evaluate Sources and Intakes (Initiate)	C&C	Cape	Bhatti
2.5.2 (a) Evaluate Water Treatment Facilities (Initiate)	C&C	Cape	Bhatti
2.5.3 (a) Evaluate Water Distribution Systems (Initiate)	C&C	Cape	Bhatti
2.5.4 (a) Evaluate Water System Management (Initiate)	Bhatti	C&C	Cape
2.6.1 (a) Evaluate W.W. Collection Systems (Initiate)	C&C	Cape	Bhatti
2.6.2 (a) Evaluate W.W. Treatment Facilities (Initiate)	C&C	Cape	Bhatti
2.6.3 (a) Evaluate W.W. Disposal Provisions (Initiate)	C&C	Cape	Bhatti
2.6.4 (a) Evaluate Sludge Provisions (Initiate)	C&C	Cape	Bhatti
2.6.5 (a) Evaluate W.W. System Management (Initiate)	Bhatti	C&C	Cape
4.1.3 Review Innovative Mgmt. Models In-Place	Bhatti	C&C	Cape

PAYMENT/TASKS	RESPONSIBLE ENTITY 1	2	3
5.1.1 (b) Develop Financial Model (Continue data gathering, initiate model development)	Tusk	Bab	Bhatti
PAYMENT 5			
2.4.5 Document Projections Findings	C&C	Cape	Bhatti
2.4.6 Finalize Projections Findings w/Grantee	C&C	Cape	Bhatti
2.5.1 (b) Evaluate Sources and Intakes (Complete)	C&C	Cape	Bhatti
2.5.2 (a) Evaluate Water Treatment Facilities (Complete)	C&C	Cape	Bhatti
2.5.3 (b) Evaluate Water Distribution Systems (Complete)	C&C	Cape	Bhatti
2.5.4 (b) Evaluate Water System Management (Complete)	Bhatti	C&C	Cape
2.6.1 (b) Evaluate W.W. Collection Systems (Complete)	C&C	Cape	Bhatti
2.6.2 (b) Evaluate W.W. Treatment Facilities (Complete)	C&C	Cape	Bhatti
2.6.3 (b) Evaluate W.W. Disposal Provisions (Complete)	C&C	Cape	Bhatti
2.6.4 (b) Evaluate Sludge Provisions (Complete)	C&C	Cape	Bhatti
2.6.5 (b) Evaluate W.W. System Management (Complete)	Bhatti	C&C	Cape
2.7.1 (a) Options for Water Treatment (Initiate)	C&C	Cape	Bhatti
2.7.2 (a) Options for Wastewater Treatment (Initiate)	C&C	Cape	Bhatti
3.1.1 Evaluate Current O&M	C&C	Cape	
3.1.2 Summarize Current O&M	C&C	Cape	
4.1.4 (a) Identify Mgmt. Options (Initiate)	Bhatti	C&C	Cape
PAYMENT 6			
2.5.5 Identify Water Infrastructure Needs	C&C	Cape	Bhatti
2.6.6 Identify W.W. Infrastructure Needs	C&C	Cape	Bhatti
6.1.1 Develop Evaluation Criteria	C&C	Cape	
PAYMENT 7			
2.5.6 Document Water Inf. Findings	C&C	Cape	Bhatti
2.6.7 Document W.W. Inf. Findings	C&C	Cape	Bhatti
2.7.1 (b) Options for Water Treatment (Complete)	C&C	Cape	Bhatti
2.7.2 (b) Options for Wastewater Treatment (Initiate)	C&C	Cape	Bhatti
3.1.3 Develop O&M Improvement Options	C&C	Cape	
4.1.4 (b) Identify Mgmt. Options (Complete)	Bhatti	C&C	Cape
4.1.5 Comparative Analysis of Mgmt. Options	Bhatti	C&C	Cape
5.1.1 (c) Develop Financial Model (Create preliminary financial model)	Tusk	Bab	Bhatti
5.1.2 Summary Worksheet	Tusk	Bab	Bhatti
6.1.2 Conduct Impact Evaluations	C&C	Cape	
PAYMENT 8			
2.7.3 Present W/WW Inf. Options/Rec.	C&C	Cape	Bhatti
3.1.4 Comparative Analysis of O&M Options	C&C	Cape	
3.1.5 (a) Present O&M Options/Recommendation	C&C	Cape	
4.1.6 Present Mgmt. Options/Recommendation	Bhatti	C&C	Cape
5.1.3 Input Additional Detailed Information into Financial Model	Tusk	Bab	Bhatti
5.1.4 Calculate User Fees, Fin. Structure Charges	Tusk	Bab	Bhatti
6.1.3 Recommend Mitigation Measures	C&C	Cape	
6.1.4 Discuss Analyses with Grantee	C&C	Cape	
6.1.5 Document Mitigation Measures	C&C	Cape	
PAYMENT 9			
5.2.1 Run Sensitivities	Tusk	Bab	Bhatti
5.2.2 Sensitiviites Report	Tusk	Bab	Bhatti

PAYMENT/TASKS	RESPONSIBLE ENTITY 1	2	3
7.1.1 Recommended Imp. Plan, Final Rpt. (Initiate)	C&C	All	
PAYMENT 10			
2.7.4 Select W/WW Inf. Option with Grantee	C&C	Cape	Bhatti
3.1.5 (b) Select Agreed-to O&M program, Mgmt. Arrangments	C&C	Cape	
3.1.6 Document Selected O&M Option	C&C	Cape	
5.3.1 Prepare Financing Plan	Tusk	Bab	Bhatti
5.3.2 Present Plan, Review, Finalize	Tusk	Bab	Bhatti
7.1.2 Discuss Recommendations with Grantee	C&C		
7.1.3 Structure Selected Plan	C&C		
PAYMENT 11			
2.7.5 Document Selected W/WW Inf. Option	C&C	Cape	Bhatti
4.1.7 Document Selected Mgmt. Option	Bhatti	C&C	Cape
7.1.4 Recommended Imp. Plan, Final Rpt. (Complete)	C&C	All	

Lake Victoria South Water and Wastewater Feasibility Study

APPENDIX 1-6

Catalog of Data Collected (3/9/2006)

Lake Victoria South Water and Wastewater Feasibility Study

LIST OF DATA COLLECTED

(Does not include all data collected prior to January 2006)

As of March 9, 2006

NATIONAL INFORMATION

1. Republic of Kenya. *Kenya Gazette Supplement No. 67 (Legislative Supplement No. 51)*, 30th November 1999 (Water Tariff Information)
   a. Legal Notice No. 173. The Water Act (Cap. 372). The Water (Water Development Department) (General) (Amendment) Regulations, 1999
   b. Legal Notice No. 174 and 175. The Water Act (Cap. 372). The Water (Water Development Department) (Tariff) (Amendment) Regulations, 1999.
   c. Legal Notice No. 176. The Water Act (Cap. 372). The Water (National Water Conservation and Pipeline Corporation) (Tariff) (Amendment) Regulations, 1999.

2. Republic of Kenya. *The Water Act 2002.* 24th October, 2002

3. Ministry of Water Resources, Republic of Kenya. *Sessional Paper No.1 of 1999 on National Policy on Water Resources Management and Development.* 29th April 1999.

4. Japan International Cooperation Agency and Ministry of Water Resources, Republic of Kenya. *The Aftercare Study on the National Water Master Plan in the Republic of Kenya, Final Report and Supporting Report.* November 1998, Nippon Koei Co., Ltd, Kokusai Kogyo Co., Ltd.

5. World Health Organization. *Report #9*[1]

6. Republic of Kenya. *Design Manual for Water Supply in Kenya.* 2005[1]

LVSWSB REGIONAL INFORMATION

1. *Performance Contract Between the Government of the Republic of Kenya and the Board of Directors, Lake Victoria South Water Services Board for the Period 1st July 2005 to 30th June 2006.* Undated, unsigned copy.

2. Lake Victoria South Water Services Board. *Draft Strategic Plan (July 2005-June 2010).* April 2005.

3. United Nations Human Settlements Programme (UN-Habitat) Water for African Cities Programme. *Lake Victoria Region Water and Sanitation Initiative (LVWATSAN) Booklet.* Undated, 2005?

4. United Nations Human Settlements Programme (UN-Habitat) Water for African Cities Programme. *Lake Victoria Region Water and Sanitation Initiative (LVWATSAN) Project Proposal.* November 2004.

[1] Reviewed during Jan/Feb 2006 visit. Currently awaiting hardcopies being sent via mail.

5. United Nations Human Settlements Programme (UN-Habitat) Water for African Cities Programme. *Lake Victoria Region Water and Sanitation Initiative (LVWATSAN) Report.* August 2004.

6. Ministry of Water Resources. *US Investments in the Water Treatment/Sewer Treatment Sector In Kenya – Brief on Kericho, Kisii, Migori, Oyugis, Embu and Nanyuki Towns Water Supply and Sewerage Facilities.* Provided to Project Team by Eng. K.G. Chesang via email in August 2003.

KERICHO

1. GPS points for 9 locations

2. Pre-Visit Survey and Data Request. Completed by Kericho Water and Sanitation Company (KEWASCO) Limited Managing Director, 19th January 2006.

3. Town of Kericho (?). *Kericho Water Supply and Sewerage System.* Two-page description of system. Undated. Provided to JJC during 2003 visit.

4. Kericho Water and Sanitation Company (KEWASCO) Limited. *Kericho Water and Sewerage Project.* Three page description provided by KEWASCO during January 2006 visit.

5. Kericho Water Supply Scheme Plans (Blueprint copies) by H.P. Gauff, K.G. Consulting Engineers
   a. *Kericho Town Development Plan – Existing & Proposed Reticulation System*, July 1983, Rev. 20-09-91 (As-Built), Drg. No 3604. Sheet 1 of 13. Scale 1:50,000. Prepared by H.P. Gauff, K.G.
   b. *General Layout of Reticulation System in Rural Area*, May 1983, Rev 12-9-90 (As-Built), Drg. No 3604, Sheet 1 of 3. Scale 1:20,000
   c. *Schematic Layout of Pipework in Rural Area Showing Static & Hydraulic Pressures at Nodes*, July 1985 (As-Built), Drg. No. 3604, Sheet 2 of 3. Scale 1:20,000. Prepared by H.P. Gauff, K.G.
   d. *Treatment Plant General Layout*, Dec 1990, Rev. 14-08-91 (As-Built) Drg. No. 3604 Sheet 1 of 1. Scale 1:250. Prepared by H.P. Gauff, K.G.

6. H.P. Gauff KG Consulting Engineers. *Final Design Report, Kericho Water Supply Augmentation Measures, Kitenges River Injection and Timbilil Treatment Works Improvements.* March 1993.

7. Kericho Water and Sanitation Company Limited (KEWASCO) Limited. *Annual Report for the Year 2004/2005.* October 2005.

8. Effluent Discharge Standards for discharge to Dionosoiyet River (from main treatment works). Not dated. Provided by KEWASCO during January 2006 visit.

9. Drinking Water Standards. Provided by KEWASCO during January 2006 visit.

10. Drinking water sampling results and comparison to standards for January 12th (or Dec 1st?) 2005 from Kericho treatment facility.

11. Water and Wastewater Tariff rates (3 pages) revised 11-10-1994. Provided by KEWASCO.

12. Turbine Manufacturers / Suppliers and Cost Benefit Analysis of various Turbines. Two pages. Provided by KEWASCO January 2006.

13. Kericho Municipal Council. Water and Sanitation Department O&M and Financial Management Report for September 2002.

KISII

1. GPS points for 3 locations.

2. Pre-Visit Survey and Data Request. Completed by Kisii District Water Officer, 20th January 2006.

3. United Nations Human Settlements Programme (UN-Habitat) Water for African Cities Programme. *Lake Victoria Region Water and Sanitation Initiative (LVWATSAN) Report – Kisii Town.* August 2004.

4. 'Water Supply Brief Report – Central Kisii District' two page summary of water supply system in Kisii. Provided to Project Team during January 2006 visit.

5. Kisii Water Supply Scheme Project Brief, November 2001. Ten page summary of Kisii water supply scheme provided to Project team during November 2003 visit.

MIGORI

6. GPS points for 13 locations.

7. Pre-Visit Survey and Data Request. Completed by Migori District Water Officer, 20th January 2006.

8. Japanese International Cooperative Agency (JICA). *Study of Institutional Improvement and Rehabilitation of Water Supply Systems for 10 Local Towns in the Republic of Kenya. DRAFT FINAL REPORT, Volume 2G: Main Report (Including Appendices) – Migori Town.* December 2000.

9. United Nations Human Settlements Programme (UN-Habitat) Water for African Cities Programme. *Lake Victoria Region Water and Sanitation Initiative (LVWATSAN) Report – Migori Town.* August 2004.

10. Ministry of Lands and Settlement, Physical Planning Department. *Migori Part Development Plan.* Departmental Ref No. HPO 123/2004. Scale 1:2,2500. Dated 23.07.2004. Designed by Felix J.O. Aboka, Municipal Planning.

11. Village Partnership Nyasare Valley/Kenya-Rhine Valley/Austria. *Nyasare Water Supply Project Gravity Piped Water Supply with Spring Catchment Water Reservoir and Public Tapstands Surveying Map.* Scale 1:5,000. Dated 5.11.1990. Plan No. 003. (Also second title block labeled Kaburu Okelo & Partners Consulting Engineers, dated Oct. 1992, Dwg. No. KOP184/21 – assume this is for overlaid network features?)

12. Migori District Water Office. 'Migori – Team Lake Victoria South Water and Waste Water Feasibility Study'. Eight page document prepared by District Water Officer on background of system. Not dated. Received from District Water Officer January 2006.

13. Nyasare Water Supply Associateion. *Nyasare Water Supply Association Project Overview (Highlights).* Prepared by Maurice N. Otieno, NWSA Manager. Undated five-page document received January 2006.

14. Migori Water and Sanitation Company (MIWASCO) Limited. *Water Service Provider Area and Rapid Assessment.* Not dated. Appears to be in Draft format. Provided during January 2006 visit.

ADDITIONAL REFERENCE MATERIALS

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3. African Development Fund. *Rift Valley Water Supply and Sanitation Project Appraisal Report.* 2004. Tunisia.

4. Porras, Ina and John Thompson. Drawers of Water II: 30 years of change in domestic water use *and environmental health in East Africa.* 2001. London, United Kingdom, International Institute for Environment and Development.

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APPENDIX 2-1

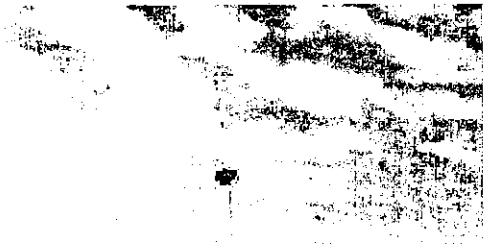
World Health Organization Report #9, Table 5.1
"Anticipated Contribution of Domestic Sewage from Various Types of Establishments"

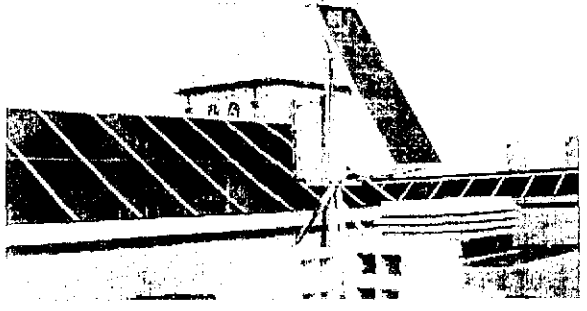
Table 5.1 Anticipated Daily Contribution of Domestic Sewage from Various Types of Establishments

Type of Establishment	Daily Water Consumption		Unit (per)	Factor (per cent)	Anticipated Qu of Sewage Produ Daily	
	Litres	Gallons			Litres	Gall
High Class Housing	300	66	head	75	say 220	48
Average Urban Housing	150	33	head	80	120	26
Low Cost Housing	75	16.5	head	85	say 65	14
Communal Latrine/ ablution blocks (serving low cost dwellings which do not have individual facilities)	say 70	15.5	head	85	say 60	13
Public Latrines	-	-	-	-	say 1,500 litres (330 gallons) fo water closet or of three urinals	
Day Schools, Shps and Offices	say 25	5.5	head	85	say 21	5
Hospitals, High Class	400	88	bed	80	320	70
Hospitals, Medium Class	200	44	bed	80	160	35
Hospitals, Low Class	100	22	bed	80	80	17
Hotels, high class	600	132	bed	80	480	106
Hotels, others	300	66	bed	80	240	52
Dispensaries	50	11	Out-pat-ient	80	40	9
Non-resident factory workers	say 25	5.5	head	80	20	4

APPENDIX 4-1

Automatic Meter Reading (AMR) Informational Brochure
(City of Cambridge, Massachusetts)

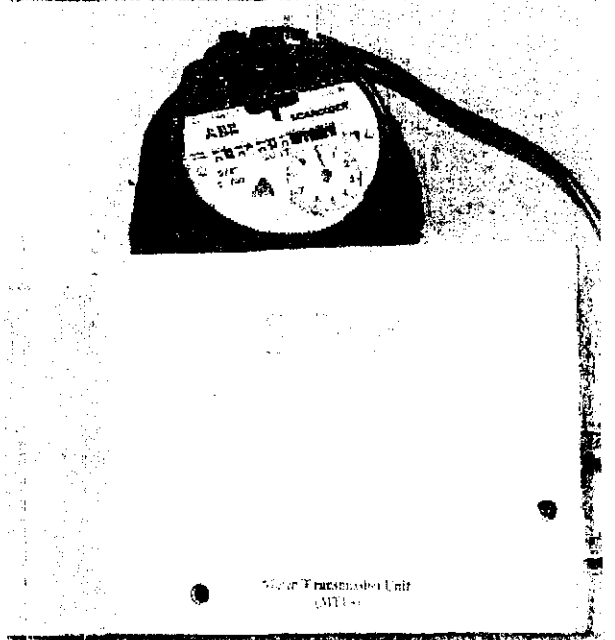




Be sure to ask your installer to present his/her photo ID prior to entering your home. Concerns/ questions? call CWD"s EasyRead Hotline at 617 349-6293

Cambridge Water Department
250 Fresh Pond Parkway
Cambridge, MA 02138
617 349-6293
cwd@cambridgema.gov

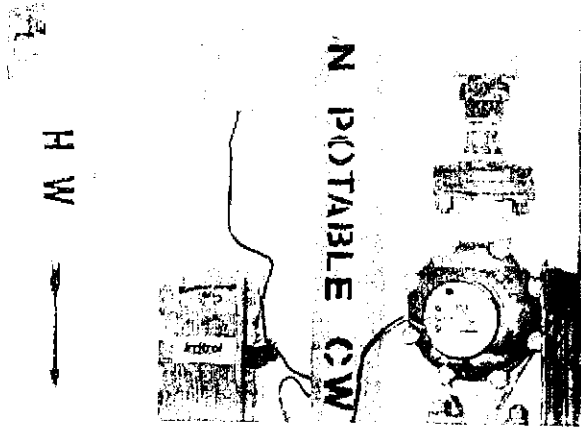
Automated Meter Reading



The "EasyRead" System

Improved Customer Service

The Cambridge Water Department (CWD) is installing an automated meter reading (AMR) system called EasyRead. Using radio signals the system will transmit meter readings to the Water Department daily. Updates concerning this program are available by calling: 617 349-[illegible] or visiting us at: [illegible]



Accurate and Efficient

Quarterly billing will be maintained at present. Over the next 18 months every home and business in Cambridge will be upgraded with the new EasyRead system. Installation will begin in Oct. of 2004. The City and its installation contractor, MASS Installation Inc., will contact customers with introductory information and details on how to schedule an appointment. Appointments will be weekdays, evenings and Saturdays.

At locations where there is no outside reading device an EasyRead installer must gain access to your property. Along with installing a meter transmitting unit, [illegible] water meters will be replaced. Standard installation should take less than an hour. There may be a brief interruption in your water service [illegible] to be replaced.

Easy Installation

APPENDIX 4-2

Sample Consumer Confidence Reports for 2004 and 2005
(City of Cambridge, Massachusetts)

Contamination from Cross-Connections

Cross-connections that could contaminate drinking water distribution lines are a major concern. A cross-connection is formed at any point where a drinking water line connects to equipment (boilers), systems containing chemicals (air conditioning systems, fire sprinkler systems, irrigation systems) or water sources of questionable quality. Cross-connection contamination can occur when the pressure in the equipment or system is greater than the pressure inside the drinking water line (backpressure). Contamination can also occur when the pressure in the drinking water line drops due to fairly routine occurrences (main breaks, heavy water demand) causing contaminants to be siphoned out from the equipment and into the drinking water line (backsiphonage).

Outside water taps and garden hoses tend to be the most common sources of cross-connection contamination at home. The garden hose creates a hazard when submerged in a swimming pool or when attached to a chemical sprayer for weed killing. Garden hoses that are left lying on the ground may be contaminated by fertilizers, cesspools or garden chemicals. Improperly installed valves in your toilet can also be a source of cross-connection contamination.

Community water supplies are continuously jeopardized by cross-connections unless appropriate valves, known as backflow prevention devices, are installed and maintained. We have surveyed all industrial commercial, and institutional facilities in the City to make sure that all potential cross-connections are identified and eliminated or protected by a backflow preventer. We also inspect and test each backflow preventer to make sure that it is providing maximum protection.

For more information, call us at 617-349-4770 or visit the Web site of the American Backflow Prevention Association (www.abpa.org) for a discussion of current issues.

24 Hour Emergency/Customer Service
Phone Number 1-617-349-4770

Visit Our Web Site at
www.cambridgema.gov/cwd/

Email us at cwd@cambridgema.gov

Cambridge Water Department
250 Fresh Pond Parkway
Cambridge, MA 02138

Este relatório contem informação muito importante sobre seu que bebendo agua. Por favor traduza-o, ou fala com alguém quem entende-o.

This report contains very important information about your drinking water. Please translate it, or speak with someone who understands it.

Questa relazione contiene delle informazioni molto importanti del suo che la bendo acqua. Per favore tradurlo, o parlare con qualcuno che capisce esso.

City of Cambridge Water Department
2004 Annual Drinking Water Quality Report

250 Fresh Pond Parkway
Cambridge, MA 02138

DEP PWS ID#3049000

June 2005

24 Hour Emergency/Customer Service
Phone Number 1-617-349-4770

"This report is a snapshot of drinking water quality that we provided in 2004, last year. Included are details about where your water comes from, what it contains, and how it compares to state and federal drinking water standards. We are pleased to be providing this report and encourage you to use the contact information if you have questions or need further information about your water system." Sam Corda, Managing Director, Cambridge Water Department (CWD)

This Year's Annual Drinking Water Quality Report Includes:

- **An introduction to our Automated Meter Reading Project**
- **Our Contact Information**
- **Opportunities for Public Involvement**
- **Water Conservation Tips**
- **Cambridge Water System Description**
- **2004 Water Quality Data**
- **DEP and US EPA Water Quality Information**
- **An Introduction to Cross-Connections**

Costomer Service: Automated Meter Reading (AMR) Project

The Cambridge Water Department (CWD) began installing an, Automated Meter Reading (AMR) system on Oct. 12, 2004. The system will remotely transmit a signal that will enable the Water Department to read water meters on a daily basis. To date over 4,500 MTU's and 2,300 new meters have been installed. Over the next 2 years, every home and business in Cambridge will be upgraded with the new AMR system. The cost to implement this program is included in your water rates.

Benefits:
CWD is constantly looking for ways to improve service to our customers. The AMR program helps to advance this goal as follows:

•Virtually eliminate estimate bills, providing readings based on actual water usage;

•Reduce the number of visits by Water Department staff as the meters will be read remotely;

•Water conservation; and most importantly

•Improve customer service by proactively monitoring extraordinary water usage and notifying customers.

AMR Installation:
The City's contractor, Mass Installation Inc., will contact customers to schedule an appointment. The installation pattern has been according to our Water billing cycles. Cycle 3 began in October 2004 Cycle 4 in February 2005 we will then move to cycles 5, 6, and then 1and 2. If you don't know what cycle you are in please refer to your water bill or call the AMR hotline at 617 349-6293. Appointments will be available during weekdays and on Saturdays.

An installer will arrive with proper ID and knowledge to perform the installation of the new system upgrade. An adult over the age of 18 is required to be present and standard installation should take less than an hour. There may be a brief interruption of your water service if your meter needs to be replaced.

A majority of water meters are located inside residential homes and it is essential that the AMR installer gain access to your property.

After installation is complete, the installer will leave behind an informational card with a contact number. Property owners should call if there are any concerns or questions about the AMR system or about the old water meter.

The AMR system will allow the CWD to read water meters remotely, thereby reducing the need to enter your home for meter readings. However, there may be certain circumstances when we will need to access your home to investigate, change or repair the new water meter system.

Leaks are Costly:
A major component of the AMR system is the systems ability to produce information daily and in time define usage patterns. If an account begins to show unusual activity CWD personnel will be alerted so that we may notify the homeowner of the discovery and then assist with a solution.

Safety First:
The Cambridge Water Department continues to ensure that customer safety is its number one priority with the AMR system.

Working together, we, the City and Mass Installation Inc. want to assure you that installations will be performed by certified well-trained professionals. These installers will use identifiable vehicles and a photo ID .Be sure to ask your installer to present his/her photo identification before entering your home.

AMR hotline at 617 349-6293

24 Hour Emergency/Customer Service
Phone Number 1-617-349-4770

Visit Our Web Site at
www.cambridgema.gov/cwd/

Email us at cwd@cambridgema.gov

Opportunities for Public Participation and Further Information

•The Cambridge Water Board meets monthly, usually on the first Monday of the month, from 5:00 pm to 6:30 at Walter J. Sullivan Water Purification Facility at 250 Fresh Pond Parkway, Cambridge, MA 02138.
•For more information about the dates of upcoming meetings and to review minutes from previous meetings, refer to the Cambridge Water Department Website (www.cambridgema.gov/cwd/).
•If you have additional questions about your water supply, please contact Timothy W.D. MacDonald, Manager of Water Operations, at 617-349-4773.

Water leaks are costly and an unnecessary waste of water. A simple investigation could save you money and conserve water!

Water Conservation Tip - Checking for Leaks:
Many households have water leaks and do not even know it. Typically, most leaks are found at the toilet tank. Leaks are costly, and consumers can end up paying a great deal for wasted water and the resulting sewer charges. Here are some useful tips to determine if you have a leak in your home:

To check the internal plumbing system in your house:
1.) Read your water meter before you go to bed or leave for work in the morning, when no one will be using the water in your house for several hours.
2.) Read the meter again in the morning or when you get home from work.
3.) The two readings should be about the same.
4.) If they are not, you probably have a leak.

To check for leaks in a toilet:
1.) Test the flapper plug. Carefully remove the lid from the toilet tank. Mark the water level in the tank with a pencil. Shut off the water supply to the toilet. If the water remains on the mark you made for at least 10 minutes, the flapper plug is not leaking. If the water level does drop below the mark, it is leaking and should be replaced.
2.) Check the overflow tube. The water level in the tank should be at least 1 inch below the top of the overflow tube. If the water level is at the top of the overflow tube, this could be where a leak is occurring. The float that controls the water level in the tank should be adjusted so that the water level in the tank is at least 1 inch below the top of the tube.
3.) Most toilet tank leaks result from worn parts or misalignment of a part of the flushing mechanism. If you are an experienced "do-it- yourselfers," you can probably handle the repair. If you don't feel comfortable repairing it, call a plumber.

Facts About the Cambridge Water System and Water Qauality Data from 2004

The Cambridge Water Supply: The Cambridge water supply comes from three surface water reservoirs located in Cambridge, Lexington, Waltham, Lincoln and Weston. The Hobbs Brook (3049000-01S-4S) and Stony Brook (3049000-03S) reservoirs are the primary sources of water for our system. The total capacity of the two up-country reservoirs is 3095 million gallons. The water is transferred to the terminal reservoir, Fresh Pond (3049000-02S), via the Stony Brook Conduit. The Fresh Pond Reservoir has an additional 1308 million gallons of water storage. Our supply is also backed up by interconnections to the Massachusetts Water Resources Authority(MWRA) water system.

Our water system is routinely inspected by the Department of Environmental Protection (DEP) for its technical, financial and managerial capacity to provide safe drinking water to you. To ensure that we provide the highest quality water the system is operated by Massachusetts certified treatment and distribution operators. Descriptions and details of ongoing improvements in watershed, distribution, and treatment systems and our customer service efforts in engineering, billing and metering are available on the City and Department Web sites www.cambridgema.gov and www.cambridgema.gov/cwd/

Watershed Protection: As part of the CWD's ongoing commitment to protecting the resource water we participated with the DEP in the preparation of a Source Water Assessment Program (SWAP) Report for the Cambridge water supply system during 2003. The SWAP Report assesses the susceptibility of our public water supply and notes the key land use and protection issues, which includes: Zone A Land Uses, Residential Land Uses, Transportation Corridors, Hazardous Material Storage and Use, and Presence of Oil or Hazardous Materials Contamination Sites.

The report commends the Cambridge Water Department for taking an active role in promoting source protection measures and recommends that we continue these efforts to further protect the supply. These practices include:
•Working cooperatively with watershed towns on emergency response and storm water management.
•Placing spill kits at strategic points within the watershed.
•Actively monitoring source water quality throughout the watersheds and using the data to target source protection.
•Working cooperatively with businesses in the watersheds to encourage source protection.
•Adopting the Fresh Pond Master Plan, which includes long-term source protection measures for the Fresh Pond Reservation.
•Dedicating staff resources to inspections, public education, and coordinating of source protection efforts.

While a susceptibility ranking of High was assigned to the Cambridge water supply system using the land use and potential sources of contamination information collected during the assessment by DEP, the actual risks may be lower based on the implementation of best management practices (BMP's) throughout the Cambridge watershed and by the ongoing watershed protection programs.

For a copy of the SWAP Report and details of CWD's plans and schedules for implementing recommendations, please visit our web site at www.cambridgema.gov/cwd/

How We Treat Your Water: The Walter J. Sullivan Water Purification Facility at Fresh Pond Reservation changes the incoming source waters of the Cambridge reservoir system into the drinking water that is delivered to your home or business. The raw water is treated to exceed State and Federal drinking water standards. The processes include:

Pretreatment: This includes the pre-oxidation with the application of ozone , rapid mix, coagulation and dissolved air flotation (DAF). These processes and a coagulant chemical, alum, remove: manganese, natural color, particles, algae, protozoa, viruses and bacteria from the water.
Primary Ozone Disinfection: Fine bubbles of ozone are dissolved into the water and disinfect the water by killing bacteria, viruses, and protozoa. The ozone is generated in the plant and introduced into the water in a series of chambers that allow contact and mixing of the ozone with the water.
Filtration using Granular Activated Carbon (GAC) Media: This step follows the ozone application to help remove any organic compounds by biological action in the filters and further polish the water by removing additional particles, color and protozoa from the water.
Chlorination/Chloramination: Kills bacteria that may develop during the normal operation of the filters. This second disinfection step provides a level of redundancy in the overall process and provides a constant disinfection level in the distribution system.
Post Treatment Chemical Addition: This includes the adjustment of pH for corrosion control and the addition of fluoride for dental health.

The water quality of our system is constantly monitored by us in our State certified laboratory and the DEP to determine the effectiveness of existing water treatment and to determine if any additional treatment is required.

Cambridge Water Department - Consumer Confidence Report 2004 Data

Lead and Copper	**Units**	**90% Value**	**Range**	**Action Level(AL) (90%)**	**MCLG**	**Violation**	**Sites exceeding the AL**	
Copper (2002)	ppm	0.06	0 - 0.09	1.3	0	NO	0 of 60	Corrosion of household plumbing.
Lead (2002)	ppb	6	0 - 251	15	0	NO	3 of 60	Corrosion of household plumbing.
Regulated- Inorganic Contaminants		**Highest**	**Range**	**MCL**	**MCLG**	**Violation**		
Barium	ppm	0.045	0.03-0.045	2	2	NO		Erosion of natural deposits.
Fluoride	ppm	1.2	0.98-1.21	4	4	NO		Water additive to promote strong teeth.
Nitrate as Nitrogen	ppm	0.76	0.25-0.76	10	10	NO		Runoff from fertilizer use.
Nitrite as Nitrogen	ppm	0.1	0.004-0.10	1	1	NO		Runoff from fertilizer use.
Unregulated - Inorganic Contaminant		**Average**	**Range**					
Sulfate	ppm	25	23-30					Erosion of natural deposits.
Sodium	ppm	73	68-82					road salt.
Unregulated - Organic Contaminants		**Average**	**Range**					
Bromodichloromethane	ppb	3	1.4-4.6					By-product of drinking water chlorination.
Bromoform	ppb	1.3	0.5-2.1					By-product of drinking water chlorination.
Chloroform	ppb	1.6	0.6-3.1					By-product of drinking water chlorination.
Dibromodichloromethane	ppb	3.9	2.0-5.8					By-product of drinking water chlorination.
Regulated -Volitale Organic Contami		**Highest Ave**	**Range**	**MCL**	**MCLG**	**Violation**		
Total Trihalomethanes(THMs)	ppb	15.4	4.4-15.4	80	0	NO		By-product of drinking water chlorination.
Haloacetic Acids(HAA5)	ppb	14.1	2.6-14.1	60	0	NO		By-product of drinking water chlorination.
		Highest Ave	**Range**	**MRDL**	**MRDLG**	**Violation**		
Chlorine as Chloramine	ppm	2.2	1.5 - 2.2	4	4	NO		Water additive used to control microbes.
Regulated - Radioactive Contaminants						**Violation**		
Gross Beta Activity(2002)	pCi/L	13	n/a	50	0	NO		Decay of naturally occurring deposits.
Turbidity	**TT**	**Lowest Monthly %**		**Highest Daily Value**		**Violation**		
Daily Compliance(NTU)	1			0.19		NO		Suspended matter from soil runoff.
Monthly Compliance	At least 95%	100				NO		Suspended matter from soil runoff.
Bacteria	**Highest % Positive in a Month**			**Total # positive**	**MCL**	**Violation**	**MCLG**	
Total Coliform	1%(Apr,Sept,Dec)			1,1,1	>5%	NO	0	Naturally occurring in the enviroment.

What the EPA and DEP say about Drinking Water - Substances Found In Tap Water:

Sources of drinking water (both tap water and bottled water) include rivers, lakes, streams, ponds, reservoirs, springs, and wells. As water travels over the surface of the land or through the ground, it dissolves naturally occurring minerals, and in some cases, radioactive material, and can pick up substances resulting from the presence of animals or from human activity.

Contaminants that may be present in source water include:
Microbial contaminants -such as viruses and bacteria, which may come from sewage treatment plants, septic systems, agricultural livestock operations, and wildlife.
Inorganic contaminants -such as salts and metals, which can be naturally-occurring or result from urban stormwater runoff, industrial, or domestic wastewater discharges, oil and gas production, mining, and farming
Pesticides and herbicides -which may come from a variety of sources such as agriculture, urban stormwater runoff, and residential uses.
Organic chemical contaminants -including synthetic and volatile organic chemicals, which are by-products of industrial processes and petroleum production, and can also come from gas stations, urban stormwater runoff, and septic systems.
Radioactive contaminants -which can be naturally occurring or be the result of oil and gas production and mining activities.

In order to ensure that tap water is safe to drink, the Massachusetts Department of Environmental Protection (DEP) and U.S. Environmental Protection Agency (EPA) prescribe regulations that limit the amount of certain contaminants in water provided by public water systems. The Food and Drug Administration (FDA) and Massachusetts Department of Public Health (DPH) regulations establish limits for contaminants in bottled water that must provide the same protection for public health. All drinking water, including bottled water, may reasonably be expected to contain at least small amounts of some contaminants. The presence of contaminants does not necessarily indicate that water poses a health risk. More information about contaminants and potential health effects can be obtained by calling the EPA's Safe Drinking Water Hotline (800-426-4791).

Some people may be more vulnerable to contaminants in drinking water than the general population. Immuno-compromised persons such as persons with cancer undergoing chemotherapy, persons who have undergone organ transplants, people with HIV/AIDS or other immune system disorders, some elderly, and some infants can be particularly at risk from infections. These people should seek advice about drinking water from their health care providers. EPA/Centers for Disease Control and Prevention (CDC) guidelines on lowering the risk of infection by cryptosporidium and other microbial contaminants are available from the Safe Drinking Water Hotline (800-426-4791).

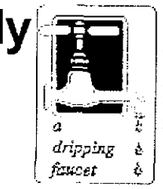
IMPORTANT DEFINITIONS
Maximum Contaminant Level (MCL) – The highest level of a contaminant that is allowed in drinking water. MCLs are set as close to the MCLGs as feasible using the best available treatment technology.
Maximum Contaminant Level Goal (MCLG) –The level of a contaminant in drinking water below which there is no known or expected risk to health. MCLGs allow for a margin of safety.
Maximum Residual Disinfectant Level (MRDL) — The highest level of a disinfectant (chlorine, chloramines, chlorine dioxide) allowed in drinking water. There is convincing evidence that addition of a disinfectant is necessary for control of microbial contaminants.
Maximum Residual Disinfectant Level Goal (MRDLG) — The level of a drinking water disinfectant (chlorine, chloramines, chlorine dioxide) below which there is no known expected risk to health. MRDLG's do not reflect the benefits of the use of disinfectants to control microbial contaminants.
Treatment Technique (TT) – A required process intended to reduce the level of a contaminant in drinking water.
Action Level (AL) – The concentration of a contaminant which, if exceeded, triggers treatment or other requirements that a water system must follow.
90th Percentile – Out of every 10 homes sampled, 9 were at or below this level.
Variances and Exemptions – State or EPA permission not to meet an MCL or a treatment technique under certain conditions.
ppm= parts per million, or milligrams per liter (mg/l)
ppb= parts per billion, or micrograms per liter (ug/l)
ppt= parts per trillion, or nanograms per liter
pCi/l = picocuries per liter (a measure of radioactivity)
NTU= Nephelometric Turbidity Units
N/A= Not Applicable
ND= Not Detected
mrem/year = millimrems per year (a measure of radiation absorbed by the body)

Water Leak$ are Co$tly

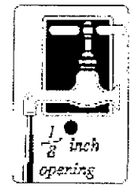
It is not unheard of to have a water leak in the plumbing system of your house and not be aware of it until your water and sewer bill arrives.

The best tip to avoid a high water and sewer bill is to discover and repair leaks immediately. In the table to the right, we have illustrated examples of leaks and their relative costs to users.

The following examples show the amount of water that can be lost (and billed to your account) for various sizes and types of leaks. The basis for the quarterly cost that a consumer would be charged in Cambridge is the fiscal year 2006 water and sewer increasing block rate structure.



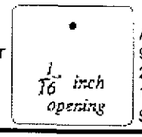
A dripping leak:
15 gal/day
450 gal/month
1.8 units/qtr
$16/qtr



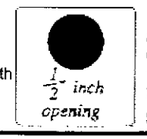
A 1/8 in. leak:
3,806 gal/day
114,200 gal/month
456 units/qtr
$4,500/qtr

A 1/32 in. leak:
264 gal/day
7,920 gal/month
31 units/qtr
$290/qtr

A 1/4 in. leak:
15,226 gal/day
456,800 gal/month
1,830 units/qtr
$19,000/qtr



A 1/16 in. leak:
943 gal/day
28,300 gal/month
115 units/qtr
$1,000/qtr



A 1/2 in. leak:
60,900 gal/day
1,827,00 gal/month
7,500 units/qtr
$80,600/qtr

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Phone Number 1-617-349-4770

Visit Our Web Site at
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Email us at cwd@cambridgema.gov

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- **Water Conservation: the Cost of Leaks**

2005/2006 Fresh Pond Reservation Restoration Projects

Currently, there are two landscape restoration projects occurring at the Reservation at Fresh Pond: the Little Fresh Pond Shoreline Restoration and Drainage Improvement Project, and the Northeast Sector Project. Both of these projects are pieces of the implementation of a larger strategy laid out for the Reservation in the Fresh Pond Reservation Master Plan.

Restoration of Little Fresh Pond was ranked amongst the highest of priorities for the restoration of the health of the Reservation in the Fresh Pond Master Plan. The shoreline of Little Fresh Pond had been severely eroded due to soil compaction, and it was compromising the safety of visitors using the Perimeter Road. Invasive species and proximity to the golf course were also a threat to Little Fresh Pond.

In order to combat the overall degradation of this water body, a vital component of this project was to stabilize the shoreline of Little Fresh Pond and reduce erosion. This has been achieved through a series of steps.

First, the entire shoreline of Little Fresh Pond was regraded to attain a more gradual slope to slow the flow of water and soils. Then, the shoreline was reinforced with a dense log made of coconut fibers called coir fascine.

The coir fascines were designed to retain surface water and catch sediments before they can enter the Pond, therefore helping to build up the shoreline to support vegetation. Planting was the final aspect of the shoreline restoration. Using a variety of wetland grasses, wet meadow plants, and upland shrubs and trees, we were able to repopulate the pond with native plant species. The root system of these plants will hold soils in place, and because they are native species, will assist in improving the overall health of the Fresh Pond Reservation ecosystem.

The Northeast Sector Project has been designed to reduce compaction and erosion in a 30-acre area of the Reservation that includes Lusitania Field and the environs around Neville Place. Compaction will be alleviated through repairing degraded hillsides and creating a system of pathways that are integrated with the contours of the landscape.

Erosion will be stemmed through the use of natural and permeable erosion control materials throughout the site. These will slow the flow of water and reduce sedimentation into the Reservoir.

A major goal of the Fresh Pond Reservation Master Plan and of the Northeast Sector is to promote biodiversity through the removal of aggressive invasive vegetation and the planting of native trees, shrubs, wildflowers, and aquatic plants. A working, healthy ecosystem within the Reservation will provide an important natural function to the citizens of Cambridge by filtering contaminants from the water, as well as provide food, shelter and habitat for animals and insects. To this end, over 69,000 plants in the form of trees, shrubs and understory vegetation are to be planted as part of the Northeast Sector Project.

Join us for our weekly Fresh Pond Reservation Project Walkabouts every Monday evening at 6pm through the summer of 2006. Chip Norton, Watershed Manager, will meet participants at the Walter J. Sullivan Water Treatment Facility, 250 Fresh Pond Parkway, Cambridge for a walk to and around the project sites. See you there!

24 HOUR EMERGENCY/CUSTOMER SERVICE PHONE NUMBER 1-617-349-4770

VISIT OUR WEB SITE AT WWW.CAMBRIDGEMA.GOV/CWD/

EMAIL US AT CWD@CAMBRIDGEMA.GOV

Opportunities for Public Participation and Further Information

•The Cambridge Water Board meets monthly, usually on the first Monday of the month, from 5:00 pm to 6:30 at Walter J. Sullivan Water Purification *Facility at 250 Fresh Pond Parkway, Cambridge, MA 02138.*
•For more information about the dates of upcoming meetings and to review minutes from previous meetings, refer to the Cambridge Water Department Website (www.cambridgema.gov/cwd/).
•If you have additional questions about your water supply, please contact Timothy W.D. MacDonald, Manager of Water Operations, at 617-349-4773.

Contamination from Cross-Connections

Cross-connections that could contaminate drinking water distribution lines are a major concern. A cross-connection is formed at any point where a drinking water line *connects to equipment (boilers), systems containing chemicals (air conditioning systems, fire sprinkler systems, irrigation systems) or water* sources of questionable quality (rain water). Cross-connection contamination can occur when the pressure in the equipment or system is greater than the pressure inside the drinking water line (backpressure). Contamination can also occur when the pressure in the drinking water line drops due to fairly routine occurrences (main breaks, heavy water demand) causing contaminants to be siphoned out from the equipment and into the drinking water line (backsiphonage).

Outside water taps and garden hoses tend to be the most common sources of cross-connection contamination at home. The garden hose creates a hazard when submerged in a swimming pool or when attached to a chemical sprayer for weed killing. Garden hoses that are left lying on the ground may be contaminated by fertilizers or garden chemicals. Protection can be provided through the installation of an inexpensive device called a hose connection vacuum breaker. Also at home, improperly installed valves in your toilet can also be a source of cross-connection contamination.

Community water supplies are continuously jeopardized by cross-connections unless appropriate valves, known as backflow prevention devices, are installed and maintained. We have surveyed industrial commercial, and institutional facilities in the City to make sure that potential cross-connections are identified and eliminated or protected by a backflow preventer. We also inspect and test each backflow preventer to make sure that it is providing maximum protection.

For more information, call us at 617-349-4770 or visit the Web site of the American Backflow Prevention Association (www.abpa.org)

Facts About the Cambridge Water System and Water Qauality Data from 2005

The Cambridge Water Supply: The Cambridge water supply comes from three surface water reservoirs located in Cambridge, Lexington, Waltham, Lincoln and Weston. The Hobbs Brook (3049000-01S-4S) and Stony Brook (3049000-03S) reservoirs are the primary sources of water for our system. The total capacity of the two up-country reservoirs is 3095 million gallons. The water is transferred to the terminal reservoir, Fresh Pond (3049000-02S), via the Stony Brook Conduit. The Fresh Pond Reservoir has an additional 1308 million gallons of water storage. Our supply is also backed up by interconnections to the Massachusetts Water Resources Authority(MWRA) water system.

Our water system is routinely inspected by the Department of Environmental Protection (DEP) *for its technical, financial and managerial capacity to* provide safe drinking water to you. To ensure that we provide the highest quality water the system is operated by Massachusetts certified treatment and distribution operators. Descriptions and details of ongoing improvements in watershed, distribution, and treatment systems and our customer service efforts in engineering, billing and metering are available on the City and Department Web sites www.cambridgema.gov and www.cambridgema.gov/cwd/

Watershed Protection: *As part of the CWD's ongoing commitment to* protecting the resource water we participated with the DEP in the preparation of a Source Water Assessment Program (SWAP) Report for the Cambridge water supply system during 2003. The SWAP Report assesses the susceptibility of our public water supply and notes the key land use and protection issues, which includes: Zone A Land Uses, Residential Land Uses, Transportation Corridors, Hazardous Material Storage and Use, and Presence of Oil or Hazardous Materials Contamination Sites.

The report commends the Cambridge Water Department for taking an active role in promoting source protection measures and recommends that we continue these efforts to further protect the supply. These practices include:
•Working cooperatively with watershed towns on emergency response and storm water management.
•Placing spill kits at strategic points within the watershed.
•Actively monitoring source water quality throughout the watersheds and using the data to target source protection.
•Working cooperatively with businesses in the watersheds to encourage source protection.
•Adopting the Fresh Pond Master Plan, which includes long-term source protection measures for the Fresh Pond Reservation.
•Dedicating staff resources to inspections, public education, and coordinating of source protection efforts.

While a susceptibility ranking of High was assigned to the Cambridge water supply system using the land use and potential sources of contamination information collected during the assessment by DEP, the actual risks may be lower based on the implementation of best management practices (BMP's) throughout the Cambridge watershed and by the ongoing watershed protection programs.

For a copy of the SWAP Report and details of CWD's plans and schedules for implementing recommendations, please visit our web site at *www.cambridgema.gov/cwd/*

How We Treat Your Water: The Walter J. Sullivan Water Purification Facility at Fresh Pond Reservation changes the incoming source waters of the Cambridge reservoir system into the drinking water that is delivered to your home or business. The raw water is treated to exceed State and Federal drinking water standards. The processes include:

Pretreatment: This includes the pre-oxidation with the application of ozone , rapid mix, coagulation and dissolved air flotation (DAF). These processes and a coagulant chemical, alum, remove: manganese, natural color, particles, algae, protozoa, viruses and bacteria from the water.
Primary Ozone Disinfection: Fine bubbles of ozone are dissolved into *the water and disinfect the water by killing bacteria, viruses, and protozoa.* The ozone is generated in the plant and introduced into the water in a series of chambers that allow contact and mixing of the ozone with the water.
Filtration using Granular Activated Carbon (GAC) Media: This step follows the ozone application to help remove any organic compounds by biological action in the filters and further polish the water by removing additional particles, color and protozoa from the water.
Chlorination/Chloramination: Kills bacteria that may develop during the normal operation of the filters. This second disinfection step provides a level of redundancy in the overall process and provides a constant disinfection level in the distribution system.
Post Treatment Chemical Addition: This includes the adjustment of pH for corrosion control and the addition of fluoride for dental health.

The water quality of our system is constantly monitored by us in our State certified laboratory and the DEP to determine the effectiveness of existing water treatment and to determine if any additional treatment is required.

Cambridge Water Department - Consumer Confidence Report 2005 Data

Lead and Copper	**Units**	**90% Value**	**Range**	**Action Level(AL)90%**	**MCLG**	**Violation**	**Sites exceeding AL**	
Copper	ppm	0.035	0.001-1.09	1.3	0	NO	0 of 60	Corrosion of household plumbing.
Lead	ppb	7	0 - 157	15	0	NO	2 of 60	Corrosion of household plumbing.
Regulated- Inorganic Contaminants		**Highest**	**Range**	**MCL**	**MCLG**	**Violation**		
Barium	ppm	0.047	0.035-0.047	2	2	NO		Erosion of natural deposits.
Fluoride	ppm	1.3	0-1.3	4	4	NO		Water additive to promote strong teeth.
Nitrate as Nitrogen	ppm	0.74	0.29-0.74	10	10	NO		Runoff from fertilizer use.
Nitrite as Nitrogen	ppm	0.015	0-0.015	1	1	NO		Runoff from fertilizer use.
Unregulated - Inorganic Contaminants		**Average**	**Range**					
Sulfate	ppm	25	23-27					Erosion of natural deposits.
Sodium	ppm	70	60-92					road salt.
Unregulated - Organic Contaminants		**Average**	**Range**					
Bromodichloromethane	ppb	2.8	1.6-4.6					By-product of drinking water chlorination.
Bromoform	ppb	1.8	0.9-3.4					By-product of drinking water chlorination.
Chloroform	ppb	1.4	0.7-3.0					By-product of drinking water chlorination.
Dibromodichloromethane	ppb	3.9	2.3-6.3					By-product of drinking water chlorination.
Regulated -Volitale Organic Contaminants		**Highest Ave**	**Range**	**MCL**	**MCLG**	**Violation**		
Total Trihalomethanes(THMs)	ppb	10.3	4.8-18	80	0	NO		By-product of drinking water chlorination.
Haloacetic Acids(HAA5)	ppb	8.7	3.5-20	60	0	NO		By-product of drinking water chlorination.
		Highest Ave	**Range**	**MRDL**	**MRDLG**	**Violation**		
Chlorine as Chloramine	ppm	3	1.3 - 3.0	4	4	NO		Water additive used to control microbes.
Regulated - Radioactive Contaminants (2002)						**Violation**		
Gross Alpha Activity	pCi/L	0.3	n/a	15	0	NO		Erosion of natural deposits.
Gross Beta Activity	pCi/L	14	n/a	AL = 50	0	NO		Decay of naturally occurring deposits.
Turbidity	**TT**	**Lowest Monthly %**		**Highest Daily Value**		**Violation**		
Daily Compliance(NTU)	1			0.16		NO		Suspended matter from soil runoff.
Monthly Compliance	At least 95%	100				NO		Suspended matter from soil runoff.
Bacteria	**Highest % Positive in a Month**			**Total # positive**	**MCL**	**Violation**	**MCLG**	
Total Coliform	1%(April)			1	>5%	NO	0	Naturally occurring in the enviroment.

What the EPA and DEP say about Drinking Water - Substances Found In Tap Water:

Sources of drinking water (both tap water and bottled water) include rivers, lakes, streams, ponds, reservoirs, springs, and wells. As water travels over the surface of the land or through the ground, it dissolves naturally occurring minerals, and in some cases, radioactive material, and can pick up substances resulting from the presence of animals or from human activity.

Contaminants that may be present in source water include:
Microbial contaminants -such as viruses and bacteria, which may come from sewage treatment plants, septic systems, agricultural livestock operations, and wildlife.
Inorganic contaminants -such as salts and metals, which can be naturally-occurring or result from urban stormwater runoff, industrial, or domestic wastewater discharges, oil and gas production, mining, and farming
Pesticides and herbicides -which may come from a variety of sources such as agriculture, urban stormwater runoff, and residential uses.
Organic chemical contaminants -including synthetic and volatile organic chemicals, which are by-products of industrial processes and petroleum production, and can also come from gas stations, urban stormwater runoff, and septic systems.
Radioactive contaminants -which can be naturally occurring or be the result of oil and gas production and mining activities.

In order to ensure that tap water is safe to drink, the Massachusetts Department of Environmental Protection (DEP) and U.S. Environmental Protection Agency (EPA) prescribe regulations that limit the amount of certain contaminants in water provided by public water systems. The Food and Drug Administration (FDA) and Massachusetts Department of Public Health (DPH) regulations establish limits for contaminants in bottled water that must provide the same protection for public health. All drinking water, including bottled water, may reasonably be expected to contain at least small amounts of some contaminants. The presence of contaminants does not necessarily indicate that water poses a health risk. More information about contaminants and potential health effects can be obtained by calling the EPA's Safe Drinking Water Hotline (800-426-4791).

Some people may be more vulnerable to contaminants in drinking water than the general population. Immuno-compromised persons such as persons with cancer undergoing chemotherapy, persons who have undergone organ transplants, people with HIV/AIDS or other immune system disorders, some elderly, and some infants can be particularly at risk from infections. These people should seek advice about drinking water from their health care providers. EPA/Centers for Disease Control and Prevention (CDC) guidelines *on lowering the risk of infection by cryptosporidium and other microbial* contaminants are available from the Safe Drinking Water Hotline (800-426-4791).

IMPORTANT DEFINITIONS
Maximum Contaminant Level (MCL) – The highest level of a contaminant that is allowed in drinking water. MCLs are set as close to the MCLGs as feasible using the best available treatment technology.
Maximum Contaminant Level Goal (MCLG) –The level of a contaminant in drinking water below which there is no known or expected risk to health. MCLGs allow for a margin of safety.
Maximum Residual Disinfectant Level (MRDL) — The highest level of a disinfectant (chlorine, chloramines, chlorine dioxide) allowed in drinking water. There is convincing evidence that addition of a disinfectant is necessary for control of microbial contaminants.
Maximum Residual Disinfectant Level Goal (MRDLG) — The level of a drinking water disinfectant (chlorine, chloramines, chlorine dioxide) below which there is no known expected risk to health. MRDLG's do not reflect the benefits of the use of disinfectants to control microbial contaminants.
Treatment Technique (TT) – A required process intended to reduce the level of a contaminant in drinking water.
Action Level (AL) – The concentration of a contaminant which, if exceeded, *triggers treatment or other requirements that a water system must follow.*
90th Percentile – Out of every 10 homes sampled, 9 were at or below this level.
Variances and Exemptions – State or EPA permission not to meet an MCL or a treatment technique under certain conditions.
ppm= parts per million, or milligrams per liter (mg/l)
ppb= parts per billion, or micrograms per liter (ug/l)
ppt= parts per trillion, or nanograms per liter
pCi/l = picocuries per liter (a measure of radioactivity)
NTU= Nephelometric Turbidity Units
N/A= Not Applicable
ND= Not Detected
mrem/year = millimrems per year (a measure of radiation absorbed by the body)

APPENDIX 4-3

LVSWSB Detailed Projects and Cost Estimation Matrix

LAKE VICTORIA SOUTH WATER SERVICES BOARD

Recommended Activities and Preliminary Cost Estimates Matrix

Note: Some tasks will require collaboration with the Water Resources Management Authority (WRMA), Water Services Regulatory Board (WSRB), Catchment Area Advisory Committees (CAC), Water Service Providers (WSP), customers, and other stakeholders.

No.	SUMMARY TITLE	OBSERVED PROBLEM / NEED	PROPOSED SOLUTION(S)	EST. COST (USD)	COST SOURCE
1	System Inventory and Asset Management Planning Toolkit	A water and wastewater system inventory and asset management plan should be created for each LVSWSB town. Accurate inventories are required before meaningful planning can be accomplished. A standardized format will make the process easier for the towns and enable LVSWSB to efficiently review plans from all towns. The inventories will be important for almost all future work including O&M plans, infrastructure planning, mapping, tariff analysis, staffing planning, accounting and other activities An inventory is the first step towards creating an asset management plan. Once the inventory is created, assets should be valued and prioritized into an asset management plan for future rehabilitation, replacement, or upgrade. Fully defining existing assets and creating a documented, prioritized plan for upgrades and maintenance will also enhance systems' attractiveness to grant / loan entities. The asset management plan should be a "living" document that is followed consistently and reviewed and updated at least annually.	Develop a standardized methodology for creating system inventories and asset management plans. Inventories should include major equipment, piping, tanks, and treatment systems. Available data such as age, expected useful life, condition, service history, and nameplate data should be included. Financial value of assets and list of depreciated assets should be included. Develop or use available standard forms, or purchase and customize available software (recommended) to create inventories and convert to an asset management plan by prioritizing assets and estimating future needs and costs. Priority should be given to critical infrastructure at or past the end of its useful life. USEPA's Total Electronic Asset Management System (TEAMS) may be useful as a guide. Local hydraulic modeling may be required to prioritize investments. The priority list and cost estimates will enable Towns to determine the magnitude of reserve funds required for future projects. After Towns prepare inventories and asset management plans, LVSWSB should follow up with towns to ensure they are implementing the plans and that they review and revise the plans at least annually. The system inventories should also be used to develop a separate spare parts inventory and to determine appropriate stocks of spare parts. Assist WSPs to effectively utilize the toolkit to meet LVSWSB service goals.	$ 20,000	Engineering Estimate. May be partially or fully covered by existing LVSWSB budget. Funds for future expenditures related to this task will come from LVSWSB budget.
2	Tariff Analysis Toolkit	Most LVSWSB towns are in need of setting system-specific water and wastewater service tariffs to achieve cost recovery and build reserve funds. Currently, tariffs in many towns are set at levels that do not cover the cost of normal operation and maintenance. As a result, service is often poor, customers are dissatisfied, systems operate at a financial loss, and service quality and physical assets continue to degrade. However, in many towns the willingness and ability to pay for services are relatively high and people are generally willing to pay more for reliable, quality services. Tariff rate increases should be based on real data and reasonable projections, not arbitrary values. By utilizing a transparent methodology for justifying rate increases, obtaining "buy-in" from customers will be much more likely.	Develop a toolkit to assist towns in the process of establishing new tariff structures. WSRB is responsible for developing guidelines for fixing tariffs and reviewing tariff increase requests. However, LVSWSB should assist towns in assembling data required to request rate increases. Using available guidelines and working with WSRB, LVSWSB should clearly define a rational, stepwise process for towns to follow to assemble the information required for defining required tariffs. This will include clearly defining current and expected future costs of service provision (including expected future capital expenditures). The inventory and asset management plan will be very useful in defining current and future costs. Consideration should be given to lowering up-front costs (i.e. connection fees) and implementing incentive programs to encourage more residents to connect to existing water and wastewater systems.	$ 15,000	Engineering Estimate. May be partially or fully covered by existing LVSWSB budget. Funds for future expenditures related to this task will come from LVSWSB budget.

No.	SUMMARY TITLE	OBSERVED PROBLEM / NEED	PROPOSED SOLUTION(S)	EST. COST (USD)	COST SOURCE
3	Operator Training and Certification, Managers' Training	A structured program for training, testing, and certification of operators should be created and administered at the LVSWSB level. Requiring certification of water and wastewater facilities operators and continuing education will develop competency of local staff, ensure operator safety, and enable LVSWSB to reap maximum benefits from its infrastructure investments. Local managers should also be trained in various topics including computer use, billing and collections management, handling illegal connections, public relations, on-site wastewater management, and kiosk and public toilet management.	Develop a structured program for training, testing, and certification of operators and training of managers. Programs should meet or exceed operator training requirements set by the Kenyan national government. Train LVSWSB staff or hire independent consultants to serve as operator and manager trainers. Trainer(s) should function as "circuit-riders" and visit various towns for periodic training sessions to ensure participation, tailor training to local facilities/equipment, and to minimize travel time for operators. Some training may need to be performed at LVSWSB when required. Training should also include "soft" subjects such as maintaining professional appearance, customer relations, etc.	$ 50,000	Engineering Estimate. May be partially or fully covered by existing LVSWSB budget. Funds for future expenditures related to this task will come from LVSWSB budget.
4	Preventative Maintenance Toolkit	In order to maximize equipment lifespan and operating efficiency, all WSPs should develop documented preventative maintenance plans, follow them closely, and be vigilant about recording maintenance histories for equipment.	Develop a model preventative maintenance and maintenance tracking system, including all inventory components. The system may incorporate traditional maintenance card techniques, "out-of-the box" software, or customized software. Software packages are now readily available to schedule and track all required preventative maintenance and are recommended. Assist WSPs to effectively utilize the toolkit to meet LVSWSB service goals.	$ 20,000	Engineering Estimate. May be partially or fully covered by existing LVSWSB budget. Funds for future expenditures related to this task will come from LVSWSB budget.
5	Illegal Connections Toolkit	Illegal water service connections are a problem in many LVSWSB communities. Kisii reported that their staff received threats from residents during attempts to remedy illegal connections. A structured approach and toolkit should be developed to assist communities in handling this issue and changing the mindset of residents who still feel that having an illegal connection is acceptable.	Develop a toolkit for handling illegal connections, including a model by-law with fines and penalties. Include media materials to educate users about the benefits of a legal connection and problems associated with illegal connections. Problems include potential cross-contamination and increasing financial burden on those who have legal connections (i.e. If your neighbor has an illegal connection, your tariffs will rise to cover the cost of service to illegal connections). Include suggested incentive programs for encouraging illegal connections to become metered connections (i.e. amnesty from fines if you install a proper metered connection prior to a certain date). Assist WSPs to effectively utilize the toolkit to meet LVSWSB service goals.	$ 10,000	Engineering Estimate. May be partially or fully covered by existing LVSWSB budget. Funds for future expenditures related to this task will come from LVSWSB budget.
6	Metering and Arrears Toolkit	Some towns have reported difficulties in collecting fees owed in arrears and transitioning to billing based on metering data. LVSWSB should provide guidance to towns regarding this process and offer helpful suggestions for a smooth transition. In addition, towns require assistance on transitioning to new technology including computerized billing systems and consideration of using remote reading water meters.	LVSWSB should develop a toolkit with suggested programs for transitioning to a fully metered system and collecting arrears. This information should describe a stepwise process for making a smooth transition and sensitizing customers to new systems and the importance of accurate billing and payments. LVSWSB should also gather and evaluate information on available computerized billing systems and metering technology (including remote reading water meters), suggest appropriate technologies, and offer training to town staff.	$ 10,000	Engineering Estimate. May be partially or fully covered by existing LVSWSB budget. Funds for future expenditures related to this task will come from LVSWSB budget.

No.	SUMMARY TITLE	OBSERVED PROBLEM / NEED	PROPOSED SOLUTION(S)	EST. COST (USD)	COST SOURCE
7	Watershed (Catchment) Protection Toolkit	Watershed protection is crucial to improving and maintaining water quality for the long term. Many water sources in the LVSWSB area are facing increasing pressure and contamination threats from loss of riparian vegetation, expanding agriculture, and various forms of development. Communities require assistance to address these issues.	Develop a watershed protection toolkit to assist communities in protecting water sources. Elements should include a model watershed protection by-law and a model local watershed protection plan. The Board and communities may need to work with CACs and WRMA to develop and implement watershed protection plans including designation of protected areas and restricting certain activities within sensitive watersheds. Assist WSP to effectively utilize the toolkit to meet LVSWSB service goals. USEPA's 'Draft Handbook for Developing Watershed Plans to Restore and Protect Our Waters' and similar documents may serve as a useful guide.	$ 10,000	Engineering Estimate. May be partially or fully covered by existing LVSWSB budget. Funds for future expenditures related to this task will come from LVSWSB budget.
8	On-Site Wastewater Management Toolkit	Many on-site wastewater systems (latrines, septic systems, tight tanks, etc.) are failing and represent an acute public health hazard and a public nuisance. Failing on-site systems contaminate local public and private groundwater and surface water supplies. LVSWSB should develop standard methodologies for creating an on-site system inventory and tracking system so that this important infrastructure serves as a public health benefit, not a liability. On-site systems can adequately protect public health and are often more cost effective than public sewers. However, these systems must be appropriately designed and maintained in order to protect public health.	Develop an on-site wastewater management toolkit including design standards and methodology for creating an on-site system inventory, tracking system, and program for mandatory periodic inspections and pump-outs. Include model by-laws. Include suggestions for data collection techniques, including sample survey. The system should be integrated with electronic mapping systems to the extent feasible. "Off-the-shelf" software programs may be used, but should be customized for local conditions. USEPA's 'Management Handbook for Septic/Decentralized Systems' (2005) and USEPA's free software called 'The Wastewater Information System Tool' (TWIST) may serve as a useful guides. The toolkit should include provisions for management of private septage haulers including a manifest system, setting dumping fees, and mandating discharge only at approved facilities. Assist WSPs to effectively utilize the toolkit to meet LVSWSB service goals.	$ 20,000	Engineering Estimate. May be partially or fully covered by existing LVSWSB budget. Funds for future expenditures related to this task will come from LVSWSB budget.
9	Water Kiosks, Water Vendors, and Public Toilet Management Toolkit	Water kiosks and public toilets will serve as an important component in many towns' water and wastewater systems. Water vendors currently meet the water needs of unserved neighborhoods and are relied upon where infrastructure is unavailable In order to function effectively, these systems need to be properly designed, regulated, managed, and maintained. LVSWSB should develop a toolkit to assist Towns with developing, regulating, managing, and maintaining this important infrastructure. Where piped connections are unavailable, efforts should be made to provide kiosk water within 400 meters of residences.	Develop guidance standards for the design, regulation, management, and maintenance of water kiosks and public toilets. Guidance should include: design and maintenance standards for kiosks and public toilets including metering / piping, security, cleanliness, lighting, and signage requirements (logos / fonts, prices, hours of operation, contact information, etc.); training and certification standards for private kiosk and toilet operators; standard lease agreements; regulations regarding fixing prices and billing standards; and inspection procedures including water quality sampling. Guidance should also be provided for implementing a vendor training, certification, and water sampling program to ensure vendors are distributing safe water. Assist WSPs to effectively utilize the toolkit to meet LVSWSB service goals.	$ 15,000	Engineering Estimate. May be partially or fully covered by existing LVSWSB budget. Funds for future expenditures related to this task will come from LVSWSB budget.

No.	SUMMARY TITLE	OBSERVED PROBLEM / NEED	PROPOSED SOLUTION(S)	EST. COST (USD)	COST SOURCE
10	Public Education Toolkit	An informed customer base is vital in effectively protecting public health, garnering support for LVSWSB projects, and ensuring successful project implementation. LVSWSB should develop and distribute public education tools for use by towns and WSP.	Develop and distribute pamphlets, "bill stuffers", and newsletters to towns for local dissemination. Topics should include: water and energy conservation and associated financial savings; health awareness including dangers of obtaining water from potentially contaminated sources including water vendors; proper use and maintenance of on-site sanitation systems including hand-washing; source water protection; etc. Develop a template for brief annual WSP reports (newsletter-style) to customers including information about their water sources, distribution systems, and wastewater collection and treatment systems. Utilize U.S. 'Consumer Confidence Reports' as an example. Develop and distribute education program packages for schools or use readily available materials such as those available through USEPA or Government of Kenya. Consider creating a mascot and including educational games for children in distributed materials. Encourage WSPs to hold public meetings. Assist WSPs to effectively utilize the toolkit to meet LVSWSB service goals.	$ 20,000	Engineering Estimate. May be partially or fully covered by existing LVSWSB budget. Funds for future expenditures related to this task will come from LVSWSB budget.
11	Community Public Relations / Communica-tions	Establishing a positive relationship with customers and cooperative relationships among WSP, municipal departments and citizens groups is crucial to the successful implementation of water and wastewater projects. This includes establishing transparency regarding proposed investments, rate increases, supply interruptions, permit violations, etc. Customers and municipal departments should be involved in the planning and implementation process so that they become vested and committed to success. In fact, complete success is only possible through collaborative efforts between LVSWSB, WSPs, and the customers. When citizens are assured their money is being spent wisely and can see tangible positive results, it will create trust and lead to successful project implementation.	Consider designating an LVSWSB staff person for public relations. Develop a plan for establishing 'Community Stakeholders Collaboratives' in each town including representatives from interested community groups and municipal departments. Cooperation with local town departments responsible for planning, zoning, by-laws enforcement, and police / law enforcement will be important for effective implementation of water and wastewater projects. Encourage towns to designate public relations liaisons to foster communications between departments and citizens groups and garner collective support for projects. Continue to develop and distribute LVSWSB newsletter to customers. Consider use of advertising to defray costs. *NOTE: LVSWSB Business Plan 2006-2011 NOTES THAT ONE OF THE FUNCTIONS OF THE FINANCIAL AND ADMIN DEPT. INCLUDES SOME OF THESE TYPES OF ACTIVITIES. THERE IS A POSITION TITLED 'CORPORATE COMMUNICATION/PUBLIC RELATIONS OFFICER' BUT THE POSITION IS CURRENTLY NOT FILLED.*	$ 10,000	Engineering Estimate. May be partially or fully covered by existing LVSWSB budget. Future expenditures from LVSWSB budget.
12	Bulk Procurement Evaluation	LVSWSB towns currently procure chemicals and other needs individually. By bidding for services at the LVSWSB level, towns may be able to secure lower rates for frequently used commodities by establishing exclusive agreements at the LVSWSB level and contracting with a limited number of suppliers.	Evaluate feasibility of bidding for provision of chemicals, water meters, water savings devices, etc. at the LVSWSB level. Towns would be required to sign on to exclusive agreements and obtain goods from a limited number of suppliers. Storing large amounts of chemicals or other goods at LVSWSB headquarters is unlikely to be necessary as suppliers would deliver directly to Towns. Consider bulk purchase of water saving devices including sink aerators and low flow showerheads for distribution to towns.	$ 10,000	Engineering Estimate. May be partially or fully covered by existing LVSWSB budget. Funds for future expenditures related to this task will come from LVSWSB budget.
13	Upgrade LVSWSB Garage for Regional Activities	LVSWSB garage facility behind LVSWSB offices in Kisumu may be suitable for a number of centralized activities including equipment repair and testing, storage of bulk supplies, spare parts, training, etc.	Evaluate feasibility of upgrading LVSWSB garage and converting to a useful facility for centralized activities. Add security, beautify grounds.	$ 110,000	Assume $10,000 for Feasibility Study, $100,000 for upgrades if advisable.

No.	SUMMARY TITLE	OBSERVED PROBLEM / NEED	PROPOSED SOLUTION(S)	EST. COST (USD)	COST SOURCE
14	LVSWSB Headquarters Centralized Laboratory Testing and QA/QC, Laboratory Certification Program	The laboratory at LVSWSB Headquarters is a valuable resource and should be effectively utilized for analyses requiring expensive equipment and for regular quality assurance and quality control (QA/QC) of town sampling. LVSWSB should ensure that proper sampling, testing, QA/QC, and recordkeeping techniques are being employed in local labs by establishing a laboratory inspection and certification program.	Develop structured program for LVSWSB laboratory to be used as regular QA/QC check on Towns' sampling programs to ensure compliance with permit requirements. Define which types of sampling should be done locally and which should be done at LVSWSB based on cost effectiveness to avoid unnecessary equipment and labor cost duplication. Parameters that must be sampled daily or weekly should be done locally, while less frequent sampling may be done more cost effectively at LVSWSB. Final determinations will need to be based on facility-specific permit requirements. Develop a laboratory inspection and certification program to ensure town laboratories are utilizing proper techniques.	$ 20,000	Engineering Estimate. May be partially or fully covered by existing LVSWSB budget. Funds for future expenditures related to this task will come from LVSWSB budget.
15	Leak Detection and Repair Equipment and Operators	UfW is high in most LVSWSB communities. Investments in leak detection and repair will increase revenues, improve system pressures and the number of customers served, and delay the need for expensive investments in source augmentation and pumping and treatment capacity. However, investing in leak detection equipment and specialized training may not be cost-effective for individual communities that only require the service annually or less frequently. Effective use of leak detection equipment requires experience and is best done by a specialist. LVSWSB should develop leak detection capacity and charge WSP a fee for the service.	Evaluate available options and purchase leak detection equipment at the LVSWSB level and train LVSWSB staff in its operation. Develop rental fee rates for WSP as part of a leak detection "circuit rider" program. Educate WSP about availability of leak detection services and encourage utilization of the service to meet LVSWSB UfW goals. This could also be undertaken as a private entrepreneurship opportunity, or LVSWSB could lease the equipment to a private operator.	$ 24,000	Metrotech HL90, Heath Aqua-Scope, or similar ~$3,000 per setup, assume two. Training assume 2-day class @ $1,400 / day plus trainer travel expenses (~$5,000). Additional $10,000 for consultancy in setting up program, contingency. Round up.
16	Septage Exhauster, Sewer and Drain Cleaning Equipment	Insufficient septage exhausters and sewer / drain cleaning equipment exist in LVSWSB area. Many towns do not own such equipment and either borrow / rent from other towns or do not perform these services. Some towns may not have sufficient budget or need to own their own equipment.	Evaluate available options and purchase septage exhauster, sewer / drain cleaning equipment, and Vacutug machines at LVSWSB level to be dispatched to towns as required. Develop fee structure for this service and ensure that towns require pumping of latrines and septic systems as included in local on-site system management plans. This could also be undertaken as a private entrepreneurship opportunity or LVSWSB could lease the equipment to a private operator.	$ 230,000	Budget ~$200,000 for large Vactor-type truck outfitted with sewer/septic/drain exhausting and cleaning equipment; two Vacutug machines @ $7,000 each; Additional funds for consultant detailed evaluation of need and bids, contingency, shipping.
17	Water Bowser	Water bowser required for dispatching to towns during emergencies.	Purchase water bowser for use during water emergencies. *Note: During August 2006 visit a new bowser was present in LVSWSB parking lot. This item may no longer be required.*	$ 100,000	Engineering Estimate. May be partially or fully covered by existing LVSWSB budget. Funds for future expenditures related to this task will come from LVSWSB budget.
			TOTAL	**$ 694,000**	
			SAY	**$ 700,000**	

APPENDIX 5-1

Kericho Detailed Water Demand and Wastewater Flow Estimates

Kericho Domestic Water Consumption and Wastewater Flow Projections

Part A. Domestic Service Connection Projections

	Initial (2006)		Future (2015)		Ultimate (2025)	
Population	**100%**	**113,000**	**100%**	**150,000**	**100%**	**200,000**
High/Med.Income	**25%**	**28,250**	**35%**	**52,500**	**45%**	**90,000**
IWC	70%	19,775	80%	42,000	80%	72,000
NWC, ISA	10%	2,825	10%	5,250	10%	9,000
NWC, NISA	20%	5,650	10%	5,250	10%	9,000
ISC	25%	7,063	35%	18,375	40%	36,000
NSC, ISA	5%	1,413	7%	3,675	10%	9,000
NSC, NISA	70%	19,775	58%	30,450	50%	45,000
Low Income	**75%**	**84,750**	**65%**	**97,500**	**55%**	**110,000**
IWC	50%	42,375	60%	58,500	60%	66,000
NWC, ISA	30%	25,425	20%	19,500	20%	22,000
NWC, NISA	20%	16,950	20%	19,500	20%	22,000
ISC	3%	2,543	5%	4,875	7%	7,700
NSC, ISA	5%	3,814	5%	4,875	5%	5,500
NSC, NISA	93%	78,394	90%	87,750	88%	96,800
		-		-		-

TOTALS FOR ALL INCOME GROUPS

IWC	55%	62,150	67%	100,500	69%	138,000
NWC, IWSA	25%	28,250	17%	24,750	16%	31,000
NWC, NISA	20%	22,600	17%	24,750	16%	31,000
ISC	9%	9,605	16%	23,250	22%	43,700
NSC, ISA	5%	5,226	6%	8,550	7%	14,500
NSC, NISA	87%	98,169	79%	118,200	71%	141,800
Pop. in Water Service Area	80%	90,400	84%	125,250	85%	169,000
Pop. in Wastewater Service Area	13%	14,831	21%	31,800	29%	58,200

NOTES:

IWC	Individual Water Connection	ISC	Individual Wastewater Connection
NWC, ISA	No Water Connection, In Water Service Area	NSC, ISA	No Wastewater Connection, In Wastewater Service Area
NWC, NISA	No Water Connection, Not in Water Service Area	NSC, NISA	No Wastewater Connection, Not in Wastewater Service Area

Kericho Domestic Water Consumption and Wastewater Flow Projections

Part B. Domestic Water Consumption and Wastewater Flow Projections

	Per Capita Water Consumption or WW Flow (m^3/d)*	Initial (2006)		Future (2015)		Ultimate (2025)	
		Water Consumption (m^3/d)	Wastewater Flow (m^3/d)	Water Consumption (m^3/d)	Wastewater Flow (m^3/d)	Water Consumption (m^3/d)	Wastewater Flow (m^3/d)
High/Med. Income							
IWC	0.150	2,966		6,300		10,800	
NWC, ISA	0.02	57		105		180	
NWC, NISA	-	-		-		-	
ISC**	0.05		353		919		1,800
NSC, ISA***	0.006		8		22		54
NSC, NISA	-		-		-		-
Low Income			-		-		-
IWC	0.075	3,178		4,388		5,178	
NWC, ISA	0.02	509		390		440	
NWC, NISA	-	-		-		-	
ISC**	0.05		127		244		385
NSC, ISA***	0.006		23		29		33
NSC, NISA	-		-		-		-
TOTAL		**6,709**	**512**	**11,183**	**1,214**	**16,598**	**2,272**

NOTES:

IWC	Individual Water Connection	ISC	Individual Wastewater Connection
NWC, ISA	No Water Connection, In Water Service Area	NSC, ISA	No Wastewater Connection, In Wastewater Service Area
NWC, NISA	No Water Connection, Not in Water Service Area	NSC, NISA	No Wastewater Connection, Not in Wastewater Service Area

* Based on per capita values presented in 2005 Design Manual and WHO Report #9, except where noted.

** Based on actual data from KEWASCO, wastewater flow is approximately 50 liters per person.

*** Due to minimal use of public toilets, it is assumed that wastewater flows from people without sewer connections within the wastewater service area are 30% of water use, not 80% as recommended in WHO Report #9.

Note that 2005 estimated water consumption is near current production and far in excess of the ~3,600 m^3/d actually sold. Current per capita water use values are likely less than those used in the table.

Kericho Large Water Users Consumption Projections

	Initial (2005)* m^3/d	Future (2015)** m^3/d	Ultimate (2025)** m^3/d	Notes
KETEPA	225	303	407	KEWASCO records Oct 2004 - Oct 2005
District Hospital	91	123	165	KEWASCO records Aug 2004-Aug2005
Kericho High School	84	113	152	KEWASCO records Oct 2004 - Oct 2005 (Three accounts)
Tea Hotel	72	97	130	KEWASCO records Oct 2004 - Oct 2005
Kipsigis Girls School	47	64	86	KEWASCO records Oct 2004 - Oct 2005
Gotab Sanik	24	33	44	KEWASCO records Oct 2004 - Oct 2005 (Four accounts)
Kericho Teacher's College	20	27	36	KEWASCO records Oct 2004 - Oct 2005 (Estimated)
G.K. Prison	19	26	35	KEWASCO records Oct 2004 - Oct 2005
Sunshine Hotel	12	16	21	KEWASCO records Aug 2004-Aug 2005
Milimani Primary School	8	11	15	KEWASCO records Oct 2004 - Oct 2005
Highlands Bible College	20	27	36	Assumed Data - Records not provided
Kericho Primary School	10	13	18	Assumed Data - Records not provided
Kericho Tea Secondary School	10	13	18	Assumed Data - Records not provided
Kericho Boys Boarding School	20	27	36	Assumed Data - Records not provided
Other Large Users	500	672	903	Assume other large commercial/industrial/municipal users.
TOTAL Large User Water Consumption	1,164	1,564	2,101	

Notes:

* Kericho Water Supply records may be inaccurate due to unknown meter age/condition.

** Future and Ultimate year projections assume growth of 3% per anum, equivalent to expected town population growth rate.

Kericho Total Water Consumption Projections

	Initial (2005)*** m^3/d	Future (2015)**** m^3/d	Ultimate (2025) m^3/d
Total Domestic Water Consumption	6,709	11,183	16,598
Total Large User Water Consumption	1,164	1,564	2,101
TOTAL Water Consumption	7,873	12,746	18,700

Notes:

*** Actual present water production is approximately 7,300 m^3/d. Water sold (consumption) is presently 3,660 m^3/d.

**** It is expected that by 2015 the Kegati Water Treatment works will be capable of producing 12,960 m^3/d. UfW is assumed to be 25% by 2015. Therefore, the entire projected water demand may not be met in 2015.

Kericho Wastewater Flows From Large Users Projections

	Initial (2005)** m^3/d	Future (2015)** m^3/d	Ultimate (2025)** m^3/d	Notes
KETEPA*		180	242	Assume 60% of water use due to process water use.
District Hospital	73	98	132	
Kericho High School*		91	122	
Tea Hotel	57	57	57	Assume no expansion of Tea Hotel.
Kipsigis Girls School*		38	51	
Gotab Sanik*		19	26	
Kericho Teacher's College*		16	16	Assume no expansion of Teacher's College.
G.K. Prison	15	21	28	
Sunshine Hotel	9	13	17	
Milimani Primary School*		9	12	
Highlands Bible College*		22	29	
Kericho Primary School*		11	14	
Kericho Tea Secondayr School*		11	14	
Kericho Boys Boarding School*		22	29	
Other Large Users*		67	90	Assume Other Large Water Users contribution small.
TOTAL Large User Wastewater Flow	155	673	879	

Notes:

* Not currently connected to Kericho sewer system.

** Flow calculations assume 80% of water use converted to wastewater (per WHO Report #9) except where noted and that all above facilities are connected to wastewater system. Kericho Water Supply records may be inaccurate due to unknown meter age/condition.

Kericho Total Wastewater Flow Projections

	Initial (2005)*** m^3/d	Future (2015) m^3/d	Ultimate (2025) m^3/d
Total DomesticWastewater Flow	512	1,214	2,272
Total Large User Wastewater Flow	155	673	879
TOTAL Wastewater Flow	667	1,886	3,151

***Actual flow received at treatment plant was 501 m^3/d based on 2004/2005 KEWASCO records.

APPENDIX 5-2

Kericho Detailed Projects, Phasing, and Cost Estimation Matrix

KERICHO

Recommended Immediate KEWASCO Actions

Recommended Projects and Preliminary Cost Estimates

Ph	NO.	YR STRT	YR FIN	TYPE	SUMMARY TITLE	OBSERVED PROBLEM / NEED	PROPOSED SOLUTION(S)	NOTES	UNITS	QUAN.	EST. UNIT PRICE (USD)	EST. COST (USD)	COST NOTES	EST. CATEGORY COST (USD)
						WATER	WASTEWATER	1 USD =	70	Kshs				
						WATER & WASTEWATER								
						NOTES / UNUSED								
				IMMEDIATE WATER PROJECTS / ACTIONS (Within ~1 Year)										
IW				MANAGEMENT										$ 800,000
IW	IW-1	2007	2007	MANAGEM	**Mapping**	No current mapping exists for Kericho. Most recent available Survey of Kenya map > 30 years old. More recent system maps and development plans are available (1980s). Detailed mapping and population density and land use identification important for planning system expansion, supply augmentation, public water kiosks, public toilets, watershed protection, and other tasks.	Obtain satellite imagery and prepare GIS mapping similar to that being done for Migori and Kisii by UN-Habitat and the Regional Center for Mapping and Development. Layers should include: existing land use; streets; neighborhoods; population density; water system features including intakes, treatment facilities, piping network, and storage facilities; wastewater collection system piping and treatment facility; water kiosks; public toilets; bulk water meters. All water and wastewater systems included in system inventory should be included in mapping.	Kisii UN-Habitat Study includes $137,000 for aerial photographs, creation of a physical plan, and layout plans of water, wastewater, and drainage systems. Add $10,000 for staff training in GIS software, round up.	Sum	1	$ 150,000	$ 150,000	Engineering estimate.	
IW	IW-2	2007	2007	MANAGEM	**Bulk Water Meters**	Bulk meters are required to quantify UfW, assess system integrity, and reduce water losses. Current UfW is estimated at ~50%. Nine bulk meters exist in the system (six reported working, three without counter). A map provided by KEWASCO shows no master meters in southwest portion of system. It is unclear if master meters are being used effectively for UfW assessment.	Repair non-working bulk meters, add additional bulk meters as needed at strategic locations throughout distribution network. Calibrate master meters at both treatment plants. Assume all nine master meters will need replacement and upgrading to uniform technology, plus addition of four more. Data Evaluation included in water audit.	KEWASCO's 12/10/06 comments note we should include 8 meters. Assume 13 to allow for sufficient number of bulk meters.	Sum	1	$ 30,000	$ 30,000	UN Kisii Report 6" meter cost $1,370. Assume 13 meters at 15K each (includes ~$100 installation), plus 35% consultancy / contingency. Round up.	
IW	IW-3	2007	2007	MANAGEM	**Consumer Water Meters, Pilot Program**	According to KEWASCO, ~75% of existing consumer meters are over 10 years old and many are over 40 years old. KEWASCO estimates ~4,000 meters probably need replacement. Existing meters may be under-recording water usage, which could increase UfW and decrease revenue. Need to increase revenue through accurate billing and collections.	Implement water meter pilot program to evaluate automatic meter reading (AMR) technology and gather data to assess expected UfW and estimate increased revenue from large scale meter replacement program. Program should include 400 new AMR meters (~5% of total). Replace meters for 100 largest consumers, plus all meters in each of three "routes" (each route includes ~100 meters) to assess remote reading metering technology effectiveness. Remote reading system may be hand-held or drive-by units. Data evaluation included in Water Audit.	KEWASCO's 12/10/06 comments suggested replacing all meters in one route.	Sum	1	$ 150,000	$ 150,000	Standard consumer meter cost estimates vary from $40 to $100. In U.S., remote reading meters cost ~$160, install cost ~$100. Assume Kenyan install cost less than half U.S. cost, therefore assume complete cost per installation ~$200. Assume $30,000 for hardware/software/training plus 35% for consultancy (technology selection, neighborhood selection, bidding, evaluation of results) and contingency.	
IW	IW-4	2007	2007	MANAGEM	**System Inventory, Asset Management Plan**	An accurate water and wastewater system inventory is required before meaningful planning can be accomplished. The inventory will be important for almost all future work including O&M plans, infrastructure planning, mapping, tariff analysis, staffing planning, accounting and other activities An inventory is the first step towards creating an asset management plan. Once the inventory is created, assets should be valued and prioritized into an asset management plan for future rehabilitation, replacement, or upgrade. Specific distribution system component requirements will be analyzed in system improvement plan included separately.	Develop water and wastewater system inventories and asset management plans. Utilize toolkit proposed to be created by LVSWSB. Inventory should include major equipment, piping, tanks, and treatment systems. Available data such as age, expected useful life, condition, service history, and nameplate data should be included. Financial value of assets and list of depreciated assets should be included. Develop or use available standard forms, or purchase and customize available software (recommended) to create inventories and convert to an asset management plan by prioritizing assets and estimating future needs and costs. Priority should be given to critical infrastructure at or past the end of its useful life.		Sum	1	$ 30,000	$ 30,000	Engineering estimate.	
IW	IW-5	2007	2007	MANAGEM	**Illegal Connections**	Number of existing illegal connections is unknown. Revenue and water losses from illegal connections may be significant.	Implement comprehensive program to investigate and register and meter illegal connections. Couple with leak detection and repair program. If any registered but "non-active" customers are drawing water from the system, register and meter the connections. Utilize proposed LVSWSB toolkit and model by-law for handling illegal connections. KEWASCO has noted that illegal connections are not a significant problem in Kericho. However, a structured program should be developed to quantify and address the issue including public education and bylaw enforcement.	KEWASCO already has a 'UfW Section' responsible for investigating illegal connections, etc.. See info provided by KEWASCO during Aug 2006 visit.	Sum	1	$ 20,000	$ 20,000	Most tasks to be accomplished with existing staff and existing operations budget. Allowance included for consultation to develop structured program for dealing with illegal connections including bylaw development, media campaign, public education.	
IW	IW-6	2007	2008	MANAGEM	**Water Audit**	A detailed understanding of the source of water losses in the distribution system does not exist. A water audit will identify inadequacies and assist in prioritizing improvements.	Perform system-wide water audit to determine UfW sources and identify problem areas. Compile and analyze data gathered from installation of bulk meters; compare flows from new bulk and consumer meters to previous flows, estimate increased revenues from expanded metering program. Evaluate losses in raw water mains and treatment facilities including elevated tank at Timbilil WTP (known to leak at expansion joints). Evaluate record-keeping practices to determine possible UfW in accounting. Full audit only possible after installation of master and consumer meters, weir at intake.		Sum	1	$ 20,000	$ 20,000	Engineering estimate.	
IW	IW-7	2007	2007	MANAGEM	**Preventative Maintenance Plan**	In order to maximize equipment lifespan and operating efficiency, KEWASCO should document preventative maintenance plans for water and wastewater facilities, follow the plans closely, and be vigilant about recording maintenance histories for equipment.	Develop preventative maintenance plan and maintenance tracking system, including all inventory components. Utilize toolkit proposed to be created by LVSWSB. The system may incorporate traditional maintenance card techniques, "out-of-the box" software, or customized software. Software packages are now readily available to schedule and track all required preventative maintenance and are recommended.		Sum	1	$ 20,000	$ 20,000	Engineering estimate.	

Pri	NO.	YR STRT	YR FIN	TYPE	SUMMARY TITLE	OBSERVED PROBLEM / NEED	PROPOSED SOLUTION(S)	NOTES	UNITS	QUAN.	EST. UNIT PRICE (USD)	EST. COST (USD)	COST NOTES	EST. CATEGORY COST (USD)
IW	IW-8	2007	2007	MANAGEM	**Staffing Planning**	KEWASCO is currently over-staffed. Staff is being reduced through attrition.	Review water and wastewater staffing levels and continue staff reductions. Conduct staff rationalization study by an external Human Resources consultant. Study should include organizational chart development, task analysis, determination of staffing requirements, creation of job descriptions, and implementation plan for staffing changes.		Sum	1	$ 15,000	$ 15,000	Engineering estimate.	
IW	IW-9	2007	2007	MANAGEM	**Tariffs Analysis**	KEWASCO currently uses a modified version of national tariff rates. Rates are lower than national standard. Current tariff structure causes KEWASCO to operate at a loss and the company does not have reserve funds for new capital projects. The company has no existing debt service.	Conduct detailed analysis of current tariff structure in conjunction with proposed new projects and costs from asset management plan. Utilize toolkit proposed to be developed by LVSWSB. Include consultation and participation of stakeholders. Revise tariff structures so revenues cover all operational expenses and generate additional funds for capital improvements, equipment, meter replacements, planning, etc.. Proposed tariffs should not be arbitrary. Tariffs should be based on real data, reasonable projections, and a transparent methodology.	KEWASCO drafted a proposal for new tariffs in late August 2006 and it is currently under review by WSRB. Version provided to Project Team during August 2006 visit appeared to include an arbitrary 50% increase in rates.	Sum	1	$ 20,000	$ 20,000	Engineering estimate.	
IW	IW-10	2007	2008	MANAGEM	**Watershed Protection Program**	Although the main water source is located within the Mau Forest and is protected, some encroachment in this and the Kimugung River watershed exists and should be managed.	Implement program to monitor and restrict development within the water source watersheds and work to implement BMPs for farming to reduce source water contamination and encroachment. Utilize toolkit proposed to be developed by LVSWSB. Include public education of residents in watershed. Special focus should be on removing squatters, reducing erosion/development, and implementing farming BMPs within. Purchasing land may be required to protect watershed. Will require cooperation with other town departments, agricultural and public health officials, and local politicians.		Sum	1	$ 50,000	$ 50,000	Engineering estimate.	
IW	IW-11	2007	2008	MANAGEM	**Public Education Program**	No public education program currently exists at KEWASCO. An informed customer base is vital in effectively protecting public health, gamering support for local projects, and ensuring successful project implementation. KEWASCO should develop a public education program.	Implement program to inform residents about the importance of water conservation, water quality, source protection, sanitation, and potential resultant financial savings. Utilize public education toolkit proposed to be developed at LVSWSB. Couple latrine rehabilitation and construction with public education program for both public and private facilities. Work with local environmental and health groups on public education programs. Begin school programs addressing water, water conservation, health and hygiene. Consider publishing and distributing annual informational reports to customers similar to Consumer Confidence Reporting in U.S. for educating customers about water and watershed protection. Designate staff responsible for public education and public relations including informing customers of any expected service disruptions and handling complaints.	Public should be informed regarding importance of clean water and sanitation, especially health impacts. Promotion of water conservation and installation of water-saving devices in homes could save additional water, allowing Kericho to serve additional customers and extending time before additional supplies are needed. Many homes are expected to have wells and pit latrines co-located. Need to begin to make health-based and economic case for public water and wastewater services.	Sum	1	$ 50,000	$ 50,000	Engineering Estimate. UN-Habitat included $70,000 in immediate activities for this task in Ktsii.	
IW	IW-12	2007	2007	MANAGEM	**Commercialization / Entrepreneurship Opportunities**	Need for additional income-generating activities and reduced demands on KEWASCO staff.	Consider commercialization of water kiosks and latrines/public toilets; private operation of KEWASCO-owned exhauster truck(s) or Vacutug; Compost production and distribution; Utilize sludge at one of several existing or possible new seedling nurseries at existing plant; algae harvesting from lagoons; irrigated sugar cane/bamboo/other; aquaculture with WWTF effluent. Consider market for biogas from digesters.		Sum	1	$ 10,000	$ 10,000	Engineering Estimate.	
IW	IW-13	2007	2007	MANAGEM	**Regionalization**	Economies of Scale may be attained by regionalization.	KEWASCO should investigate becoming part of Kisumu-based programs including training, equipment repair/rehab, spare parts, chemical procurement, bulk purchases incl. water meters, leak detection equipment, purchasing in-home water saving devices, water bowser, public education, etc..		Sum	1	$ 10,000	$ 10,000	Engineering Estimate.	
IW	IW-14	2007	2007	MANAGEM	**Training / Certification for Kiosk Operators, Public Toilet Operators**	Kiosk operators and public toilet operators require training in financial management and operation of the stations to protect public health. According to KEWASCO, there are very few water vendors.	Develop and implement kiosk and public toilet operator training and certification program.		Sum	1	$ 10,000	$ 10,000	Engineering Estimate.	
IW	IW-15	2007	2007	MANAGEM	**Office Furniture, Office Space**	Existing offices contain old chairs, small rooms and makeshift work areas. Ventilation is inadequate. Offices require immediate equipment upgrades. KEWASCO will require eventually require new offices.	Purchase office chairs, desks, faxes, copiers, computers/printers, filing cabinets, lockable drawers for plumbing tools, safe for cash. Begin planning for new offices at existing office location or new location.		Sum	1	$ 20,000	$ 20,000	Information on needs provided by KEWASCO August 2006. Estimate assorted office furniture, cabinets @ $5,000; 2 computers with printers @ $1,500 ea.; copier / fax @ $2,500, safe $1,000; assume assorted other needs ~$3,000; Assume $5,000 to determine future office space needs and begin planning; round up.	
IW	IW-16	2007	2007	MANAGEM	**Vehicles**	Staff in need of transportation.	Purchase three trucks, 10 motor cycles, 1 executive vehicle.		Sum	1	$ 190,000	$ 190,000	Based on KEWASCO suggestion, assume 3 4WD pickup trucks @ $30,000, 10 motorcycles @ $5,000, 1 executive vehicle @ $20,000.	
IW				SOURCE										$ 50,000
IW	IW-17	N/A	N/A	SOURCE	**Timbilil Intake - Siltation**	Siltation and plant growth at existing stilling basin.	Perform regular manual de-silting as needed. Dam will likely be selected option, which will obviate need for de-silting intake.	Staff currently performs this task annually, which takes 24 person-days (3 days w/ 8 staff)	N/A	1	$ -	$ -	Assume can be accomplished with existing staff.	
IW	IW-18	2007	2007	SOURCE	**Timbilil Raw Water Main - Bulk Metering**	The raw water main consists of 6,363 m 450-mm pipeline and 8,532 m 350-mm pipeline. Water losses along the pipeline may be significant and should be evaluated.	The intake at Timbilil WTP is equipped with a 54 degree V-notch weir for incoming flow monitoring. A similar measuring device should be installed at the river intake to measure flow and compare with flow reaching Timbilil WTP.	Pipeline and weir data from "Kericho Water Supply Timbilil Scheme - Phase 1 O&M Manual"	Sum	1	$ 5,000	$ 5,000	Engineering estimate.	

[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	Source Augmentation Feasibility	Involved design and service cost expected. All future WTP expansion is short term and source augmentation is long term or better. Although existing raw water rate and proposed expanded treatment facility should meet expected demand through 2070, storage and/or source augmentation may be required earlier due to seasonal flow variations in Tindall River. A dam and reservoir expected to be required to store wet weather flows for dry season. Increased use of Tindall River or additional sources will be required to meet expected long term demands.	Conduct updated comparative study of the three identified options for source augmentation (Tindall Dam, Storage WTP expansion/upgrade, Storage raw water pipeline) and estimate costs. Clearly define of existing PPWS and define permitting requirements and time frame required for construction of selected option. Include consideration of hydropower (including hydraulic ram) for pumping in expanded service areas or for sale to grid. Include consideration of expedited situation of reservoir.	Based on available information and opinion of SDWA&SCO, it appears Tindall Dam will emerge as best option, due to proximation of Tindall source and substantial operation and maintenance advantages of all-gravity system. Copy of drilling permit provided by SDWA&SCO in Aug 2008 - appears to have lapsed ~18 years ago.	Sum	1	1	40,000	1	40,000	Engineering estimate based on Tindall application planning and source augmentation study. Split into two separate actions.	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
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Ph	NO.	YR STRT	YR FIN	TYPE	SUMMARY TITLE	OBSERVED PROBLEM / NEED	PROPOSED SOLUTION(S)	NOTES	UNITS	QUAN.	EST. UNIT PRICE (USD)	EST. COST (USD)	COST NOTES	EST. CATEGORY COST (USD)
IW	IW-20	2007	2008	TREATME	**WTP Upgrade / Expansion Planning**	The existing Timbilil WTP is producing 7,300 m3/d, maximum capacity 8,640 m3/d. The treatment works were designed to allow a 50% increase in capacity (4,320 m3/d increase) to 12,960 m3/d using land available on-site. 12,960 m3/d is sufficient to meet expected demand through ~2015, especially if UfW is reduced. Sufficient capacity exists in raw water main to accommodate this flow, although existing impoundment at intake on Timbilil River is not sufficient to provide this flow in dry season. Kimugu WTP supplements flow during dry months (Dec-Feb) and produces up to 2,500 m3/d. It is in need of upgrades to ensure facility operates at least until Timbilil WTP expanded and source augmented.	Conduct study for upgrading and expansion work at Timbilil and Kimugu WTP, with main focus should on Timbilil WTP. Estimate costs, determine permitting requirements, develop preliminary design. Include evaluation of present backwash water discharge at Timbilil and explore provisions for treatment. Include recommendations for laboratory upgrade and new equipment. Review HP Gauff 1993 Final Design Report recommendations for facility upgrades and incorporate into recommendations as appropriate.	KEWASCO does not have project costs for original Timbilil Plant, nor estimates for expansion.	Sum	1	$ 40,000	$ 40,000	Engineering estimate $80,000 for Timbilil expansion planning and source augmentation study. Split into two separate studies.	
IW				TREATME	**Timbilil WTP - Evaluate Environmental Impact from Chemical discharge**	**Backwash water is discharged directly to a nearby stream, causing water pollution. Discharge 302 out of 365 days/ year. Avg daily discharge is 302 days is 76 m3/day**	**Composition of backwash water unknown. Begin by testing backwash water to determine composition and analyzing at Kisumu LVSWSB lab. Begin planning for backwash water / sludge treatment as part of Timbilil WTP expansion. Town had considered buying land below WTP for backwash discharge treatment.**	**Based on data provided during Aug 2006 mtgs with KEWASCO.**						
IW	IW-21	2007	2008	TREATME	**Timbilil WTP - Lab facilities**	Upgrades to lab facilities at Timbilil water treatment facility required. Existing equipment is very limited although lab space exists.	Install laboratory facilities to take basic daily measurements. Currently only pH, turbidity, and residual chlorine are done locally. Coordinate with WWTF lab facilities upgrade to avoid excessive overlap.		Sum	1	$ 25,000	$ 25,000	KEWASCO 12/10/06 comments note $25,000 required for water lab, $25,000 for wastewater lab.	
IW				DISTRIBUTION										$ 180,000
IW	IW-22	2007	2008	DISTRIBU	**Hydraulic Model, Distribution System Improvement Plan**	KEWASCO should develop and begin to implement a prioritized plan for distribution system improvements, with focus on replacing older water mains.	Review water audit results and system inventory / asset management plan. Create hydraulic computer model of system if sufficient data available, making use of previous modeling work done by HP Gauff in 1985. Develop a prioritized plan for distribution system improvements. Utilize mapping created under mapping task.		Sum	1	$ 40,000	$ 40,000	Engineering estimate.	
IW	IW-23	2007	2008	DISTRIBU	**Leak Detection and Repair**	As noted in its annual report, KEWASCO has been "putting concerted efforts to identify leakages and bursts and attending to them promptly". However, UfW is still high (approximately 50%).	Develop and perform System-Wide Leak Detection and Repair program. Expect to utilize LVSWSB-owned and operated leak detection equipment. Program should initially focus on any known leaks (such as stream crossings noted by KEWASCO), then key water mains. Program should be coupled with investigating and registering / removing illegal connections. Some pipes may require replacement instead of repair and should be included in the distribution system improvements plan.		Sum	1	$ 130,000	$ 130,000	Assume $30,000 for 'rental' of circuit rider leak detection equipment and operator from LVSWSB for leak detection study; $100,000 to repair leaks. Actual cost will depend on number of leaks found. Expect initial cost to be part of capital funding program, but future leak detection and repair to be covered by operation budget.	
IW	IW-24	2007	2007	DISTRIBU	**Public Water Kiosks Inventory / Rehabilitation / Commercialization**	Kiosks are identified on map provided during August 2006 visit (11 shown, 5 reported active). Where advisable, existing kiosks should be rehabilitated and prices fixed in accordance with proposed kiosk management toolkit to be developed by LVSWSB. Fee and time of operation should be posted. Kiosks should be commercialized and operators trained. Water is needed in informal settlements, markets, and other areas to prevent exploitation by water vendors and associated health impacts. KEWASCO noted kiosks infrequently used because private connections generally available and others utilize rainwater harvesting or nearby streame.	Utilize Kiosk and Public Toilet Toolkit (proposed to be created by LVSWSB) to create plan for building, managing, and maintaining kiosks. Inventory all water kiosks including information on location, condition, present water production, present operator, and fees charged. Include training for kiosk operators. Water quality sampling should also be performed and recorded. Utilize mapping for optimal location of kiosks. Where required, kiosks should be rehabilitated to include security, lighting, and metering. Kiosks should be commercialized including fixing price and training for operators. Emphasis of kiosks should be in informal settlements with dense population, not rural areas with available clean water.	Kiosks identified on map provided during August 2006 visit. Gather additional data on existing kiosks in anticipation of rehabilitation and commercialization. Collected data should include name, location, condition, present water production, present operator, and fees charged. Digital photos should be taken and cataloged if possible.	Sum	1	$ 10,000	$ 10,000	Engineering estimate.	
				SUBTOTAL										$ 1,100,000
				SHORT TERM WATER PROJECTS (2008-2015)										
SW				MANAGEMENT										$ 950,000
SW	SW-1	2008	2010	MANAGEM	**Watershed Protection Land Purchase**	Source waters require continued and increased protection to prevent contamination due to development pressure/encroachment.	Purchase land required for source water protection.		Sum	1	$ 100,000	$ 100,000	Engineering estimate.	
SW	SW-2	2010	2010	MANAGEM	**New Offices**	**A new office block will eventually be required for KEWASCO.**	**Purchase office space or construct new offices at existing location as recommended by planning study .**		**Sum**	**1**	**$ 250,000**	**$ 250,000**	**Engineering estimate.**	
SW	SW-3	2008	2012	MANAGEM	**Consumer Water Meters**	According to KEWASCO, ~75% of existing consumer meters are over 10 years old and many are over 40 years old. KEWASCO estimates ~4,000 meters probably need replacement. Existing meters may be under-recording water usage, which could increase UfW and decrease revenue. Need to increase revenue through accurate billing and collections.	Replace / Install 6,000 consumer meters for existing active registered consumers and non-active registered customers. Total active connections is 5,259 - assume 4,000 need replacement based on KEWASCO estimation. Total registered, non-active customers ~2,600. Assume re-activate and install meters at ~2,000 locations. Type of meter installed (and cost) will depend on results of water meter pilot program.		ea.	6,000	$ 100	$ 600,000	Estimates vary from $40 to $100. UN Kisii Report uses $100, which includes allowance for installation fittings. Note actual cost will depend on type of meter selected.	
SW				SOURCE										$ 8,260,000
SW	SW-4	2008	2010	SOURCE	**Additional Water Supply Planning / Permitting / Design for Chosen Additional Water Source**	Time required for planning, permitting, and design activities for water source augmentation is expected to be on the order of years, especially for dam option. KEWASCO should begin this process as soon as the selected option is chosen.	Identify all permitting, design, and data collection efforts required for preferred alternative for water source augmentation and raw water pipeline. Collect required data, file permits, prepare initial design as required.		Sum	1	$ 60,000	$ 60,000	Engineering estimate.	

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SW	SW-5	2010	2013	SOURCE	**Construct Timbilil Dam, Reservoir**	Existing impoundment and intake on Timbilil River is not sufficient to provide sufficient flow throughout year. Dam and reservoir required to store water during wet season for use in dry season.	Complete final design, construct dam, reservoir, and associated appurtenances on Timbilil River. Construct raw water main from reservoir to existing raw water main at present impoundment as required.		Sum	1	$ 5,000,000	$ 5,000,000	1983 HP Gauff estimated cost of Timbilil Dam / Reservoir at 17.1 Million Kshs (Sec 5.01; 1983 Cost); updated 2005 cost is 177 Million Kshs (2.5 Million USD), add 35% engineering and contingency, arrive at 3.4 million USD. The 1998 JICA Aftercare Study estimated dam cost (on Kimungung, not Timbilil) to be $11,849,000 USD (Table 5.3.1, 1998 Cost) or 22 million USD in 2005 dollars - very high. A 2001 Kisii Report document (no author listed) estimated the cost of a Dam at Bunyuyu in Kisii at $5 Million USD. Assume 5 Million USD is reasonable estimate at this stage for planning purposes.	
SW	SW-6	2010	2013	SOURCE	**Construct New Raw Water Main**	Additional raw water main capacity will be required after present 150 l/s (12,960 m3/d) capacity exceeded, expected sometime around 2015.	Design and construct second raw water main from intake to WTP. Assume adjacent to existing main.		m	16,000	$ 200	$ 3,200,000	KEWASCO does not know cost of existing raw water main. HP Gauff estimate in 1983 was 15.3 Million Kshs. 1983 KCECI 374.4, 2005 KCECI 3883, therefore 2005 cost is 159 Million Kshs or 2.2 Million USD. Add 35% eng, cont., round up, cost ~$3 Million USD. However, CAPE suggests $200 / m to allow for stream crossings, chambers etc..	
SW				TREATMENT										$ 1,960,000
SW	SW-7	2008	2009	TREATME	**Timbilil WTP - Upgrade**	Improvements described in HP Gauff 1993 Final Design Report were not implemented including backwash water pumps, air blowers, chemical stirrers, chemical delivery pipework and hydroturbine improvements.	Implement recommended improvements from HP Gauff 1993 Final Design Report.		Sum	1	$ 200,000	$ 200,000	HP Gauff 1993 Final Design Report, pg 13, updated to 2005, add 35% engineering and contingency. Add additional $60,000 (engineering estimate) for backwash water treatment. Round up.	
SW	SW-8	2009	2010	TREATME	**Timbilil WTP - Expansion**	Demand will increase beyond present capacity within several years. Treatment plant capacity should be increased by 50% as planned in original design to achieve total capacity of 12,960 m3/d using land available on-site. If possible, a larger addition should be made on the existing land.	Design and construct expansion of Timbilil WTP by 4,320 m3/d as allowed in design, or greater if possible. The capacity of the expanded facility is expected to be sufficient to meet demand through ~2015. However, delivering 12,960 m3/d raw water to the plant will not be possible in all seasons with existing Timbilil impoundment and continued reliance on Kimugu WTP will be required until source augmentation (i.e. dam) is complete.	KEWASCO does not have project costs for original Timbilil Plant, nor estimates for expansion. Number of people served assumes 75 lpcd and 40% UfW.	Sum	1	$ 1,400,000	$ 1,400,000	1998 Aftercare Study Fig 5.3.3 cost, update to 2005 cost, add 15% eng and conting (not 35% because addition, not new), round up.	
SW	SW-9	2008	2009	TREATME	**Kimugu WTP - Upgrade**	Expect improvements will be required at Kimugu treatment works in short term to enable this facility to continue to serve as backup (especially during dry season) until Timbilil WTP expansion and source augmentation completed.	Misc. repairs and upgrades at Kimugu WTP		Sum	1	$ 200,000	$ 200,000	Engineering estimate.	
SW	SW-10	2014	2015	TREATME	**New WTP, Raw Water Main Planning / Permitting / Design / Land**	Existing Timbilil treatment works capacity of 12,960 m3/d expected to suffice until ~2015, depending on a number of factors including UfW reduction and increases in demand. However, additional treatment capacity expected to be required by 2015.	Identify location for future treatment facility and begin planning for second raw water main from chosen new source. Plan, design, permit, purchase land.		Sum	1	$ 160,000	$ 160,000	Engineering estimate. Assume $60,000 for planning, permitting, design. KEWASCO estimates market value of land Kshs 1.75 million / Ha. Assume ~4 Ha (~10 ac), add $100,000 for land.	
SW				DISTRIBUTION										$ 1,900,000
SW	SW-11	2008	2015	DISTRIBU	**New Water Service Connections**	Additional water service connections will be required to keep pace with growth.	Install new water service connections.		ea.	3,800	$ 500	$ 1,900,000	Assume $500/connection. Includes branch main installation cost of ~$400 per connection plus ~$100 for meter. Kericho has ~92 km dist piping and 7,867 registered connections. Therefore ~12 m main / connection * main installation cost of $35/m (cost ~$20-40 / m for 100 to 200 mm pipe).	
				SUBTOTAL										**$ 13,070,000**
				LONG TERM WATER PROJECTS (2016-2025)										
LW				MANAGEMENT										$ -
LW				SOURCE										$ -
LW				TREATMENT										$ 1,900,000
LW	LW-1	2016	2017	TREATME	**Construct New Treatment Facility**	Additional treatment capacity expected to be required within 20 years, assuming Timbilil WTP expanded to full capacity and no increases in capacity at Kimugu WTP are made. Facility likely to be needed sometime around 2015.	Design and construct new treatment facility with ~6,000 m3/d capacity and capacity for expansion. Land available on site adjacent to existing Timbilil WTP.		Sum	1	$ 1,900,000	$ 1,900,000	1998 Aftercare Study Fig 5.3.3, update to 2005, add 35% engineering and contingency, round up.	
LW				DISTRIBUTION										$ 3,400,000
LW	LW-2	2016	2020	DISTRIBU	**System Expansion - Ngecherok**	Ngecherok is located northwest of the existing Kericho distribution network off the B1 road and is presently served by an independent water provider.	Construct Pump Station near intersection of E222 road and road to Telanet to pump to an existing tank in Telanet. Proposed pump station is at elevation ~2020 m, tank ground el. at ~2040 m. Horizontal distance ~4,500 m.		Sum	1	$ 500,000	$ 500,000	Assume 2,000 people, 10 persons / connection @ $500/connection, plus $200,000 for tank and pump station, plus $35/m for pipeline to tank; round up. Present demand and extent of coverage unknown.	
LW	LW-3	2016	2020	DISTRIBU	**System Expansion - Kapcheptoror**	Kapcheptoror area northwest of Timbilil WTP is proposed to be served. Consists of ~10 km2 with small scale agriculture, 2 secondary schools, 4 primary schools, 300 homesteads with ~2,000 people. Assuming 100 lpcd, demand is 240 m3/d.	Expand service to area northwest of Timbilil by constructing water mains, pumps, and elevated storage tank at location already acquired by KEWASCO.		Sum	1	$ 500,000	$ 500,000	Assume 2,000 people, 10 persons / connection @ $500 / connection, ~5,000 m water main @ $35/m, plus $200,000 for tank, pump station, round up.	

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LW	LW-4	N/A	N/A	DISTRIBUT	**System Expansion - Chelimo Residential Estate**	Proposed development with housing and shopping center proposed for south side of Kimugung River near Kimugu WTP.	Expand service across river to serve new development. Will require water mains and storage facilities. Schedule for the development of this area is unclear. Housing proposed for over 1,000 people - need to confirm this number and whether or not development will move forward.		Sum	1	$ 500,000	$ 500,000	Assume 1,000 people, 10 persons / connection @ $500 / connection, ~5,000 m water main @ $35/m, plus $200,000 for tank, pump station, round up.	
LW	LW-5	2016	2025	DISTRIBUT	**New Water Service Connections - Other Areas**	Additional water service connections will be required to keep pace with growth.	Install water service connections.		ea.	3,800	$ 500	$ 1,900,000	Assume $500/connection. Includes branch main installation cost of ~$400 per connection plus ~$100 for meter. Kericho has ~92 km dist piping and 7,867 registered connections. Therefore ~12 m main / connection * main installation cost of $35/m (cost ~$20-40/m for 100 to 200 mm pipe).	
				SUBTOTAL										$ 5,300,000
				IMMEDIATE WASTEWATER PROJECTS / ACTIONS (within ~1 year)										
IWW				**MANAGEMENT**										$ 20,000
IWW	IWW-1	N/A	N/A	MANAGEM	**Large Water Users / Wastewater Generator Discussions**	Some existing large water users currently rely on their own water sources and on-site wastewater treatment/disposal. Existing treatment may be poor and these could represent important customers.	Identify and begin discussions / negotiations with any large water users not connected to sewer system regarding incentives to connect them to sewer.	Large water users not connected to WWTP (list compiled by KEWASCO Aug 06) include Kericho Teachers Training College, Kericho Primary School, Kericho Tea Secondary School, Kericho Boys Boarding School, Kericho High School, Kericho Bible College, Milimani Academy, and Kericho Green Stadium. Also should include all hospitals and clinics; CBD; existing latrines @ markets, near sewers; slaughterhouse near treatment plant; all schools; all public buildings; sports stedium; Tea Hotel.	N/A					
IWW	IWW-2	2007	2008	MANAGEM	**On-Site Wastewater Management**	Many on-site wastewater systems (latrines, septic systems, tight tanks, etc..) are expected to be failing and represent an acute public health hazard and a public nuisance. Failing on-site systems contaminate local public and private groundwater and surface water supplies. On-site systems can adequately protect public health and are often more cost effective than public sewers. However, these systems must be appropriately designed and maintained in order to protect public health.	Develop on-site wastewater system inventory, tracking system, and program for mandatory periodic inspections and pump-outs including model by-laws. Utilize toolkit proposed to be developed at LVSWSB. The system should be integrated with electronic mapping systems to the extent feasible. "Off-the-shelf" software programs may be used, but should be customized for local conditions. The system should include provisions for management of private septage haulers including a manifest system and requiring discharge only at approved facilities.		Sum	1	$ 20,000	$ 20,000	Engineering estimate.	
IWW				**COLLECTION**										$ 160,000
IWW	IWW-3	2007	2008	COLLECTI	**Wastewater Collection System Expansion Planning**	Four areas have been identified for sewer system expansion. Each should be considered in turn and plans should be made to prioritize expansion and determine if sewer capacity is sufficient to accommodate increased flows. Need for new or relocated sewer pumping station, septage hauling equipment, and sewer cleaning equipment should also be examined. Note existing WWTF el. ~1940 m, most of Town between 1960 and 2000 m. Most wastewater conveyance may be accomplished by gravity.	Conduct planning study to refine proposed sewer expansion areas and future sewer facilities and equipment needs. Area 1: E. bank of Dionsoyiet River, between river and CBD, including stadium. Area 2: W.bank Dionsoyiet River, including inf. Settlement, college, school, KCC dairy. May require new river crossing or could connect via existing crossing. Area 3: Between B1 and Kimugung River, behind Tea Hotel down to main intersection. Note Area 3 currently being connected via new gravity sewer along 2nd contour south of B1, expect completion 2008. Area 4: Northeast section of town incl. Kapkugerwet market and tea worker residences. Expansion Areas 1 and 2 likely will need pumping, as may some localized areas. Proper design should be able to serve development along B1 to Tea Hotel by gravity. Kapkugerwet market and tea worker housing may be served by existing plant, but may be best routed to proposed alternate site. If a pump station is chosen for Areas 3 and 4, it may be located in vicinity of golf course.	See Aug 2006 notes and KEWASCO answers to questions. Obtained consensus on existing and future expansion areas, more or less the areas we identified, with some changes. During November 2006 visit, it was noted that WSP provides skilled labor while city/customers provides manual labor.	Sum	1	$ 40,000	$ 40,000	Engineering estimate.	
IWW	IWW-5	2007	2007	COLLECTI	**Sewer Connections Infill Priority List**	Existing WWTF capacity 990 m3/d, but average flow only 500 m3/d (maximum month 2005 treated 720 m3/d). There is an apparent need to increase sewer connections by "infill". There are 1,702 sewer connections. In 2004/2005 KEWASCO added an average of about 1 sewer connection per month. Mains do not extend throughout service area, so it is costly for many residents to connect. KEWASCO provides skilled labor while customers provide pipes and manual labor for excavation.	Create four tier priority list for new connections as part of sewer expansion study. 1st tier: unconnected residents/businesses served with water and adjacent to existing sewers. 2nd tier: Unconnected residents/businesses served with water, in sewer service area, but not directly adjacent to sewer lines. 3rd-tier: Unconnected residents/businesses in sewer service area who are not served with water (but will be soon) and are adjacent to existing sewers. 4th tier : Unconnected residents/businesses in sewer service area not served with water and not adjacent to existing sewers. First priority should be given to the largest water users and any commercial/industrial facilities that might have high-strength wastewater.	Large water users not connected to WWTP (list compiled by KEWASCO Aug 06) include Kericho Teachers Training College, Kericho Primary School, Kericho Tea Secondary School, Kericho Boys Boarding School, Kericho High School, Kericho Bible College, Milimani Academy, and Kerich Green Stadium. Also should include all hospitals and clinics; CBD; existing latrines @ markets, near sewers; slaughterhouse near treatment plant; all schools; all public buildings; sports stadium; Tea Hotel.	N/A				Cost included in 'Wastewater Collection System Expansion Planning'	
IWW	IWW-6	2007	2008	COLLECTI	**Sewer Connections - 1st Tier of Infill Priority List**	Many relatively easy connections may be made immediately. Connecting additional customers will 1) eliminate on-site disposal problems, 2) "jump start" revenue collection, and 3) increase flows to the sewer system for the flushing benefits.	Using infill priority list and an incentive program, make all the easiest connections (parcels close to existing sewers) first.		ea.	50	$ 300	$ 15,000	Engineering estimate. Assume 1st tier connection cost $300, 2nd tier $400, other tiers $500.	

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IWW	IWW-7	2007	2007	COLLECTI	**Public Latrines / Toilets - Inventory, Rehab / Commerclalization Plan**	Public latrines and toilets are an important piece of wastewater management infrastructure and should be appropriately regulated, managed, maintained, and expanded. The facilities are currently operated by Kericho Municipal Council, not KEWASCO. A plan should be developed to ensure this infrastructure is safe, sustainable, and income-generating. Initial inventory provided by KEWASCO (7 pubiic facilities) in August 2006.	Thoroughly evaluate current condition, and determine requirements for bring facilities up to standards set forth in toolkit proposed to be created by LVSWSB (including signage, lighting, security, certified operator, etc..). Collected information should include location, size (number of stalls), if water flush or latrine, if water is available, security and lighting, and current condition. Facilities should be ranked based on facilities easiest to rehabilitate and most frequently used (or potential to be most frequently used once rehabilitated). Develop a plan for rehabilitation and commercialization of the facilities, using the toolkit proposed to be created by LVSWSB. Enter discussions with the Municipal Council regarding KEWASCO taking over operation, maintenance, and management of all public toilets / latrines.		Sum	1	$ 5,000	$ 5,000	Partially completed by local staff. Budget estimate for limited consultancy.	
IWW	IWW-8	2007	2008	COLLECTI	**Public Latrines / Toilets - Rehabilitate / Commerclalize**	Existing public toilets are in need of rehabilitation and should be commercialized to ensure sustainability and income generation. Facilities should be brought up to standards as set out in proposed LVSWSB toolkit.	Rehabilitate and commercialize facilities utilizing priority list and proposed LVSWSB toolkit. Commercialization should include lease agreements as appropriate. Public toilets at District Hospital should be reopened and commercialized.		nr.	7	$ 2,000	$ 14,000	UN-Habitat Kisii report estimates ~$1,700 for rehabilitation / commercialization of each unit. Round up to include limited consultancy.	
IWW	IWW-9	2007	2007	COLLECTI	**Exhausters for latrines / septic**	KEWASCO has an immediate need for new exhauster truck.	Replace existing exhauster.	UN-Habitat Kisii Report, Item 2.7.1 (b) est. for trailer mounted exhauster is ~$12,300. Low - may just be trailer. KEWASCO estimates cost at $50,000. KEWASCO provided haulage data during Aug 2006 visit. Need to develop estimates of septage quantities as function of pumping freq. to determine need for additional trucks. However, KEWASCO notes that they need to replace their existing tractor and buy two additional exhauster trucks. They acknowledge it may put some private haulers out of business. If KEWASCO implements a mandatory pumping program, they may create a market for more private haulers to go into business who can still make a profit by charging to discharge at WWTF. Assume KEWASCO will replace existing truck and also promote private trucks' integration into mandatory pumping programme.	ea.	1	$ 50,000	$ 50,000	KEWASCO 12/10/06 comments estimate exhauster truck cost $50,000.	
IWW	IWW-10	2007	2007	COLLECTI	**Sewer Flushing Equipment**	KEWASCO in need of sewer rodding, winching, jetting, swabbing, etc.. Town noted plugging of KKC sewer line. During Nov 2006 visit noted need for new rotary machine.	Purchase sewer cleaning equipment.		Sum	1	$ 25,000	$ 25,000	Engineering estimate.	
IWW	IWW-11	2007	2007	COLLECTI	**Sewer I/I Evaluation**	I/I is purported to be a problem in the sewer network according to KEWASCO 2004/2005 Annual Report and August 2006 meeting with KEWASCO. Flows at treatment facility increase during rains. Expect roof drains may be connected to sewer system.	Investigate apparent I/I problem. Do "detective work" in late night/early a.m. during rainstorm when no water being used to determine source of flow. Or use smoke testing.		Sum	1	$ 10,000	$ 10,000	To be accomplished with existing staff. Funds included for testing equipment, limited consultancy.	
IWW				TREATMENT										$ 220,000
IWW	IWW-12	2007	2008	MANAGEM	**WWTF Sampling, Lab facilities**	Lab equipment needed. Assume existing building space adequate. Limited sampling data is available. Without this information, the performance of the treatment system cannot be assessed. In 2005, effluent BOD was reduced from 43 mg/l to 30 mg/l (limit 20 mg/l). Unclear if meeting TSS limit. Sampling results are uncharacteristically consistent. Additional QA/QC is recommended.	Install laboratory facilities to take basic daily measurements, including microbiological test kits, chemical test kits, equipment for TSS, BOD, COD, pH, DO, turbidity. BOD5, pH, dissolved oxygen, temperature, and turbidity are sampled when equipment is functioning. Coordinate with WTF lab facilities upgrade to avoid excessive overlap. A program should be implemented to QA/QC check the existing influent and effluent sampling program. Begin sampling for TSS.		Sum	1	$ 25,000	$ 25,000	KEWASCO 12/10/06 comments note $25,000 required for water lab, $25,000 for wastewater lab.	
IWW	IWW-13	2007	2008	TREATME	**WWTF Aesthetic buffer**	No vegetative buffer exists at the facility.	Plant bougainvillea for odor improvement and trees to improve aesthetics.		m	600	$ 3.00	$ 1,800	Kisii UN-Habitat Report item 2.4.1 cost per meter, rounded up. Length estimated.	
IWW	IWW-14	2007	2008	TREATME	**WWTF Drying bed covers**	Covers are stained, reducing sunlight penetration.	Replace drying bed covers. KEWASCO plans to replace after 5 years to improve efficiency as noted in KEWASCO Self-Environmental Audit Report, Dec. 2005, Table 3.		m2	3,000	$ 2.00	$ 6,000	From available mapping, estimate cover area is ~3,000 m2 (two areas, one 100 x 20 m, one 50 x 20 m). Estimate $2 / m2. Round up.	
IWW	IWW-15	2007	2008	TREATME	**WWTF Trickling filter arm repair / replacement**	Trickling filter arms do not distribute flow evenly.	Repair or replace to ensure even flow distribution. Install electric motors.		ea.	2	$ 2,000	$ 4,000	Engineering estimate.	
IWW	IWW-16	2007	2008	TREATME	**WWTF Supplemental Aeration, Pilot Study**	Treatment facility currently not meeting BOD limits. Supplemental aeration in ponds could reduce effluent BOD.	Install supplemental aeration using solar aerators as pilot program.		Sum	1	$ 100,000	$ 100,000	Solar Bee estimated 15 - 40 K per unit, plus 30% for international applications. Number of units need to be determined based on further study. Assume 2 units @ 30K ea.+ 30% for international installation. Round up to include funds for consultancy, contingency.	
IWW	IWW-17	2007	2008	TREATME	**WWTF Algae Control Baffles**	No algae control baffles are installed at facility effluent resulting in potentially high algae load to receiving stream.	Install algae control baffles.		Sum	1	$ 3,000	$ 3,000	Engineering estimate.	
IWW	IWW-18	2007	2008	TREATME	**WWTF Expansion & Upgrade Options**	Existing WWTF capacity 990 m3/d, but average flow only 500 m3/d (maximum month in 2005 treated 720 m3/d). The existing treatment facility will exceed its capacity as additional connections are added and population grows.	Examine options for increasing capacity of existing treatment works. Options include new trickling filters in parallel (if space allows) or supplemental aeration of lagoons. Sampling data suggests most BOD removal occurring in trickling filters. Therefore, adding a 3rd trickling filter may increase capacity by ~ 50%. Also consider new decanting system for septage, biogas abstraction system for digesters.		Sum	1	$ 30,000	$ 30,000	Engineering estimate. Expect ~$50,000 required for studies to examine existing plant expansion and new facility needs. Split into two studies.	

Ph	NO.	YR STRT	YR FIN	TYPE	SUMMARY TITLE	OBSERVED PROBLEM / NEED	PROPOSED SOLUTION(S)	NOTES	UNITS	QUAN.	EST. UNIT PRICE (USD)	EST. COST (USD)	COST NOTES	EST. CATEGORY COST (USD)
IWW	IWW-19	2007	2008	TREATME	**New WWTF(s) - Planning, Permitting, Preliminary Design**	Capacity of existing WWTF will be exceeded with additional connections and town growth. Study is required to identify needs, location, and costs.	Determine needs for new WWTFs, possible locations, effluent discharge requirements, and estimate costs including land acquisition. A potential location for a new WWTF is a Unilever-owned site (available for purchase) with over 2 ha of land along Dionsoyiet River near transformer station at intersection of B1 and C23 Roads southwest of town center. Also consider sites further downstream if site with more favorable conditions (area, topography, soils, etc..) can be identified. Consider adding polishing wetlands along riverbank. Also consider potential satellite treatment facility near Kapkugerwet market.		Sum	1	$ 20,000	$ 20,000	Engineering estimate. Expect ~$50,000 required for studies to examine existing plant expansion and new facility needs. Split into two studies.	
IWW	IWW-20	2007	2008	TREATME	**WWTF Sludge Reuse / Disposal Planning**	Sludge is a resource which could be used to create a soil amendment or compost either directly from the sludge or using a supplement form the solid waste stream (including agricultural wastes, bagasse). Existing sludge reuse program should be expanded. A program is in place for sludge give-away and potting soil operation exists. All sludge is given away, mostly in one ton pick-up vehicles.	Existing programs could serve as foundation for a more formal program to create soil amendment or compost either directly from sludge or using supplement from solid waste stream (including ag. Waste). Opportunities include slope stabilization, fertilizer and soil amendment for tea plantations. Consider use for on-site planting (bougainvillea), off-site plantings (at public toilets or other public facilities), access road stabilization, or other uses. Consider on-site demonstration of one option for sludge re-use in anticipation of a future large-scale program including sales of product for revenue generation. Assume re-use program can be undertaken by KEWASCO with existing staff, possibly in conjunction with a local university. Assume funds required to develop program and for testing equipment and training of staff in sludge management.		Sum	1	$ 10,000	$ 10,000	Engineering estimate.	
IWW	IWW-21	2007	2008	TREATME	**Septage Handling Planning**	KEWASCO has a single exhauster truck that is apparently in widespread demand. When KEWASCO truck unavailable, one of three local private haulers are called upon. Additional exhauster trucks and / or Vacutug may be required. Septic tank cleaning truck needed. No septic system information tracking system exists. No mandatory pumping and inspection program exists.	Develop estimates of septage quantities (as a function of pumping frequency) to determine the need for one or more additional trucks / trailer / Vacutug. Evaluate current septage receiving station and plan upgrades. Note development of manifest system for septage haulers, by-laws, etc., included in 'On-Site Wastewater Management'.	KEWASCO provided haulage data during Aug 2006 visit. Need to develop estimates of septage quantities as function of pumping freq. to determine need for additional trucks. However, KEWASCO notes that they need to replace their existing tractor and buy two additional exhauster trucks. They acknowledge it may put some private haulers out of business. If KEWASCO implements a mandatory pumping program, they may create a market for more private haulers to go into business who can still make a profit by charging to discharge at WWTF. Assume KEWASCO will replace existing truck and also promote private trucks' integration into mandatory pumping programme.	Sum	1	$ 20,000	$ 20,000	Engineering estimate.	
				SUBTOTAL										$ 400,000
				SHORT TERM WASTEWATER PROJECTS (2008-2015)										
SWW				MANAGEMENT										$ -
SWW				COLLECTION										$ 1,440,000
SWW	SWW-1	2008	2009	COLLECTI	**Wastewater Pumping Station**	One pumping station exists ~600 m northeast of WWTF along Dionsoyiet River but does not have standby pump or standby power. Consider relocation to WWTF near sand drying beds where bed under-drainage is now pumped to headworks. Locating a standby generator at that site would be more easily accessible than the current facility and could serve WWTF. KEWASCO noted in August 2006 that no excess capacity exists and that expansion and new pump sets required.	Design and construct new relocated pump station near WWTF sand drying beds. Include spare pump and auxiliary power (expect diesel generator most appropriate).	Est. cost for Pump Station, Generator	Sum	1	$ 210,000	$ 210,000	Assume $150,000 for pump station, generator, and piping, add 35% for engineering and contingency, round up	
SWW	SWW-2	2008	2015	COLLECTI	**Sewer Connections - 2nd Tier of Infill Priority List**	Many "2nd tier" priority list (residents / businesses in sewer service area served by water but not directly adjacent to existing sewer lines) should be connected to existing sewer system which has excess capacity.	Using infill priority list and incentive program, work to make all the easiest connections (parcels closest to existing sewers or requiring least effort) first.	Est. cost includes main construction.	ea.	2,400	$ 400	$ 1,000,000	Engineering estimate. Assume 1st tier connection cost $300, 2nd tier $400, other tiers $500.	
SWW	SWW-3	2008	2010	COLLECTI	**Establish public toilets / latrines at key locations**	Insufficient or no latrines at key locations.	Install public toilets or latrines in accordance with plan and LVSWSB toolkit at key locations such as sports stadium and markets where they do not already exist. Include provisions for future conversion to water flush systems. Commercialize by establishing fees and an operator to maintain facilities and ensure they are pumped (if latrine). Include provisions for security and lighting (possibly solar)		Building with ~10 stalls, wash basins	2	$ 15,000	$ 30,000	UN-Habitat, Kisii estimate for building with 10 stalls, washbasins. Round up. Number estimated by C&C.	
SWW	SWW-4	2008	2009	COLLECTI	**Exhausters for latrines / septic systems**	Expect to need additional equipment for exhausting and cleaning latrines and septic tanks.	Purchase two additional exhauster trucks, additional sewer cleaning equipment if needed.	UN-Habitat Kisii Report, Item 2.7.1 (b) est. for trailer mounted exhauster is ~$12,300. KEWASCO estimates exhauster cost at $50,000.	Sum	2	$ 100,000	$ 200,000	KEWASCO 12/10/06 comments estimate exhauster truck cost $50,000. Assume 2 @ $100,000 to include cleaning equipment.	
SWW				TREATMENT										$ 600,000
SWW	SWW-5	2010	2012	TREATME	**Kericho WWTF - Digester Mixing, Biogas**	Existing digester mixing system in need of repair / improvements.	Install new digester mixing system, add provisions for biogas abstraction and sale / on-site use if feasible.		Sum	1	$ 200,000	$ 200,000	Assume $75,000 for new mixers, $75,000 for biogas system, plus 35% engineering and contingency.	
SWW	SWW-6	2010	2012	TREATME	**Kericho WWTF - Expansion**	Existing WWTF capacity 990 m3/d, but average flow only 500 m3/d (maximum month 2005 treated 720 m3/d). The existing treatment facility will exceed its capacity as additional connections are added and population grows. Expect to require capacity > 1,700 m3/d by 2015.	Add new trickling filter in parallel to increase capacity by ~50% to ~1,500 m3/d (sampling data suggests most BOD removal occurring in trickling filters, therefore, adding a 3rd trickling filter should increase capacity by ~ 50%.) Add additional capacity by adding aeration. Assume capacity increase to > 1,800 possible at existing facility.		Sum	1	$ 350,000	$ 350,000	JICA 1998 Aftercare Study Figure 4.2.4 estimate 700 m3/d expansion, adjust to 2005 cost, add 35% engineering and contingency.	
SWW	SWW-7	2010	2012	TREATME	**WWTF Septage Receiving Improvements**	Improvements to existing septage receiving facility at WWTF may be warranted.	Install a decanting system to divert liquid to headworks and solids to digester.		Sum	1	$ 50,000	$ 50,000	Assume $35,000 for decanting system, 35% eng. / cont., round up.	
				SUBTOTAL										$ 2,040,000

Ph	NO.	YR STRT	YR FIN	TYPE	SUMMARY TITLE	OBSERVED PROBLEM / NEED	PROPOSED SOLUTION(S)	NOTES	UNITS	QUAN.	EST. UNIT PRICE (USD)	EST. COST (USD)	COST NOTES	EST. CATEGORY COST (USD)
				LONG TERM WASTEWATER PROJECTS (2016-2025)										
LWW				MANAGEMENT										
														$ -
LWW				COLLECTION										
														$ 3,400,000
LWW	LWW-1	2016	2020	COLLECTI	**Kericho Sewer Network Expansion**	Need to extend service to additional areas to keep pace with demand, and reduce impacts of on-site system failures including impacts to public health and the environment.	Extend service to additional areas. Assume ~10 km will be required. Some localized pumping may be required.		m	10,000	$ 143	$ 1,500,000	1998 Aftercare Study average cost for sewer main installation, adjusted to 2005 cost, is $106/m. Add 35% eng/cont., assume $143/m, round up.	
LWW	LWW-2	2017	2025	COLLECTI	**Sewer Connections 3rd and 4th Tier of Infill Priority List**	Many "3rd and 4th Tier" priority list (residents / businesses in sewer service area, but without water service) should be connected to existing sewer system. Most of these residents/businesses should have water connections by the time this phase is implemented.	Using infill priority list and incentive program, work to make all the easiest connections (parcels closest to existing sewers or requiring least effort) first.		ea	3,700	$ 500	$ 1,900,000	Engineering estimate. Assume 1st tier connection cost $300, 2nd tier $400, other tiers $500.	
LWW				TREATMENT										
														$ 1,100,000
LWW	LWW-3	2016	2017	TREATME	**New WWTF - Design and Construction**	Will need additional treatment facility to meet long term demand. Expect 2025 flow to approach or exceed 3,000 m3/d. Expanded existing treatment facility expected to be approximately 1,500 m3/d.	Construct pond treatment facility at proposed location abutting Dionsoyiet River near transformer station near intersection of B1 and C23 Roads southwest of town center or at location identified in study. Assume capacity ~1,500 m3/d. Actual capacity will depend on maximum expansion of existing WWTF and actual demand.		Sum	1	$ 900,000	$ 900,000	Aftercare Study Figure 4.2.4, add 35% for engineering and contingency, round up. Add $100,000 for land.	
LWW	LWW-4	2016	2017	TREATME	**New Satellite WWTF - Design and Construction**	May require satellite WWTF to serve Kapkugerwet market area.	Construct satellite WWTF facility to serve Kapkugerwet market area. Assume ~300 m3/d.		Sum	1	$ 200,000	$ 200,000	Aftercare Study Figure 4.2.4, add 35% for engineering and contingency, round up. Add $50,000 for land.	
				SUBTOTAL										$ 4,500,000

APPENDIX 5-3

Kericho Immediate Action Items

KERICHO

Recommended Immediate KEWASCO Actions

NO.	SUMMARY TITLE	IMMEDIATE ACTION
IW-1	**Mapping**	Compile central file and electronic list of all existing maps for use in creation of comprehensive water and wastewater system mapping. Mapping showing roads, land use, population distribution, and all water and wastewater infrastructure including facilities layouts should be assembled. Sources include physical development plans prepared by national, regional, and municipal government, KEWASCO and its consultants, and other sources. STATUS: Partially complete. Several maps were provided as part of current feasibility study.
IW-2	**Bulk Water Meters**	Compile existing data from working bulk water meters. Begin taking regular readings from bulk water meters.
IW-3	**Consumer Water Meters, Pilot Program**	Compile list of largest 100 consumers and identify three water meter reading routes of ~100 meters each to be included in automatic meter reading pilot study.
IW-4	**System Inventory, Asset Management Plan**	Compile list of all major equipment, piping, tanks, and treatment systems required for creation of a system inventory. Available data such as age, expected useful life, condition, service history, and nameplate data should be included. Financial value of assets and list of depreciated assets should be included.
IW-7	**Preventative Maintenance Plan**	Compile manufacturer's recommendations for equipment maintenance; compile list of current preventative maintenance schedules / practices
IW-10	**Watershed Protection Program**	Develop list of suspected and known threats to existing water supplies as initial step in developing watershed protection plan. Include list of specific farming operations, industries, etc.. Initiate discussions with farming community about implementing best management practices to protect water supplies.
IW-11	**Public Education Program**	Develop ideas for most effective ways to distribute public education materials. Identify schools that should be targeted for public education campaigns. Begin developing ideas ("brainstorm") for public education materials to be distributed with bills. Review examples of U.S. Consumer Confidence Reports and consider developing similar materials. Review available public education materials on USEPA's website at http://www.epa.gov/epahome/educational.htm.
IW-15	**Office Furniture, Office Space**	Clearly define expected office space and equipment needs and investigate costs of developing new space at existing location.
IW-18	**Timbilil Raw Water Main - Bulk Metering**	Investigate options for metering raw water flow from intake to WTP.
IW-19	**Source Augmentation Planning**	Establish flow and water quality monitoring station at proposed dam location. Begin taking measurements in accordance with GOK requirements. Compile electronic database of historic data on Timbilil flow and water quality data (may need to obtain historic data from WRMA). Gather any other existing data regarding previous dam investigations (possibly performed at national level) and create file. Existing Kimugu permit provided is illegible and appears to have lapsed - determine current status. Timbilil permit noted as 'in progress' - Clarify status. Determine permitting process requirements for dam construction and increased Timbilil river withdrawal.

NO.	SUMMARY TITLE	IMMEDIATE ACTION
SW-10	**New WTP, Raw Water Main Planning / Permitting / Design / Land**	Determine availability and cost of land near existing water treatment facility for future new water treatment facility.
LW-2	**System Expansion - Ngocherok**	Determine expected population to be served by expansion into Ngocherok. Determine if existing storage tank in Telanet is adequately sized and if any repair or upgrades are required. Confirm assumed pipe length of ~4,500 meters from proposed pump station to existing tank.
LW-4	**System Expansion - Chelimo Residential Estate**	Determine when this project is expected to move forward, expected service population, number of connections, and lengths of water mains required.
IWW-1	**Large Water Users / Wastewater Generator Discussions**	Begin discussions with large water users not connected to sewer regarding possible future connection. Identified large users not connected include: Kericho Teachers Training College, Kericho Primary School, Kericho Tea Secondary School, Kericho Boys Boarding School, Kericho High School, Kericho Bible College, Milimani Academy, and Kericho Green Stadium. Also include all hospitals and clinics; CBD; existing public toilets near sewers; slaughterhouse near treatment plant; all schools; all public buildings; sports stadium; Tea Hotel.
IWW-2	**On-Site Wastewater Management**	Begin to develop a database of existing on-site wastewater disposal systems including, at a minimum: property address, owner's name, type and size of system, year installed, last time sludge was pumped, and whether or not a private drinking water well exists on-site. Consider a survey mailing.
IWW-7	**Public Latrines / Toilets - Inventory, Rehab / Commercialization Plan**	Provide initial inventory and evaluation of conditions at all public toilets / latrines. STATUS: Initial inventory and evaluation provided August 2006. Need to augment evaluation using proposed LVSWSB toolkit.
IWW-11	**Sewer I/I Evaluation**	Perform "detective work" in late night/early a.m. during rainstorm when little or no water is being used to determine source of wastewater flow. Consider smoke testing.
IWW-19	**New WWTF(s) - Planning, Permitting, Preliminary Design**	Investigate availability, cost, and dimensions of identified Unilever-owned site along Dionsoyiet River near transformer station at intersection of B1 and C23 Roads southwest of town center. Expect over 2 ha of land available. Also investigate potential sites further downstream to determine if sites with more favorable conditions (more area, flatter topography, permeable soils, etc.,) can be identified. Also investigate availability, cost, and dimensions of potential satellite treatment facility locations near Kapkugerwet market.

Lake Victoria South Water and Wastewater Feasibility Study

APPENDIX 6-1

Kisii Detailed Water Demand and Wastewater Flow Estimates

Kisii Domestic Water Consumption and Wastewater Flow Projections

Part A. Domestic Service Connection Projections

	Initial (2005)		Future (2015)		Ultimate (2025)	
Population	**100%**	**200,000**	**100%**	**282,000**	**100%**	**400,000**
High/Med. Income	**25%**	**50,000**	**30%**	**84,600**	**35%**	**140,000**
IWC	55%	27,500	65%	54,990	75%	105,000
NWC, ISA	45%	22,500	35%	29,610	25%	35,000
NWC, NISA	0%	-	0%	-	0%	-
ISC	4%	2,000	35%	29,610	40%	56,000
NSC, ISA	42%	21,000	10%	8,460	5%	7,000
NSC, NISA	54%	27,000	55%	46,530	55%	77,000
Low Income	**75%**	**150,000**	**70%**	**197,400**	**65%**	**260,000**
IWC	1%	1,500	15%	29,610	25%	65,000
NWC, ISA	97%	145,500	85%	167,790	75%	195,000
NWC, NISA	2%	3,000	0%	-	0%	-
ISC	3%	3,900	20%	39,480	25%	65,000
NSC, ISA	35%	52,500	15%	29,610	10%	26,000
NSC, NISA	62%	93,600	65%	128,310	65%	169,000
		-		-		-

TOTALS FOR ALL INCOME GROUPS

IWC	15%	29,000	30%	84,600	43%	170,000
NWC, IWSA	84%	168,000	70%	197,400	58%	230,000
NWC, NISA	2%	3,000	0%	-	0%	-
ISC	3%	5,900	25%	69,090	30%	121,000
NSC, ISA	37%	73,500	14%	38,070	8%	33,000
NSC, NISA	60%	120,600	62%	174,840	62%	246,000
Pop. in Water Service Area	100%	200,000	100%	282,000	100%	400,000
Pop. in Wastewater Service Area	40%	79,400	38%	107,160	39%	154,000

NOTES:

IWC	Individual Water Connection	ISC	Individual Wastewater Connection
NWC, ISA	No Water Connection, In Water Service Area	NSC, ISA	No Wastewater Connection, In Wastewater Service Area
NWC, NISA	No Water Connection, Not in Water Service Area	NSC, NISA	No Wastewater Connection, Not in Wastewater Service Area

Kisii Domestic Water Consumption and Wastewater Flow Projections

Part B. Domestic Water Consumption and Wastewater Flow Projections

	Per Capita Water Consumption or WW Flow (m^3/d)*	Initial (2005) Water Consumption (m^3/d)	Initial (2005) Wastewater Flow (m^3/d)	Future (2015) Water Consumption (m^3/d)	Future (2015) Wastewater Flow (m^3/d)	Ultimate (2025) Water Consumption (m^3/d)	Ultimate (2025) Wastewater Flow (m^3/d)
High/Med. Income							
IWC	0.150	4,125		8,249		15,750	
NWC, ISA	0.02	450		592		700	
NWC, NISA	-	-		-		-	
ISC**	0.08		150		3,553		6,720
NSC, ISA***	0.002		42		76		84
NSC, NISA	-		-		-		-
Low Income			-		-		-
IWC	0.075	113		2,221		4,875	
NWC, ISA	0.02	2,910		3,356		3,900	
NWC, NISA	-	-		-		-	
ISC**	0.04		146		2,369		3,900
NSC, ISA***	0.002		105		266		312
NSC, NISA	-		-		-		-
TOTAL		**7,598**	**443**	**14,417**	**6,265**	**25,225**	**11,016**

NOTES:

IWC	Individual Water Connection	ISC	Individual Wastewater Connection
NWC, ISA	No Water Connection, In Water Service Area	NSC, ISA	No Wastewater Connection, In Wastewater Service Area
NWC, NISA	No Water Connection, Not in Water Service Area	NSC, NISA	No Wastewater Connection, Not in Wastewater Service Area

* Based on per capita values presented in 2005 Design Manual and WHO Report #9, except where noted.

** Assume wastewater flow 50% of water demand initially, rising to 80% in future.

*** Due to minimal use of public toilets, it is assumed that wastewater flows from people without sewer connections within the wastewater service area are 10% of water use, not 80% as recommended in WHO Report #9. It is assumed that the percentage increases to 60% by 2025.

Kisii Large Water Users Consumption Projections

	Initial (2005)** m^3/d	Future (2015)*** m^3/d	Ultimate (2025)*** m^3/d	Notes
Market Day*	250	353	497	Assumes 50,000 people @ 5 l/h/d
Kisii Bottlers (Coca-Cola)*	350	494	696	April 2006 Site Visit. Expected to rise from 350 m3/d to ~700 m3/d.
District Hospital	61	87	122	Kisii Water Supply Meter Readings, 2005.
Kisii High School	61	85	120	Kisii Water Supply Meter Readings, 2005.
Kereri Girls School	24	34	48	Kisii Water Supply Meter Readings, 2005.
Gusii Institute of Technology	20	28	40	Kisii Water Supply Meter Readings, 2005.
Kisii College (Egerton University)	4	6	8	Kisii Water Supply Meter Readings, 2005.
Bernard Gisicho Omae	3	5	7	Kisii Water Supply Meter Readings, 2005.
Kisii Hotel	3	5	7	Kisii Water Supply Meter Readings, 2005.
Jacob Nyamori	2	3	4	Kisii Water Supply Meter Readings, 2005.
Joseph Mituka	1	2	2	Kisii Water Supply Meter Readings, 2005.
Other Large Users	220	310	438	Assume other large commercial/industrial/municipal users.
TOTAL Large User Water Consumption	1,000	1,411	1,990	

Notes:

* Not currently connected to Kisii water supply.

** GWASCO records may be inaccurate due to unknown meter age/condition.

*** Future and Ultimate year projections assume growth of 3.5% per anum, equivalent to expected Town population growth rate.

Kisii Total Water Consumption Projections

	Initial (2005)* m^3/d	Future (2015)** m^3/d	Ultimate (2025) m^3/d
Total Domestic Water Consumption	7,598	14,417	25,225
Total Large User Water Consumption	1,000	1,411	1,990
TOTAL Water Consumption	8,598	15,828	27,215

Notes:

* Actual present water production is approximately 2,800 m^3/d. Water consumption is presently estimated at <1,300 m3/d.

** It is expected that by 2015 the proposed new Gucha River intake may be capable of producing 18,000 m^3/d. UfW is assumed to be 25% by 2015. Therefore, the entire projected water demand may not be met in 2015.

Kisii Wastewater Flows From Large Users Projections

	Initial (2005)** m^3/d	Future (2015)** m^3/d	Ultimate (2025)** m^3/d	Notes
Market Day*		282	398	
Kisii Bottlers (Coca-Cola)	175	247	348	Assume 50% of water use goes into sewer.
District Hospital	49	69	98	
Kisii High School	48	68	96	
Kereri Girls School	19	27	38	
Gusii Institute of Technology	16	23	32	
Kisii College (Egerton University)	3	4	6	
Bernard Gisicho Omae	3	4	6	
Kisii Hotel	3	4	5	
Jacob Nyamori	2	2	3	
Joseph Miruka	1	1	2	
Other Large Users		248	350	
TOTAL Large User Wastewater Flow	319	980	1,383	

Notes:

* Not currently connected to Kisii sewer system.

** Flow calculations assume 80% of water use converted to wastewater (per WHO Report #9) and that all above facilities are connected to wastewater system, except where noted. GWASCO records may be inaccurate due to unknown meter age/condition.

Kisii Total Wastewater Flow Projections

	Initial (2005)*** m^3/d	Future (2015) m^3/d	Ultimate (2025) m^3/d
Total DomesticWastewater Flow	443	6,265	11,016
Total Large User Wastewater Flow	319	980	1,383
TOTAL Wastewater Flow	762	7,245	12,399

Notes:

***Actual flow received at existing wastewater treatment facility is unknown due to lack of metering. UN-Habitat estimated present flow to be 500 m^3/d.

Lake Victoria South Water and Wastewater Feasibility Study

APPENDIX 6-2

Kisii Detailed Projects, Phasing, and Cost Estimation Matrix

KISII

Recommended Immediate GWASCO Actions

Recommended Projects and Preliminary Cost Estimates

WATER | WASTEWATER | 1 USD = 70 Kshs

WATER & WASTEWATER | Note: UN-Habitat 2005 Recommendation Categories: Immediate w/in 12 weeks; Medium w/in 12 months; Long w/in 3 years

NOTES / UNUSED

NO.	YR STRT	YR FIN	TYPE	SUMMARY TITLE	OBSERVED PROBLEM / NEED	PROPOSED SOLUTION(S)	NOTES	UNITS	QUAN.	EST. UNIT PRICE (USD)	EST. COST (USD)	COST NOTES	EST. CATEGORY COST (USD)
			IMMEDIATE WATER PROJECTS / ACTIONS (Within ~1 Year)										
			MANAGEMENT										$ 873,000
IW-1	2007	2007	MANAGEM	**Mapping**	System map provided by GWASCO is a rudimentary sketch and not to scale. The map included in the UN-Habitat report is also not to scale and doesn't include all systems. No map is included in WSPA. Detailed GIS mapping currently under production by UN-Habitat. Proposed improvements are very difficult to conceptualize, cost, and prioritize without being shown on updated, scale maps. Mapping is very important for almost all future activities.	Create water and wastewater system map in GIS using mapping currently being prepared by UN-Habitat. Obtain any other local mapping available through other municipal or regional planning departments. Clearly show all existing and proposed water and wastewater systems on GIS map with satellite photo, Survey of Kenya, and GIS polygon and point layers included. Layers should include: existing land use; streets; neighborhoods; population density; water system features including intakes, treatment facilities, piping network, and storage facilities; wastewater collection system piping and treatment facility; water kiosks; public toilets; bulk water meters. Work with GWASCO to confirm pipe interconnections. Include notation of water pipes that are currently dry and how long they have been dry. Also note sewers that are not operating / blocked (likely to correspond to dry water pipes areas). All water and wastewater systems included in system inventory should be included in mapping. Clarify existing and proposed service areas. Use mapping for all future planning activities.		sum	1	$ 140,000	$ 140,000	Note UN-Habitat Item 5 - Other Activities (Long Term) includes $137,000 for aerial photographs, creation of a physical plan, and layout plans of water, wastewater, and drainage systems. Round up.	
IW-2	2007	2007	MANAGEM	**Bulk Water Meters**	Bulk meters are required to quantify UfW, assess system integrity, and reduce losses. There are no master meters in the existing distribution system.	Determine optimal locations for bulk meters and install.		sum	1	$ 30,000	$ 30,000	UN-Habitat Item 1.1.4 (a) recommended installation of 9 bulk water meters (four 150 mm @~$1,400, five 100 mm @~$1,000). Assume 10 meters at $1,400 plus replace / install 4 master meters at treatment works if they don't presently exist. Add 35% for analysis/engineering, contingency, round up.	
IW-3	2007	2007	MANAGEM	**Consumer Water Meters, Pilot Program**	UfW is currently estimated to be in excess of 50%. GWASCO needs to reduce UfW and increase revenue through accurate metering. GWASCO estimates regarding number and age of existing consumer meters very unclear. UN-Habitat 2005 Kisii report estimates over 6,000 registered connections exist, 3,100 of which are active. Most existing meters are expected to be in need of replacement. Need to implement meter replacement program, starting with largest users. Utilize initial opportunity to implement a pilot study for evaluation of remote reading water meters.	Implement water meter pilot program to evaluate automatic meter reading (AMR) technology and gather data to assess expected UfW reduction and increased revenue from large scale meter replacements. Implement program to include 300 new AMR meters (~5% of total). Replace meters for 100 largest consumers, plus all meters in each of two meter reading areas (assume two areas of 100 meters each) to assess remote reading metering technology effectiveness. Remote reading system may be hand-held or drive-by units. Data evaluation included in Water Audit.	UN-Habitat Item 1.1.4 (a) includes replacement of 200 meters at ~$100 each. UN-Habitat Item 1.1.4 (b) recommends requiring all consumers to have functional water meters (30-days notice). Lump sum cost listed is $1,644. NOTE: La Victors Apr 2006 issue (pg 8) notes Kisii Water supply increased revenue almost double from Dec 05 to Jan & Feb 06, reactivated 110 dormant accounts, installed 200 meters, and registered 42 new connections.	Sum	1	$ 130,000	$ 130,000	Std consumer meter cost $40 to $100. In U.S., remote reading meters cost ~$160, install cost ~$100. Assume Kenyan install cost less than half U.S. cost, therefore assume cost per installation ~$200. Assume $30,000 for hardware/software/training; 35% for consultancy (technology selection, neighborhood selection, bidding, evaluation of results) and contingency.	
IW-4	2007	2007	MANAGEM	**System Inventory, Asset Management Plan**	An accurate water and wastewater system inventory is required before meaningful planning can be accomplished. The inventory will be important for almost all future work including O&M plans, infrastructure planning, mapping, tariff analysis, staffing planning, accounting and other activities. An inventory is the first step towards creating an asset management plan. Once the inventory is created, assets should be valued and prioritized into an asset management plan for future rehabilitation, replacement, or upgrade. Specific distribution system component requirements will be analyzed in system improvement plan included separately.	Develop water and wastewater system inventories and asset management plans. Utilize toolkit proposed to be created by LVSWSB. Inventory should include major equipment, piping, tanks, and treatment systems. Available data such as age, expected useful life, condition, service history, and nameplate data should be included. Financial value of assets and list of depreciated assets should be included. Develop or use available standard forms, or purchase and customize available software (recommended) to create inventories and convert to an asset management plan by prioritizing assets and estimating future needs and costs. Priority should be given to critical infrastructure at or past the end of its useful life.		Sum	1	$ 30,000	$ 30,000	Engineering estimate.	
			MANAGEM	**Empty Pipes Inventory**	Town provided map showing many neighborhoods that were once provided with water (many including tanks) but are no longer served. Town noted 79 km2 once served, but now only 29 km2 due to reduced production capacity. It is not clear if all pipes are dry, and how long they have been dry. If pipes have been dry for years, they will likely require replacement.	Town compiled list as part of 12/10/06 comments noting mains no longer in service. Need to include in proposed system mapping showing exact extent of present service and which mains are dry, and how long they have been dry.	Previously served (but no longer served) areas include: Sunkea, Gesonso, Nyanchwa, Nubia, Daraja Mbili, Nyamataro Market, Nyambera, Jogoo, Milimani, Gekomu (incl. tank), Mwembe, Menyinkwa, Kiogoro, Nyanko, Nyaguta.	N/A			$ -	To be done by GWASCO staff as part of mapping, inventory tasks. Already begun.	
			MANAGEM	**Large Users**	With the exception of Kisii Bottlers, GWASCO notes in 12/10/06 comments that all large users are currently served.	Prioritize list of future potential large water users. Expected large users not currently served include: Kisii Bottlers. According to Kisii, all other major users are served including District Hospital, Kisii High School, Kereri Girls (School?), Gusii Institute of Technology, Kisii College (Egerton University), Municipal offices and police station, prison, markets, schools, sports stadium.		N/A			$ -	To be done by GWASCO staff, already begun.	
			MANAGEM	**Large Users Discussions**	Some existing large water users currently rely on their own water sources but some expressed interest in switching to municipal supply. Lack of adequate water supply has been cited as main reason for businesses and other institutions leaving or not coming to Migori.	Begin discussions / negotiations with Kisii Bottlers and others regarding connecting to a future municipal water system. GWASCO notes in 12/10/06 comments that they have already spoken to Kisii Bottlers and that they expect to serve them once system rehabilitations are completed.		N/A			$ -	To be done by GWASCO staff, already begun.	

NO.	YR STRT	YR FIN	TYPE	SUMMARY TITLE	OBSERVED PROBLEM / NEED	PROPOSED SOLUTION(S)	NOTES	UNITS	QUAN.	EST. UNIT PRICE (USD)	EST. COST (USD)	COST NOTES	EST. CATEGORY COST (USD)
IW-5	2007	2007	MANAGEM	**Preventative Maintenance Plan**	In order to maximize equipment lifespan and operating efficiency, GWASCO should document preventative maintenance plans, follow them closely, and be vigilant about recording maintenance histories for equipment.	Develop preventative maintenance plans and maintenance tracking system, including all inventory components. Utilize toolkit proposed to be created by LVSWSB. The system may incorporate traditional maintenance card techniques, "out-of-the box" software, or customized software. Software packages are now readily available to schedule and track all required preventative maintenance and are recommended.		Sum	1	$ 20,000	$ 20,000	Engineering estimate.	
IW-6	2007	2007	MANAGEM	**O&M Manuals, Information on Existing Infrastructure**	Layout drawings, O&M manuals do not exist for most equipment and water and wastewater facilities.	Prepare O&M manuals for water and wastewater facilities including layout drawings and regular maintenance requirements. Obtain manufacturer's manuals for all existing equipment, incorporate recommended maintenance into preventative maintenance plan.	Suneka WWTF record drawings obtained during August 2006 visit from design engineer in Nairobi and provided to Town. Design report and O&M manual not available. Compile O&M manual for Suneka WWTF based on WSP Design Manual for E. Africa. Include flow measurement techniques, using water core sampler, influent and effluent sampling procedures. Note regular maintenance schedule to be included in preventative maintenance plan. Note UN-Habitat Item 2.7.2 includes $3,072 for O&M manual development for entire wastewater system.	Sum	1	$ 20,000	$ 20,000	Engineering estimate.	
IW-7	2007	2007	MANAGEM	**Illegal Connections**	Number of existing illegal connections is unknown. Due to a lack of metering and data collection, GWASCO cannot calculate the number of illegal connections. However, anecdotal data from GWASCO staff indicate the number of illegal connections is high. GWASCO staff have reported being threatened when entering areas where known illegal connections exist.	Implement comprehensive program to investigate and register / remove illegal connections. If any registered but "non-active" customers are drawing water from the system, register and meter the connections. Utilize proposed toolkit and model by-law for handling illegal connections produced at LVSWSB level. A structured program should be developed to quantify and address the issue including public education and bylaw enforcement. Develop and implement an incentive program to encourage all flat rate customers to install water meters. UN-Habitat recommended all flat rate customers purchase meters within a stipulated period. A program of incentives and cost deferment should also be included.	NOTE: La Victors Apr 2006 issue (pg 8) notes Kisii Water supply increased revenue almost double from Dec 05 to Jan & Feb 06, reactivated 110 dormant accounts, installed 200 meters, and registered 42 new connections.	Sum	1	$ 30,000	$ 30,000	Most tasks to be accomplished with existing staff and existing operations budget. Allowance included for consultation to develop structured program for dealing with illegal connections including bylaw development, media campaign, public education.	
IW-8	2007	2007	MANAGEM	**Water Audit**	Lack of detailed knowledge regarding source of water losses in existing system. An audit will identify inadequacies and assist in prioritizing improvements.	Perform system-wide water audit to determine capacity, UfW, and identify problem areas. Evaluation should include raw water mains and treatment facilities as well as illegal connections and known large leaks. Full audit may only be possible after installation of master and consumer meters.		Sum	1	$ 20,000	$ 20,000	Engineering estimate.	
IW-9	2007	2007	MANAGEM	**Staffing Planning**	Staffing levels at GWASCO will likely require adjustments as wastewater services are brought under the umbrella of GWASCO services and as service coverage expands.	Conduct staff rationalization study by an external HR consultant. Include recommendations for more effectively combining sewer division (formerly run by municipality) and water division. Study should include organizational chart development, task analysis, determination of staffing requirements, creation of job descriptions, and implementation plan for staffing changes.		Sum	1	$ 15,000	$ 15,000	Engineering estimate.	
IW-10	2007	2007	MANAGEM	**Tariffs Analysis**	GWASCO currently uses national tariff rates. Revisions to existing rates as service improves and expands will be required.	Conduct detailed analysis of current tariff structure in conjunction with proposed new projects and costs from asset management plan. Utilize toolkit proposed to be developed by LVSWSB. Include consultation and participation of stakeholders. Revise tariff structures so revenues cover all operational expenses and generate additional funds for capital improvements, equipment, meter replacements, planning, etc.. Proposed tariffs should not be arbitrary. Tariffs should be based on real data, reasonable projections, and a transparent methodology.		Sum	1	$ 20,000	$ 20,000	Engineering estimate.	
IW-11	2007	2007	MANAGEM	**Watershed Protection Program**	Encroachment and development in public water supply watersheds is expanding including the Gucha and Nyakomisaro watersheds. Turbidity is already a significant problem for both existing water treatment facilities and is likely a result of development within the watershed and loss of riparian vegetative buffers. Other existing and potential new sources of contamination are largely unknown. Erosion will need to be controlled if proposed dam at Bunyunyu is to be successful and avoid rapid siltation.	Implement program to assess present land use and monitor and restrict development within the water source watersheds. Utilize toolkit proposed to be developed at LVSWSB. Special focus should be on identifying threats, removing squatters, reducing erosion/development, and working with farmers to implement BMPs within the Gucha and Nyakomisaro watersheds. Purchasing land may be required to protect watershed. The program will require cooperation with other town departments, agricultural and public health officials, and local politicians.		Sum	1	$ 50,000	$ 50,000	Engineering estimate.	
IW-12	2007	2008	MANAGEM	**Public Education**	No public education programs are presently in place. Public needs to be informed of the health and economic benefits of water conservation, metering, source protection / contamination, and sanitation. According to UN-Habitat, a study by Prof. George Krhoda revealed that ~90% of wells and springs in Kisii are contaminated. Promotion of water conservation and installation of water-saving devices in homes could save additional water, allowing GWASCO to serve additional customers with limited supplies. Expect that many residents' water sources are contaminated, including small streams and wells.	Implement program to inform residents about the importance of water conservation, water quality, source protection, sanitation, and potential resultant financial savings. Utilize public education toolkit proposed to be developed at LVSWSB. Couple latrine rehabilitation and construction with public education program for both public and private facilities. Work with local environmental and health groups on public education programs. Begin school programe addressing water, water conservation, health and hygiene. Consider publishing and distributing annual informational reports to customers similar to Consumer Confidence Reporting in U.S. for educating customers about water and watershed protection. Designate staff responsible for public education and public relations including informing customers of any expected service disruptions and handling complaints.	Note UN-Habitat Immediate Item 5 Capacity Building and Community Development includes many education related activities, including health and hygiene education in primary schools; staff training ; training local citizens in pipeline construction; finance mgmt for Kiosk operators; etc.. - includes > $70,000 for immediate activities, $27,400 for long term. Also, UN-Habitat Item 1.1.6 included ~$5,500 for demand management campaign.	Sum	1	$ 50,000	$ 50,000	Engineering estimate.	
IW-13	2007	2007	MANAGEM	**Water Conservation Program**	Promotion of water conservation and installation of water-saving devices in homes could save additional water, allowing GWASCO to serve additional customers and extending time before additional supplies are needed.	Implement a water conservation education and assistance program to inform residents about the importance of conservation and potential money savings. Include bulk purchase of water saving devices including sink aerators, low flow showerheads, and similar devices for free distribution.		Sum	1	$ 20,000	$ 20,000	UN-Habitat Item 1.1.6 included 'demand management campaign' ~$5,500. Increase budget to include water-saving devices.	

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IW-14	2007	2007	MANAGEM	**Computer hardware, software**	Need computer hardware and software to adequately manage system and convert to electronic record-keeping system. Will require additional security for new equipment.	Purchase computers, software, printers, security. Software should include readily available billing software.		Sum	1	$ 23,000	$ 23,000	UN-Habitat Item 1.6.2 included ~$200/computer. Too low. Assume five (5) workstations @ $1,500 including computer, printer, accessories. Assume additional $15,000 for software, round up.	
IW-15	2007	2007	MANAGEM	**Other Office Equipment, Furniture, Planning**	Need desks, fax, copiers, for offices. A small portable generator or solar panels would also alleviate the frequent power outages experienced at GWASCO offices. Assume expansion will be required to accommodate upgrades and inclusion of sewer department staff.	Upgrade office equipment including desks, fax, copier, generator or solar panels, etc.. Determine office expansion requirements for existing and new staff including sewer staff.		Sum	1	$ 15,000	$ 15,000	Assume $5,000 for desks, chairs; $300 for fax; $2,500 for copier; $2,000 for small generator or solar panels; $5,000 for planning; round up.	
IW-16	2007	2007	MANAGEM	**Equipment and Data Security**	Additional security should be added for computers, office equipment, and data.	Add additional door locks, cords locking computers to desks, safe, etc.. to ensure security. Include provisions for surge protectors and electronic and hardcopy data backup due to frequent power outages.		Sum	1	$ 5,000	$ 5,000	Engineering estimate.	
IW-17	2007	2007	MANAGEM	**Computer Training**	Need training for staff in computer use and records / database management and billing software.	Hire trainer for local staff in computer use. Expect to utilize "circuit rider" trainer via LVSWSB.		Sum	1	$ 20,000	$ 20,000	Engineering estimate.	
IW-18	2007	2007	MANAGEM	**Computerize record-keeping and billing**	Recordkeeping at GWASCO is poor. Records are not computerized and all data recording is done manually. Data provided for large water users was hand written. Initial goals include increasing revenue through accurate metering and billing. Accurate records are required for this to occur. Also need to survey large users and discuss connecting to municipal system.	A database of all water and sewer customers should be created including customer name, account number, active/inactive status, location, meter age, all meter readings, bill sent, payments received. Utilize software capable of baing used for water and sewer accounts to ensure compatibility for billing water and sewer simultaneously. All billing should be computerized. Computer hardware and software included in other tasks.	NOTE: La Victors Apr 2006 issue (pg 8) notes Kisii Water supply increased revenue almost double from Dec 05 to Jan & Feb 06, reactivated 110 dormant accounts, installed 200 meters, and registered 42 new connections.	sum	1	$ 50,000	$ 50,000	Engineering estimate.	
IW-19	2007	2007	MANAGEM	**Training / Certification for Water Vendors, Kiosk Operators, Public Toilet Operators**	Water vendors should be recognized as providing a service to the community currently unmet by local WSP. Vendors should be trained / certified to ensure water provided by vendors is safe until more permanent service can be provided. Kiosk operators and public toilet operators require training in financial management and operation of the stations to protect public health.	Implement vendor, kiosk, and public toilet operator training and certification program. Encourage residents to only purchase water from registered vendors. Encourage vendors to become trained as kiosk operators as kiosks come on-line.	Kisii 12/10/06 comments note town plans to register and train all vendors.	Sum	1	$ 20,000	$ 20,000	Engineering estimate.	
IW-20	2007	2007	MANAGEM	**Staff Training**	Staff needs to be trained in system operation and O&M performance indicators. Technical, management, and financial training programs should be implemented. GWASCO staff presently lack skills to operate wastewater system.	Set up regular staff training program, including training of staff on performance indicators and technical, financial, and managerial skills. Take part in "circuit training" program proposed to be administered at LVSWSB.		Sum	1	$ 20,000	$ 20,000	UN-Habitat Item 1.6.6 included ~$4,100. Additional funds required.	
IW-21	2007	2007	MANAGEM	**Commercialization / Entrepreneurship Opportunities**	Need for additional income-generating activities and reduced demands on GWASCO staff.	Consider commercialization of water kiosks and latrines/public toilets; private operation of GWASCO-owned exhauster truck(s) or Vacutug; Compost production and distribution; Utilize sludge at one of several existing or possible new seedling nurseries at Suneka WWTF; algae harvesting from lagoons; irrigeted sugar cane/bamboo/other; aquaculture with WWTF effluent.		Sum	1	$ 10,000	$ 10,000	Engineering estimate. Consultancy to consider commercialization / entrepreneurship.	
IW-22	2007	2007	MANAGEM	**Regionalization**	Economies of Scale may be attained by regionalization.	GWASCO should become part of Kisumu-based training, equipment repair/rehab, spare parts, chemical procurement, bulk purchases incl. water meters, leak detection equipment, purchasing in-home water saving devices, water bowser, etc..		Sum	1	$ 10,000	$ 10,000	Engineering estimate. Consultancy to consider commercialization / entrepreneurship.	
IW-23	2007	2007	MANAGEM	**Meter Repair / Calibration Bench**	Kisii does not have means to repair and calibrate meters.	Construct and equip meter repair and calibration bench.		Sum	1	$ 10,000	$ 10,000	UN-Habitat Nov 2005 Item 1.6.1 included $3,425 - inadequate. Assume $10,000 to provide quality testing and repair facilities.	
IW-24	2007	2007	MANAGEM	**Vehicles**	Need transport for O&M staff. Exact number of vehicles needed unclear.	Purchase three trucks and five motor cycles. (Exact number may be adjusted based on needs analysis)		Sum	1	$ 115,000	$ 115,000	Assume three trucks @ $30,000 and five motorcycles @ $5,000. UN-Habitat Nov 2005 included 3 motorcycles at ~$5,000 and 10 bicycles. Bicycles not suitable given difficult terrain, poor roads.	
			SOURCE										$ 80,000
IW-25	2007	2008	SOURCE	**Source Augmentation Study**	Additional water supply and treatment are required. The Gucha (Kuja) River is likely to be the best option for source augmentation due to its large flow and location at higher elevation than most of the expected service area, possibly enabling gravity flow to some or all of service area. Need to begin data gathering and feasibility study, including analysis of options associated with a dam on Gucha river and possible gravity flow to treatment, storage, and distribution.	Perform full feasibility study and cost estimation for source augmentation options. Include consideration of dam at either Bunyunyu or Bonyama (Nyamataro Bridge further upstream) with gravity flow to Bobaracho Tanks with new treatment facility at Bobaracho, or to Kegati WTP with hydropower facilities installed. Consider initial step of constructing upstream intake, then add dam subsequently. Previous reports on proposed Bunyunyu Dam exist and should be obtained and reviewed. In light of current poor power reliability, gravity flow options should be favored. Site-specific flow and water quality data should be gathered for potential sources in accordance with Ministry requirements, plus information on land use and water quality threats. Detailed ground survey or accurate leveling measurements are required as part of this task to evaluate feasibility of various options. Treatment and distribution studies are included as separate tasks, but expected service areas and elevations must be considered simultaneously.	Low flow of Kuja (Gucha) River estimated by GWASCO at 18,000 m3 day (GWASCO provided flow data showing low flow for Station 1KB01 as 5.8 m3/s or ~0.5 million m3/d, location of station unclear). According to 1998 JICA Aftercare Study, six gauging stations have existed on Gucha river. National Water drafted plans for a proposed dam on Gucha, which is mentioned in the JICA Aftercare study (Pg. IV-51 and IV-T-85). Note that 2003 document titled 'US Investments in the water treatment sector in Kenya' notes Bunyunyu Dam could produce up to 9,000 m3/d and that dam on River Twach could add 17,000 m3/d. Bunyunyu is located ~7 km east of Kegati water works at elevation ~6,000 ft. Kegati works are at elevation ~5,800 feet. Bobaracho tanks are at ~6,000 feet, ~9 km from Bunyunyu. According to GWASCO and UN-Habitat's consultant, gravity flow to Bobaracho is possible and they are supportive of a plan to create a nearly all-gravity system with new treatment at Bobaracho.	Sum	1	$ 65,000	$ 65,000	Estimate ~ $150,000 required for comprehensive study for all source options, potential new service areas, use of existing plant, etc.. Break down into multiple studies. Note UN-Habitat Item 1.3.3 included $20,548 for a Gravity Flow Feasibility Study	

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IW-26	2007	2007	SOURCE	**Power Generation Study**	Hydropower potential not utilized. Micro hydropower may be feasible by diversions of Nyakomisaro River, Gucha River, or others. For example, harnessing river ~500 vertical feet above present Kegati intake, with stilling basin, could eliminate need for low lift pumps. By installing a turbine, power could also be provided for high lift pumps. Biomass gasification may also prove to be a viable option for power generation.	Investigate hydropower feasibility. Also consider a biomass gasification plant using sugar cane waste or other locally available organic materials.		Sum	1	$ 15,000	$ 15,000	Estimate ~ $150,000 required for comprehensive study for all source options, potential new service areas, use of existing plant, etc.. Braak down into multiple studies.	
			TREATMENT										$ 318,000
IW-27	2007	2008	TREATMEN	**WTPs Upgrade / Expansion Study**	Comprehensive evaluation of WTP upgrade and expansion needs and options for Kegati and Nyakomisaro WTP should be conducted to prioritize investments. UN-Habitat performed initial analysis resulting in detailed immediate interventions recommendations. Scope of study will be dependent on which UN-Habitat recommendations have already been implemented and results of source augmentation study. Most immediate UN-Habitat recommendations included below.	Conduct study for upgrading and expansion work at Kegati and Nyakomisaro WTP (main focus should be on Kegati). Eatimate costs, determine permitting requirements, develop preliminary design. Include recommendations for laboratory upgrade and new equipment. Include analysis of options for reduction of turbidity, which is high during wet season and increases treatment costs at both plants (options include sedimentation basins, withdrawal of water through riverbed via infiltration galleries, infiltration trenches, redesigned intake structure, etc..). Determination of extent of upgrades will be dependent on results of source augmentation study (e.g. significant upgrade / expansion of Kegati may not be warranted if new WTP will be constructed at Bobaracho).	Kisii 12/10/06 comments recommend inclusion of a sedimentation tank at Nyakomisaro immediately while awaiting study results.	sum	1	$ 30,000	$ 30,000	Estimate ~ $150,000 required for comprehensive study for all source options, potential new service areas, use of existing plant, etc.. Break down into multiple studies. Note UN-Habitat Item 1.3.3 included $20,548 for a Gravity Flow Feasibility Study	
IW-28	2007	2007	TREATMEN	**WTP sampling data**	Limited sampling data is available from Kegati and Nyakimasaro WTP. Without this information, the performance of the treatment systems cannot be assessed. This information is required to evaluate expansion and upgrade needs.	Provide existing data or begin program for regularly collecting data, including QA/QC programs. Testing may initially be done at LVSWSB lab in Kisumu until local labs are in place.		sum	1	$ 5,000	$ 5,000	To be accomplished by GWASCO staff. Funds allotted to develop sampling regime.	
IW-29	2007	2007	TREATMEN	**Lab Reagents, Sampling Equipment**	Lab reagents and sampling equipment are required for basic sampling.	Purchase lab reagents and sampling equipment including tube water core sampler, measurement stick for flume water level / flow rate, sample bottles and grab sampler, other assorted equipment to immediately begin limited sampling program. Full laboratory to be included in new WTP and at Suneka WWTF.		Sum	1	$ 10,000	$ 10,000	UN-Habitat 2005 Item 1.6.5 (a) included ~$7,000 for lab reagents. Assume $10,000 to include sampling equipment.	
IW-30	2007	2007	TREATMEN	**Kegati WTP - Standby power**	It is estimated this primary facility has no power or low voltage 50% of time and this is cited as primary reason for facility operating at less than half of design capacity. Standby power should be installed. Voltage should be 450 V but is often ~300 V, so amps increase and motors run hot or burn out. The facility is only able to utilize larger pumps at night when voltage is higher.	Install standby diesel generator at Kegati WTP, size > 500 kVA. Also consider installing system to atabilize voltage and minimize reliance on generator such as a Sag Fighter(R) or Tap Changer Controller. January visit notes state local staff consider diesel generators too expensive in capital and operation. Cite fuel 22,000 Ksh / day, say 50,000 ksh / day. Need 500 kW, 750 kVa. Installing generators is likely to be the fastest way to boost production and revenues and convince residants that service will improve as part of proposed programs.	UN-Habitat recommendations include providing standby power (Item 1.3.2, 200 kVA generator (undersized?), $27,397 (too low?)) as a part of long term activities . LVSWSB Feas. Study Project Team recommends including standby generator as part of immediate interventions. Lead time for design , furnishing and installing a generator could be on the order of 6 months or more.	sum	1	$ 100,000	$ 100,000	Estimate ~$75,000 for generator, 35% for engineering, contingency.	
IW-31	2007	2007	TREATMEN	**Kegati WTP - Low lift pumps**	Three of five low lift pumps are operational. Pumps are undersized.	Replace all five pumps with 125 m^3/hr pumps, 35 mhw, as recommended in UN-Habitat Item 1.3.1 (a).	GWASCO 12/10/06 comments note that two low lift pumps were purchased and installed with government funds (125 m_3/hr each). UN-Habitat to procure three more of equal capacity.	No.	3	$ 9,000	$ 27,000	UN-Habitat Nov 2005 estimate, rounded up; UN Estimate included 4 pumps. Now only require three.	
IW-32	2007	2007	TREATMEN	**Kegati WTP - High lift pumps**	Two of five high lift pumps are operational.	Replace all five pumps with 125 m^3/hr pumps, 80 mhw, as recommended in UN-Habitat Item 1.3.1 (a).		No.	5	$ 10,000	$ 50,000	UN-Habitat Nov 2005, round up.	
IW-33	2007	2007	TREATMEN	**Kegati WTP - Backwash pump**	20 hp backwash pump is not operational.	Replace backwash pump as recommended by UN-Habitat Item1.3.1 (a) (UN notes 1 faulty pump, but recommends replacement of 2)		No.	2	$ 7,000	$ 14,000	UN-Habitat Nov 2005, round up.	
IW-34	2007	2007	TREATMEN	**Kegati WTP - Control Panel**	Old intake control panel in need of repair.	Repair control panel as recommended by UN-Habitat 1.3.1 (a)		No.	1	$ 2,000	$ 2,000	UN-Habitat Nov 2005, round up.	
IW-35	2007	2007	TREATMEN	**Kegati WTP - Baffle walls**	Baffle walls required in alum mix chamber to improve efficiency, reduce alum cost	Install additional RC baffle walls in alum mix chamber as recommended by UN-Habitat Item 1.5.1 (a).		Sum	1	$ 1,000	$ 1,000	UN-Habitat Nov 2005, round up.	
IW-36	2007	2007	TREATMEN	**Kegati WTP - Leaking Valves**	3 No. 200 mm sluice valves under filters leaking.	Replace valves as recommended by UN-Habitat Item 1.1.1.		No.	3	$ 1,286	$ 4,000	UN-Habitat Nov 2005, round up.	
IW-37	2007	2007	TREATMEN	**Kegati WTP - Head-loss measurement pipes**	Head-loss measurement pipes needed.	Replace 2 N. head-loss measuring pipes as in UN-Habitat Item 1.5.1 (b).		No.	2	$ 357	$ 1,000	UN-Habitat Nov 2005, round up.	
IW-38	2008	2008	TREATMEN	**Kegati WTP - Intake Rehabilitation**	Siltation at intake results in increased operation costs. Require upgrades, possible infiltration galleries.	Upgrade intake facilities and appurtenant structures as in UN-Habitat Item 1.3.3 (Long Term). Note that although new intake to be constructed upstream on Gucha, assume rehabilitation required until new source constructed.		sum	1	$ 20,000	$ 20,000	UN-Habitat Nov 2005 suggests new intake at Kegati, cost ~$20,000. GWASCO 12/10/06 comments recommends placing new intake at Bobaracho, not Kegati. Assume UN-Habitat allotted funds will be utilized for upgrades to intake.	
IW-39	2008	2008	TREATMEN	**Nyakomisaro WTP - Filter media**	Filter media in need of replacement	Replace filter media as recommended by UN-Habitat Item 1.5.3.		CM	75	$ 29	$ 3,000	UN-Habitat Nov 2005, round up.	
IW-40	2007	2007	TREATMEN	**Nyakomisaro WTP - Alum Dosing**	Alum dosing / mixing chamber in need of repair/expansion.	Rehabilitate / expand alum dosing / mixing chamber as recommended by UN-Habitat Item 1.5.3		m^2	10	$ 229	$ 3,000	UN-Habitat Nov 2005, round up.	
IW-41	2007	2007	TREATMEN	**Nyakomisaro WTP - Troughs**	Troughs are broken and need repair / replacement.	Replace 24 m of 150 mm wide x 100 mm high stainless steel troughs as recommended in UN-Habitat Item 1.5.3.		m	24	$ 57	$ 2,000	UN-Habitat Nov 2005, round up.	
IW-42	2007	2007	TREATMEN	**Nyakomisaro WTP - Decanting Pipes**	Perforated decanting pipes do not allow adequate overflow rate.	Replace decanting pipes with toughs to increase overflow rate as recommended in UN-Habitat Item 1.5.3.		m	16	$ 57	$ 1,000	UN-Habitat Nov 2005, round up.	

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IW-43	2007	2007	TREATMEN	**Nyakomisaro WTP Outlet channel**	Outlet channel not sufficiently sized to allow sufficient flow.	Widen outlet channel from 75 mm to 150 mm to increase flow rate as recommended by UN-Habitat Item 1.5.3.		m	30	$ 29	$ 1,000	UN-Habitat Nov 2005, round up.	
IW-44	2007	2007	TREATMEN	**Nyakomisaro WTP Under Drain Piping**	GI underdrain pipes require replacement.	Replace 2 No. 150 mm GI underdrain pipes as recommended by UN-Habitat Item 1.5.3.		M	12	$ 71	$ 1,000	UN-Habitat Nov 2005, round up.	
IW-45	2007	2007	TREATMEN	**Nyakomisaro WTP Filter Media in Old Works**	Filter media in need of replacement.	Replace filter media as recommended by UN-Habitat Item 1.5.3.		CM	150	$ 29	$ 5,000	UN-Habitat Nov 2005, round up.	
IW-46	2007	2007	TREATMEN	**Nyakomisaro WTP 75 mm sluice valves under filters**	75 mm sluice valves under circular filters need replacement.	Replace sluice valves as recommended by UN-Habitat Item 1.5.3.		No.	6	$ 357	$ 3,000	UN-Habitat Nov 2005, round up.	
IW-47	2007	2007	TREATMEN	**Nyakomisaro WTP 100 mm sluice valves under filters**	100 mm sluice valves under circular filters need replacement.	Replace sluice valves as recommended by UN-Habitat Item 1.5.3.		No.	6	$ 571	$ 4,000	UN-Habitat Nov 2005, round up.	
IW-48	2007	2007	TREATMEN	**Nyakomisaro WTP 150 mm sluice valves under filters**	150 mm sluice valves under circular filters need replacement.	Replace sluice valves as recommended by UN-Habitat Item 1.5.3.		No.	3	$ 857	$ 3,000	UN-Habitat Nov 2005, round up.	
IW-49	2007	2007	TREATMEN	**Nyakomisaro WTP Air Valves on Gravity Main**	Air valve required along gravity main.	Install 100 mm air valves as recommended by UN-Habitat Item 1.5.3.		No.	2	$ 714	$ 2,000	UN-Habitat Nov 2005, round up.	
IW-50	2007	2007	TREATMEN	**Nyakomisaro WTP Air Valves on Main Line**	Air valves required along 150 mm main line.	Install 100 mm air valves as recommended by UN-Habitat Item 1.5.3.		No.	2	$ 714	$ 2,000	UN-Habitat Nov 2005, round up.	
IW-51	2007	2007	TREATMEN	**Nyakomisaro WTP Valve Chambers, Filters**	Repairs needed at valve chambers and filters.	Repair valve chambers and filters as recommended by UN-Habitat Item 1.5.3.		sum	1	$ 3,571	$ 4,000	UN-Habitat Nov 2005, round up.	
IW-52	2007	2007	TREATMEN	**Nyakomisaro WTP Chem. dosing units**	Chemical dosing units need replacement.	Replace 6 No. FRO chlorine/alum/soda ash dosing units as in UN-Habitat Item 1.5.5.		No.	6	$ 2,143	$ 13,000	UN-Habitat Nov 2005, round up.	
IW-53	2007	2007	TREATMEN	**Nyakomisaro WTP Solution tanks**	Solution tanks need replacement.	Replace 6 No. solution tanks for chlorine/alum/soda ash as in UN-Habitat Item 1.5.5.		No.	6	$ 357	$ 3,000	UN-Habitat Nov 2005, round up.	
IW-54	2007	2007	TREATMEN	**Nyakomisaro WTP Solution tank piping**	Solution tank piping required	Install 25 mm pipework and fittings for solution tanks as in UN-Habitat Item 1.5.5.		No.	6	$ 143	$ 1,000	UN-Habitat Nov 2005, round up.	
IW-55	2007	2007	TREATMEN	**Nyakomisaro WTP Head loss measuring pipes**	Head-loss measurement pipes needed.	Install 6 No. head-loss measuring pipes as in UN-Habitat Item 1.5.5.		No.	6	$ 357	$ 3,000	UN-Habitat Nov 2005, round up.	
			DISTRIBUTION										$ 663,000
IW-56	2007	2008	DISTRIBUT	**Hydraulic Model, Distribution System Improvement Plan**	GWASCO should develop and begin to implement a prioritized plan for distribution system improvements, with focus on replacing older water mains.	Review water audit results and system inventory; create hydraulic computer model of system if sufficient data available. Develop a prioritized plan for distribution system improvements. Utilize mapping created under mapping task. GWASCO noted that numerous neighborhoods now have dry pipes, including: Jogoo, Nyanchwa, Nubia, Milimani, Gekomu, Suneka, Nyambera, Nyamataro, Gesonso, Menyinkwa, Kiogoro, Nyaguta, and Nyanko.		Sum	1	$ 40,000	$ 40,000	Estimate ~ $150,000 required for comprehensive study for all source options, potential new service areas, use of existing plant, etc.. Break down into multiple studies.	
IW-57	2007	2008	DISTRIBUT	**Leak Detection and Repair**	Current UfW in Kisii Water Supply system is estimated as > 50%. Need to implement aggressive program to reduce lost water and increase water available for distribution and revenue generation.	Develop and perform System-Wide Leak Detection and Repair program. Program should initially focus on known leaks, then utilize remote leak detection equipment on key water mains. Program should be coupled with investigating and registering/removing illegal connections. Budget should be allocated for repairs. Utilize LVSWSB-owned and operated leak detection equipment and "circuit-rider" (proposed). It should be noted that any programs to increase water pressure in the system may exacerbate existing leaks or create new leaks. Coordination of flow increases should be coupled with the leak detection and repair program. According to GWASCO 12/10/06 comments, they have already begun this process and plan to purchase leak detection equipment.		Sum	1	$ 200,000	$ 200,000	Cost includes 'rental' of circuit rider leak detection equipment and operator from LVSWSB. Expect initial cost to be part of capital funding program, but future leak detection / repair to be covered by operation budget. Assume $35,000 for leak detection study, $150,000 to repair leaks, round up. Actual cost will depend on number of leaks found.	

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IW-58	2007	2008	DISTRIBUT	**Water Kiosks Planning and Pilot**	Water is needed in informal settlements, markets, and other areas to prevent exploitation by water vendors and associated health impacts. According to UN-Habitat, a study by Prof. G. Krhoda showed 90% of wells and springs where people obtain water in Kisii are contaminated. According to Kisii 12/10/06 comments, only one communal water point exists, but plans are in place to construct ten (10). Expect that hundreds of kiosks will eventually be required. Construct two kiosks immediately as pilot program.	Utilize Kiosk and Public Toilet Toolkit (proposed to be created by LVSWSB) to create plan for building, managing, and maintaining kiosks. Include training for kiosk operators. Goal is to ensure residents in informal settlements have access to water within a minimum of 400 meters. Utilize mapping for optimal location of kiosks. Number of kiosks able to be constructed will be dependent on current water supplies, but short term system upgrades should increase available supply. Review plan to build 10 kiosks as follows: Milimani 1 No, Jogoo 2 No, Nubia 1 No., Nyanchwa 1 No, Daraja Mbili 2 No, Town Center 2 No, Mwembe 1 No. Develop plans for major construction of kiosks to meet demands in informal settlements. Immediately install two kiosks as pilot program, including one kiosk for vendors as recommended by UN-Habitat.	UN-Habitat recommendations include one new water kiosk in Jogoo for vendors in immediate interventions (Item 1.4.1 (a)) and three normal kiosks as part of medium term recommendations (Item 1.4.1 (b) and 1.4.2).	Sum	1	$ 30,000	$ 30,000	C&C Estimate $20,000 for planning study, 2 kiosks @ $5,000 (UN-Habitat estimated cost ~$3,500 each, but assume first pilot kiosks more expensive).	
IW-59	2007	2007	DISTRIBUT	**Bobaracho Tanks - Activate**	2 x 250 m^3 tanks not used and were never tested / activated due to power problems and lack of sufficient water. Cannot fill tanks at Bobaracho due to low production and town demand. Therefore cannot serve Nyanguru tank area. Broken pipe leaks between Kegati and tanks also expected to be a problem.	Activate tanks as in UN-Habitat Item 1.5.2. Piping repairs included subsequently.	Bobaracho upgrades included in UN-Habitat Item 1.2.6, medium term interventions.	No.	2	$ 714	$ 2,000	UN-Habitat Nov 2005 estimates $~1,400 to activate tanks, round up; GWASCO requests addition of $30,000 for pipe repairs between WTP and tanks - this is included in short term tasks.	
IW-60	2007	2007	DISTRIBUT	**Bobaracho Tanks - Control Panel**	Pump control panel requires refurbishing.	Refurbish pump control panel as in UN-Habitat Item 1.5.2.		No.	2	$ 429	$ 1,000	UN-Habitat Nov 2005, round up.	
IW-61	2007	2007	DISTRIBUT	**Bobaracho Tanks - Sluice valve**	Sluice valve needed at Bobaracho tanks to increase efficiency of tank utilization.	Install 200 mm sluice valve as in UN-Habitat Item 1.5.6 (b).		No.	1	$ 1,286	$ 2,000	UN-Habitat Nov 2005, round up.	
IW-62	2007	2007	DISTRIBUT	**Milimani Tanks - Leaking Valves**	1 No. 150 mm sluice valve leaking.	Replace valve as recommended by UN-Habitat Item 1.1.1.		No.	1	$ 857	$ 1,000	UN-Habitat Nov 2005, round up.	
IW-63	2007	2007	DISTRIBUT	**Nyakomisaro water main - Leaking AC pipes**	2,000 m 100-mm (4") line from Nyakomisaro / University area to Milimani tanks is old and leaking.	Replace existing main with uPVC as recommended by UN-Habitat Item 1.1.2 (a).	Is this the line going to the Hospital from Milimani tanks? Why not upgrade to 6" minimum? 12/10/06 GWASCO notes that there is already a proposal of a parallel line to serve the Hospital.	m	2,000	$ 11	$ 23,000	UN-Habitat Nov 2005, round up.	
IW-64	2007	2007	DISTRIBUT	**Mwembe Area - Gravity Service**	Customers presently served off rising main.	Install 250 m of 100 mm (4") uPVC in Mwembe, shift consumers from rising main to new gravity line as recommended in UN-Habitat Item 1.1.3.	Map provided by town shows main into Mwembe area.	Sum	5,000	$ 11	$ 58,000	UN-Habitat Nov 2005 estimates 250 m pipe at $11/m plus ~$1,400 for shifting consumers to new main, round up..	
IW-65	2007	2007	DISTRIBUT	**CBD - Water main replacements**	Old AC piping in CBD is leaky.	Replace old mains in CBD with uPVC. Need to determine proper size for main replacements.		m	3,000	$ 80	$ 240,000	UN-Habitat item 1.1.5 (a) defined task, did not assign a cost. Assume 3,000 meters of new main @ $80/m for 10 or 12" main.	
IW-66	2007	2007	DISTRIBUT	**CBD - Non-Return valves (150 mm)**	Non-return valves required to increase pressure	Install non-return valves as in UN-Habitat item 1.2.2.		No.	2	$ 714	$ 2,000	UN-Habitat Nov 2005, round up.	
IW-67	2007	2007	DISTRIBUT	**CBD - Non-Return valves (100 mm)**	Non-return valves required to increase pressure	Install non-return valves as in UN-Habitat item 1.2.2.		No.	1	$ 1,143	$ 2,000	UN-Habitat Nov 2005, round up.	
IW-68	2007	2007	DISTRIBUT	**Jogoo - Pipeline to Lower Jogoo**	Low pressure, lack of service in Jogoo.	Install 500 m of 100 mm (4") uPVC from FTC/Kisii High School Tank to lower Jogoo as in UN-Habitat item 1.2.3.	Rationale for Jogoo pipelines unclear. Refine during system improvement plan development.	m	500	$ 11	$ 6,000	UN-Habitat Nov 2005, round up.	
IW-69	2007	2007	DISTRIBUT	**Jogoo - Loop in Jogoo**	Low pressure, lack of service in Jogoo.	Create loop around Jogoo using upper and lower lines as in UN-Habitat Item 1.2.3.	Rationale for Jogoo pipelines unclear. Refine during system improvement plan development.	m	500	$ 11	$ 6,000	UN-Habitat did not assign cost under Item 1.2.3. Assume 500 m additional main.	
IW-70	2007	2007	DISTRIBUT	**Jogoo - Pipeline to Upper Jogoo**	Limited water accessibility in Jogoo	Install 2,500 m of 100-mm uPVC from Bobaracho to upper Jogoo as in UN-Habitat Item 1.4.1 (a).	Rationale for Jogoo pipelines unclear. Refine during system improvement plan development. Unclear why a redundant pipeline should be installed, and if it passes Kisii Bottlers as shown on map, will it serve Kisii Bottlers? Only 4" line.	m	2,500	$ 11	$ 29,000	UN-Habitat Nov 2005, round up.	
IW-71	2007	2007	DISTRIBUT	**Jogoo - Jogoo Connection to Kisii H.S. Tanks**	Jogoo area storage tanks not efficiently used.	Connect the 2x250 m^3 tanks at Kisii High School to lower Jogoo	UN-Habitat Item 1.5.6 (a) (Lower Jogoo served by line from Kisii High Sch tanks to town over bridge - see GWASCO 12/10/06 comments)	Sum	1	$ 714	$ 1,000	UN-Habitat Nov 2005, round up.	
IW-72	2007	2007	DISTRIBUT	**FTC / Kisii H.S. Tanks - Sluice valve**	Sluice valve needed at FTC/Kisii H.S. tanks to increase efficiency of tank utilization	Install 200 mm sluice valve as in UN-Habitat Item 1.5.6 (b).		No.	1	$ 1,286	$ 2,000	UN-Habitat Nov 2005, round up.	
IW-73	2007	2007	DISTRIBUT	**Air release valves**	Air valves required throughout system to increase pressure	Add 8 air valves as in UN-Habitat Item 1.2.5.	(SEE UN-HABITAT DOCUMENT FOR LOCATIONS)	No.	8	$ 343	$ 3,000	UN-Habitat Nov 2005, round up.	
IW-74	2007	2007	DISTRIBUT	**Spare pipe**	Require spare pipe for water main repairs/replacements.	Purchase repair pipes of various sizes as in UN-Habitat Item 1.6.4.		Sum	1	$ 14,286	$ 15,000	UN-Habitat Nov 2005, round up.	
			SUBTOTAL										**$ 1,940,000**
			SHORT TERM WATER PROJECTS (2008-2015)										
			MANAGEMENT										$ 950,000
SW-1	2009	2010	MANAGEM	**New Offices**	New offices will eventually be required for GWASCO water and wastewater staff.	Purchase office space or construct new offices at existing location as recommended by planning study .		Sum	1	$ 150,000	$ 150,000	Engineering estimate.	
SW-2	2008	2012	MANAGEM	**Replace Existing Consumer Meters (Short Term)**	Town estimates regarding number and age of existing consumer meters are vaguer. Need to implement meter repair and replacement program. Many new connections and meters required to meet demand.	Replace / Install Consumer Meters for all registered customers (>6,000 registered, 3,100 active). Estimate 7,000 meters will be required (extras for some illegal connections).	UN-Habitat Item 1.1.4 (b) recommends requiring all consumers to have functional water meters (30-days notice). Lump sum cost listed is $1,644.	No.	7,000	$ 100	$ 700,000	Various estimates for standard meters vary from $40 to $100. UN 2005 Kisii Report uses $100. Cost may change if remote reading meters used.	
SW-3	2008	2008	MANAGEM	**Land Purchase for Watershed Protection**	Expect that some land purchases to secure protected areas for watershed protection may be required.	Purchase land in Gucha and Nyakomisaro watersheds as required to protect source.		Sum	1	$ 100,000	$ 100,000	Engineering estimate.	

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			SOURCE										$ 2,680,000
SW-4	2009	2010	SOURCE	**Bunyunyu Intake**	Need new intake to meet demand.	Construct new Kuja River intake at Bunyunyu or as determined in study. Likely to be located at future site of dam.		Sum	1	$ 380,000	$ 380,000	JICA Aftercare Study pg II-58, updated to 2005, plus 35%	
SW-5	2008	2010	SOURCE	**Raw Water Pipeline to Bobaracho (Ph I)**	Require pipeline from new Bunyunyu intake source to new WTP at Bobaracho.	Construct pipeline from new Bunyunyu intake source to new WTP at Bobaracho. Add provisions for addition of future second pipeline. Bunyunyu Intake el. 6,050 ft. Bobaracho el. ~6,000 ft. Horizontal distance ~9,000 m.		m	9,000	$ 250	$ 2,300,000	JICA 2001 Migori Study, Table 4.6 estimated $345/m for 600 mm gravity main. Very high - assume $250/m. Note UN-Habitat Item 1.3.3 includes 'new raw water mains' for ~$140,000. No lengths or diameters given.	
			TREATMENT										$ 4,437,000
SW-6	2009	2010	TREATMEN	**New WTP at Bobaracho (Ph I)**	Need new WTP at Bobaracho to treat water from new Kuja River intake. Flow to town by gravity.	Construct New WTP at Bobaracho with final capacity ~18,000 m^3/d (or determined capacity of Kuja River). Include new laboratory facilities.		Sum	1	$ 4,100,000	$ 4,100,000	Aftercare Study II-59 and Fig 5.3.3, updated to 2005, add 35% engineering, contingency. Add $100,000 for additional land purchase. Note UN-Habitat Item 1.3.3 - LONG TERM included ~$164,000 for new WTP, specifics not given.	
SW-7	2008	2009	TREATMEN	**Nyakomisaro WTP - Replace 80-mm GI**	Pipes tuberculated	Replace the tuberculated 80-mm GI treated water pipe with 100-mm as in UN-Habitat Item 1.5.4 - LONG TERM.		m	1,000	$ 50	$ 50,000	UN-Habitat Nov 2005, round up.	
SW-8	2008	2009	TREATMEN	**Nyakomisaro WTP - Replace 100-mm GI**	Pipes tuberculated	Replace the tuberculated 1,500 m x 100-mm GI treated water pipes as in UN-Habitat Item 1.5.4 - LONG TERM.		m	1,500	$ 50	$ 75,000	UN-Habitat Nov 2005, round up.	
SW-9	2008	2009	TREATMEN	**Nyakomisaro WTP - Replace 150-mm GI**	Pipes tuberculated	Replace the tuberculated 1,000 m x 150-mm GI treated water pipes as in UN-Habitat Item 1.5.4 - LONG TERM.		m	1,000	$ 71	$ 72,000	UN-Habitat Nov 2005, round up.	
SW-10	2008	2009	TREATMEN	**Nyakomisaro WTP - Construct Underground Spring Feed**	Increasing turbidity in Nyakomisaro stream results in high chemical costs, poor finished water quality	Construct underground spring sources to feed the water works as in UN-Habitat Item 1.5.4 - LONG TERM.		No.	10	$ 8,571	$ 86,000	UN-Habitat Nov 2005, round up.	
SW-11	2008	2009	TREATMEN	**Nyakomisaro WTP - Pipe Spring to WTP**	Increasing turbidity in Nyakomisaro stream results in high chemical costs, poor finished water quality	Lay 150-mm uPVC pipe linking spring intakes to the water works as in UN-Habitat Item 1.5.4 - LONG TERM.		m	2,500	$ 21	$ 54,000	UN-Habitat Nov 2005, round up.	
			DISTRIBUTION										$ 5,460,000
SW-12	2008	2009	DISTRIBUT	**Distribution System Expansion and Improvement Plan**	The results of the water audit, mapping, and system inventory (pipe ages, size, condition) should be reviewed to develop a prioritized plan for distribution system improvements. It is expected that many existing mains will need replacement due to numerous leaks, tuberculation, or insufficient diameter. Large expansion of existing distribution network is required. Detailed cost estimates for expansion will be required. Consideration will need to be given to results of source augmentation study.	Develop a prioritized plan for distribution system expansion and improvements.		Sum	1	$ 50,000	$ 50,000	Engineering estimate.	
SW-13	2008	2015	DISTRIBUT	**Water Kiosks**	Additional kiosks required to meet demand in informal settlements. Assuming 500 persons served / kiosk / day, hundreds of kiosks will be required.	Construct additional kiosks in informal settlements. Utilize results of pilot study to optimize kiosk location and management.	UN-Habitat Items 1.4.1 (b) and 1.4.2 include construction of two Jogoo kiosks and one in Mwembe for ~$3,400 each.	No.	120	$ 3,000	$ 360,000	UN-Habitat Nov 2005 estimated cost ~$3,500. Assume cost ~$3,000 for bulk installation.	
SW-14	2010	2015	DISTRIBUT	**Distribution System Expansion / Improvements (Ph 1)**	Extensive expansion / repair of existing reticulation system required. Many existing mains require replacement because they are undersized, broken / damaged, or have been dry for many years.	Rehabilitate / Replace main from Kegati to Suneka and from District Water offices in CBD along main road to Kiogoro.	See map sketch estimate.	m	25,000	$ 80	$ 2,000,000	Assume all 300 mm (12") at $80/m. Assume branch main costs incorporated into individual house connection costs. Note Kisii December 2006 comments on #2 include ~$940,000 of repairs to distribution system.	
SW-15	2010	2015	DISTRIBUT	**New Water Service Connections**	Additional water service connections will be required to keep pace with growth.	Install branch mains and water service connections / meters.		ea.	3,600	$ 500	$ 1,800,000	Assume $500/connection. Includes branch main installation cost of ~$400 per connection plus ~$100 for meter. Kericho has ~92 km dist piping and 7,867 registered connections. Therefore ~12 m main / connection * main installation cost of $35/m (cost ~$20-40/m for 100 to 200 mm pipe). UN-Habitat Item 1.1.4 (b) recommends requiring all consumers to have functional water meters (30-days notice). Lump sum cost listed is $1,644.	
SW-16	2010	2015	DISTRIBUT	**Distribution Storage and Pumping**	Existing storage facilities inadequete considering frequent power outages. Total present capacity ~2,400 m^3. Additional storage will be required to meet demand.	Construct sufficient storage to provide one day's demand for 2015 (~16,000 m^3). Assume five (5) additional 2,500 m^3 tanks required. Assume some pumping may be required for some areas.		No.	5	$ 250,000	$ 1,250,000	1998 JICA Aftercare Study Fig 5.3.4 storage cost ~$130,000 (adjusted to 2005 cost) for 2,500 m^3 storage tank. Assume 25% extra for small pumping system, access road; plus 35% engineering & contingency, results in cost of ~$230,000. Say $250,000 each.	
			SUBTOTAL										**$ 13,530,000**
			LONG TERM WATER PROJECTS (2016-2025)										
			MANAGEMENT										$ -
			SOURCE										$ 8,800,000
LW-1	2016	2017	SOURCE	**Bunyunyu Dam**	Need dam / reservoir to meet future demands.	Construct dam / reservoir at Bunyunyu.		Sum	1	$ 6,500,000	$ 6,500,000	NWMP & cited in Nov 2001 Document "Kisii Water Supply Scheme Project Brief", updated to 2005 cost.	

NO.	YR STRT	YR FIN	TYPE	SUMMARY TITLE	OBSERVED PROBLEM / NEED	PROPOSED SOLUTION(S)	NOTES	UNITS	QUAN.	EST. UNIT PRICE (USD)	EST. COST (USD)	COST NOTES	EST. CATEGORY COST (USD)
LW-2	2016	2017	SOURCE	**Raw Water Pipeline to Bobaracho (Ph II)**	Require additional capacity pipeline from new Bunyunyu intake source to new WTP at Bobaracho.	Construct second pipeline from new Bunyunyu intake source to new WTP at Bobaracho to increase capacity.		m	9,000	$ 250	$ 2,300,000	JICA 2001 Migori Study, Table 4.6 estimated $345/m for 600 mm gravity main. Very high - assume $250/m.	
			TREATMENT										$ 3,000,000
LW-3	2016	2017	TREATMEN	**New WTP at Bobaracho (Ph II)**	Expand WTP at Bobaracho to meet demand.	Construct Phase II expansion to meet 2025 demand.		Sum	1	$ 3,000,000	$ 3,000,000	Aftercare Study II-59 and Fig 5.3.3, update to 2005 cost, add 35% engineering and contingency, round. Assume unit costs less than for Phase I because Phase I designed for future expansion.	
			DISTRIBUTION										$ 8,760,000
LW-4	2016	2025	DISTRIBUT	**Water Kiosks**	Additional kiosks required to meet demand in informal settlements	Construct additional kiosks in informal settlements		No.	18	$ 3,000	$ 54,000	Engineering estimate.	
LW-5	2016	2025	DISTRIBUT	**Distribution System Expansion / Improvements (Ph 2)**	Extensive expansion / repair of existing reticulation system required. Many existing mains require replacement because they are undersized, broken / damaged, or have been dry for many years.	Rehabilitate / Replace / Construct water main extending into Jogoo, Gesonso, Nyamataro, Nyaguta, Menyinikwa, Nyanchwa, and other locations as indicated on sketch.	See map sketch estimate	m	60,000	$ 35	$ 2,100,000	Assume all 100-200 mm (4"-8") at $35/m. Assume branch main costs incorporated into individual house connection costs.	
LW-6	2016	2025	DISTRIBUT	**New Water Service Connections**	New water connections and meters required to meet demand. Meters should be installed at all illegal connections.	Install branch mains and water service connections / meters.		No.	10,700	$ 500	$ 5,350,000	Assume $500/connection. Includes branch main installation cost of ~$400 per connaction plus ~$100 for meter. Kericho has ~92 km dist piping and 7,867 registered connections. Therefore ~12 m main / connection * main installation cost of $35/m (cost ~$20-40/m for 100 to 200 mm pipe). UN-Habitat Item 1.1.4 (b) recommends requiring all consumers to have functional water meters (30-days notice). Lump sum cost listed is $1,644. Current number of registered consumer connections is 6,022.	
LW-7	2016	2025	DISTRIBUT	**Distribution Storage and Pumping**	Additional storage required to meet demand.	Construct additional storage to provide one day's demand for 2025 (~27,000 m^3). Five additional tanks expected to be required.		No.	5	$ 250,000	$ 1,250,000	1998 JICA Aftercare Study Fig 5.3.4 storage cost ~9.4 million Kshs (adjusted to 2005 cost) for 2,500 m^3 storage tank. Assume 25% extra for small pumping system, access road; plus 35% engineering & contingency, results in cost of ~$230,000. Say $250,000 each.	
			SUBTOTAL										**$ 20,560,000**

NO.	YR STRT	YR FIN	TYPE	SUMMARY TITLE	OBSERVED PROBLEM / NEED	PROPOSED SOLUTION(S)	NOTES	UNITS	QUAN.	EST. UNIT PRICE (USD)	EST. COST (USD)	COST NOTES	EST. CATEGORY COST (USD)
			IMMEDIATE WASTEWATER PROJECTS / ACTIONS (within ~1 year)										
			MANAGEMENT										$ 60,000
IWW-1	2007	2007	MANAGEM	**On-Site Wastewater Management**	Many on-site wastewater systems (latrines, septic systems, tight tanks, etc..) are expected to be failing and represent an acute public health hazard and a public nuisance. Failing on-site systems contaminate local public and private groundwater and surface water supplies. On-site systems can adequately protect public health and are often more cost effective than public sewers. However, these systems must be appropriately designed and maintained in order to protect public health. Kisii has a single exhauster truck that is contracted out one day per week to Migori. Additional exhauster trucks and / or Vacutug may be required. Improvements to exhauster discharge points are required. No septic system information tracking system exists. No mandatory pumping and inspection program exists.	Develop on-site wastewater system inventory, tracking system, and program for mandatory periodic inspections and pump-outs including model by-laws. Utilize toolkit proposed to be developed at LVSWSB. The system should be integrated with electronic mapping systems to the extent feasible. "Off-the-shelf" software programs may be used, but should be customized for local conditions. The system should include provisions for management of private septage haulers including a manifest system and requiring discharge only at approved facilities. Develop estimates of septage quantities (as a function of pumping frequency) to determine the need for one or more additional trucks. Mandatory pumping program should encourage sewer connections (you must pump every X years, with some of the costs refundable if you connect to the sewer within Y years). Mandatory inspection program would provide information about the long-term adequacy of on-site systems. Consider creating designated exhauster sewer discharge points managed by Gusii. Gusii should require discharge only at designated locations, track discharges via manifest system, include pr	UN-Habitat Item 2.2.2 (Long Term) "Conduct comprehensive off-site and on-site sanitation study for Kisii, $6,849".	Sum	1	$ 30,000	$ 30,000	Engineering estimate.	
IWW-2	2007	2007	MANAGEM	**Public Latrines / Toilets - Inventory, Rehab / Commercialization Plan**	Public latrines and toilets are an important piece of wastewater management infrastructure and should be appropriately regulated, managed, maintained, and expanded. UN-Habitat references 4 No. public toilets.	Evaluate current condition, and determine requirements to bring facilities up to standards set forth in toolkit proposed to be created by LVSWSB (including signage, lighting, security, certified operator, etc..). Collected information should include location, size (number of stalls), if water flush or latrine, if water is available, security and lighting, and current condition. Facilities should be ranked based on facilities easiest to rehabilitate and most frequently used (or potential to be most frequently used once rehabilitated). Develop a plan for rehabilitation and commercialization of the facilities, using the toolkit proposed to be created by LVSWSB.	According to GWASCO 12/10/06 comments, this has begun.	Sum	1	$ 10,000	$ 10,000	Partially completed by local staff. Budget included for limited consultancy.	
IWW-3	2007	2007	MANAGEM	**Sewer Connections Infill Incentive Program**	Sewer connection fee of 10,000 KShs is prohibitive. Current sewer fees of < 5 Kshs/m^3 are too low.	Develop incentive program for encouraging / requiring sewer connections, possibly with LVSWSB financing assistance. Program elements may include: Reduction in 10,000 Ksh fee; provisions for payment over time with increase in tariff per m^3; an "early-connect" discount; public outreach including well-publicized "awards to local businesses who step up (one year free compost?); all new developments must connect if in sewer service area. This program could be applied district-wide.	GWASCO has begun implementing a program. Connection fees for individuals have been reduced to 5,000, commercial connection fee remains at 10,000 and fees for institutions and industries have been raised to 20,000 and 50,000, respectively	Sum	1	$ 10,000	$ 10,000	Engineering estimate.	
IWW-4	2007	2007	MANAGEM	**Large Users Survey**	Other existing and potential large water users not fully understood. Some existing large water users currently rely on their own water sources and wastewater treatment. Existing treatment is poor and these could represent important customers.	Prioritize list of future sewer connections based on major water users. Prioritize list of future sewer connections based on major water users.					$ -	TO BE DONE BY GWASCO STAFF	
IWW-5	2007	2007	MANAGEM	**Large Users Discussions**	Some existing large water users may currently rely on their own water sources and wastewater treatment. Existing treatment may be poor and these could represent important customers.	Begin discussions / negotiations with any large water users not connected to sewer system regarding incentives to connect them to sewer. According to GWASCO 12/10/06 comments, they have already begun this process.					$ -	TO BE DONE BY GWASCO STAFF	
IWW-6	2007	2007	MANAGEM	**Kisii Bottlers effluent monitoring**	Station is in need of upgrade. LVSWSB to work with Kisii Bottlers / Coca Cola to determine pre-treatment system and sampling requirements.	Upgrade for simple effluent monitoring.		Sum	1	$ 5,000	$ 5,000	Engineering estimate.	
			COLLECTION										$ 350,000
IWW-7	2007	2008	COLLECTI	**Wastewater Collection Study**	Existing Suneka WWTF capacity 8,000 m^3/d, but flow estimated at only 500 m3/d. There are only 599 active customers, of which 385 are active according to GWASCO records. Need to increase sewer connections by "infill". The goals are to 1) eliminate on-site disposal problems, 2) "jump start" revenue collection, and 3) increase flows to the sewer system for the flushing benefits. Need to examine neighborhoods to be connected to determine feasibility and if interceptors and localized pumping will be needed. Suneka WWTF is at elevation ~5,000 ft MSL and most of town is at 5,200 to 5,700. Most of service area should be able to be connected without major pumping. Also need to consider collection system upgrades including locking manhole covers, managed septage discharge points, etc...	Examine neighborhoods to be connected to determine feasibility and if interceptors and localized pumping will be needed. Utilize mapping of existing system developed in previous tasks. Propose interceptor routes without pumping. Include locations of public toilets and latrines in plan. Create tiered priority list for new connections. Priority list expected to include: All hospitals; CBD; existing latrines @ markets and those near sewers; prison; schools; slaughterhouses; public buildings; Gusii Institute of Technology; Sports Stadium; Egerton University; coffee factory; Nubian village; one or both Jogoo neighborhoods; other neighborhoods as identified by UN-Habitat. 1st tier: unconnected residents/businesses served with water and adjacent to existing sewers. 2nd tier: Unconnected residents/businesses served with water, in sewer service area, but not directly adjacent to sewer lines. 3rd-tier: Unconnected residents/businesses in sewer service area who are not served with water (but will be soon) and are adjacent to existing sewers. 4th tier : Unconnected residents/businesses in sewer service area n	UN-Habitat Item 2.2.2 (Long Term) "Conduct comprehensive off-site and on-site sanitation study for Kisii, $6,849". NOTE: GWASCO 12/10/06 comments indicate GWASCO has already begun to make additional connections.	Sum	1	$ 30,000	$ 30,000	Engineering estimate.	

NO.	YR STRT	YR FIN	TYPE	SUMMARY TITLE	OBSERVED PROBLEM / NEED	PROPOSED SOLUTION(S)	NOTES	UNITS	QUAN.	EST. UNIT PRICE (USD)	EST. COST (USD)	COST NOTES	EST. CATEGORY COST (USD)
IWW-8	2007	2008	COLLECTI	**Sewer Connections - 1st Tier of Infill Priority List**	Many "easy" connections can be made immediately.	Using infill priority list and incentive program, work to make all the easiest connections (parcels close to existing sewers) first.	UN-Habitat Item 2.1 (Immediate) includes $1,370 for promotion of sewer connections in Jogoo and Item 2.1.1 (Long Term) "Enforce by-laws to maximiza sewar connections, $685", and "Encourage sewer connections in medium to high income areas, $1,370".	No.	200	$ 300	$ 60,000	Engineering estimate. Assume 1st tier connection cost $300, 2nd tier $400, other tiers $500.	
IWW-9	2007	2007	COLLECTI	**Lockable Manhole Covers**	Many missing manhole covers result in sewer blockages, danger to citizens.	Replace manholes with heavy-duty lockable manhole covers.		No.	50	$ 400	$ 20,000	Assume 50 covers @ $400 each. Need to determine number of covers needed and actual cost. UN-Habitat includes this as part of medium tarm interventions (Item 2.1.2); number of manholes (15) seems very low, cost of each cover ($822) seems high.	
IWW-10	2007	2008	COLLECTI	**Exhausters for latrines / septic systems**	Expect to need additional equipment for exhausting latrines and saptic tanks, to be determined as part of on-site wastewater management study.	Consider viability of purchasing a Vacutug for informal settlements and one or more exhauster trucka for Town. Equipment could be operated by private citizens but owned by Town or some other arrangement to encourage entrepreneurship.		Sum	1	$ 120,000	$ 120,000	Assume one vactor-type truck or multiple trailer mounted exhausters, budget $100,000; assume two Vacutug machines @ $7,000, round up. UN-Habitat Item 2.7.1 (b) (Medium term) included $12,329.	
IWW-11	2007	2008	COLLECTI	**Sewer Flushing Equipment, flushing program**	Frequent blockages are a public health hazard and nuisance. Require upgrades to sewer flushing equipment.	Purchase sewer cleaning equipment including rodding, winching, jetting, swabbing equipment. Also repair existing equipment. Develop and implement regular sewer flushing program, including with focus on known problem areas such as Nubian village.		Sum	1	$ 50,000	$ 50,000	UN-Habitat Item 2.7.1 (a) included ~$11,000 for this type of equipment. Assume $30,000 for equipment, $10,000 to develop flushing program.	
IWW-12	2007	2008	COLLECTI	**Public Latrines / Toilets - Rehabilitate / Commercialize**	Existing public toilets and latrines are in need of rehabilitation and should be commercialized to ensure sustainability and income generation. Facilities should be brought up to standards as set out in proposed LVSWSB toolkit.	Rehabilitate and commercialize facilities utilizing priority list and proposed LVSWSB toolkit. Commercialization should include lease agreements as appropriate.	UN-Habitat Item 2.5.1 and 2.5.2 include rehabilitation and commercialization of 4 public toilets including Daraja Mbili @ 100,000 Kshs each for rehab, 20,000 for lease agreements.	No.	4	$ 2,000	$ 8,000	UN-Habitat Kisii Rpt. Item 2.5.1 and 2.5.2 include rehabilitation and commercialization of 4 public toilets @ 100,000 Kshs each for rehab, 20,000 for lease agreements, or about $1,700 each. Assume ~$1,700 each, round up to include limited consultancy, contingency.	
IWW-13	2007	2008	COLLECTI	**Public toilets / *latrines pilot* program**	Insufficient or no latrines at key locations.	Install / replace public toilets or latrines at key locations according to plan and in accordance with LVSWSB toolkit. Include provisions for future conversion to water flush systems, commercialize by establishing fees and an operator to maintain facilities and ensure they are pumped (if latrine). Include provisions for security and lighting (solar?). Assume will construct at market, stadium, bus park. Some may have more or less stalls, which could change price. Construct as pilot program, with balance of facilities to be constructed in short term.		Building with ~10 stalls, wash basins	3	$ 15,000	$ 45,000	UN-Habitat Kisii Nov 2005, Item 2.2.1 and Annex 4 estimates ~$15,000 per building w/ 10 stalls & wash basins. Number assumed for pilot program.	
IWW-14	2007	2007	COLLECTI	**Demo Latrines - Jogoo Primary School**	Jogoo Primary School lacks proper sanitation facilities.	Support 6 No. demonstration latrines at Jogoo Primary School as recommended in UN-Habitat Item 2.6.1 (Medium Term).		No.	6	$ 2,143	$ 13,000	UN-Habitat Nov 2005, round up	
			TREATMENT										$ 30,000
IWW-15	2007	2007	TREATMEN	**Suneka WWTF - Upgrade and Expansion Planning**	Preliminary estimates indicate existing stated facility capacity of 8,000 m3/d may be sufficient for ten years, depending on the number of sewer connections and flow per connection. Long term planning is required to determine adequacy of system and evaluate the need for future expansion, improvements, or new facilities. Detailed study of proposed short term upgrades should be carried out.	If 15- or 20-year capacity does not exist, consider expanding the Suneka site, and/or constructing new facilities elsewhere. Concurrent with that exercise, assess true capacity of the existing works and how that capacity might be increased with low-cost alternatives such as supplemental (solar) aeration, pre-roughing, or other options. Improved effluent quality may be addressed through addition of a constructed wetland between tha last lagoon and the outfall. Consider rapid infiltration if soils allow. A riverbank infiltration system with the ability to harvest algae may be advisable. Consider adding laboratory equipment, algae control baffles, automatic sludge removal, sludge drying lagoon covers, planting bougainvillea.		Sum	1	$ 20,000	$ 20,000	Included in Sewer System Expansion Planning Study	
IWW-16	2007	2007	TREATMEN	**Suneka WWTF - O&M Improvements**	The existing sewerage works represent a major capital asset that desperately needs to be put into better use. Few if any changes are needed to accommodate the immediate sewer connections to be added. However, basic operation and maintenance should immediately be improved. There is no trained operator stationed at the facility, only one watchman. According to GWASCO 12/10/06 comments, only one trained operator available for system, who doubles as foreman. No flow monitoring is done at Suneka WWTF. Need to confirm flow received at plant.	At least one trained operator should be stationed at the facility to perform basic operation and maintenance duties. Staffing levels should be as recommended in Staffing Rationalization Study (proposed) and in 'Waste Stabilization Ponds: A Design Manual for Eastern Africa'. By simply measuring the depth of flow at the influent flow constriction, the flow can be calculated. These measurements should begin immediately by training an operator to use a graduated stick to measure depth and convert to flow. Also, staff noted an ultrasonic flow meter exists in a warehouse and was never installed. The flow meter should be installed.		Sum	1	$ 5,000	$ 5,000	UN-Habitat Item 2.3.3 (a) includes $2,055 for replacement of the ultrasonic flow meter. Include additional funds for limited consultancy, basic operator training for flow measurement, water quality sampling.	
IWW-17	2007	2007	TREATMEN	**Suneka WWTF - Influent and Effluent Sampling**	No water quality sampling is performed. Without this information, the performance of the treatment system cannot be assessed. *It is unclear how much I/I is received at the* WWTF and if this is a problem.	An influent and effluent sampling program should immediately be established in accordance with recommendations in 'Waste Stabilization Ponds: A Design Manual for Eastern Africa' and existing wastewater discharge permit. Immediately a minimum of monthly sampling should be implemented. Until laboratory facilities are functioning, samples should be sent to LVSWSB lab in Kisumu for analysis. Operators should immediately begin to become familiar with sampling techniques and establish a regular pattern of sample collection and a system for sending to Kisumu labs. Basic sampling equipment included under other tasks.		Sum	1	$ 3,000	$ 3,000	Estimate for limited consultancy to set up sampling plan.	
IWW-18	2007	2007	TREATMEN	**Suneka WWTF - Influent Screens**	Existing screens do not remove polyethylene bags.	Install finer screens as per UN-Habitat Item 2.3.1 (a). Note screens should be sized appropriately to avoid unnecessary clogging.		Sum	1	$ 1,000	$ 1,000	UN-Habitat Nov 2005, round up.	
			SUBTOTAL										**$ 440,000**
			SHORT TERM WASTEWATER PROJECTS (2008-2015)										
			MANAGEMENT										$ -

NO.	YR STRT	YR FIN	TYPE	SUMMARY TITLE	OBSERVED PROBLEM / NEED	PROPOSED SOLUTION(S)	NOTES	UNITS	QUAN.	EST. UNIT PRICE (USD)	EST. COST (USD)	COST NOTES	EST. CATEGORY COST (USD)
			COLLECTION										$ 3,640,000
SWW-1	2008	2015	COLLECTI	**Sewer Connections - 2nd Tier of Infill Priority List**	Many "2nd tier" priority list (residents / businesses in sewer service area served by water but not directly adjacent to existing sewer lines) should be connected to existing sewer system which has excess capacity.	Using infill priority list and incentive program, work to make all the easiest connections (parcels closest to existing sewers or requiring least effort) first.	UN-Habitat Item 2.1 (Immediate) includes $1,370 for promotion of sewer connections in Jogoo and Item 2.1.1 (Long Term) "Enforce by-laws to maximize sewer connections, $685", and "Encourage sewer connections in medium to high income areas, $1,370".	ea.	8,000	$ 400	$ 3,200,000	Engineering estimate. Assume 1st tier connection cost $300, 2nd tier $400, other tiers $500.	
SWW-2	2008	2012	COLLECTI	**Establish public toilets / latrines at key locations**	Additional public toilet facilities required to keep pace with demand.	Install / replace public toilets or latrines at key locations according to plan and in accordance with LVSWSB toolkit. Ensure latrines are constructed to be easily converted to flush toilets when water and sewer are available.	UN-Habitat Item 2.2.1 (Medium) "construct public toilet at the stadium - upper gate opp. Garage, $13,699" and 2.2.2 "Conduct comprehensive off-site and on-site sanitation study for Kisii, $6,849"	No.	29	$ 15,000	$ 435,000	UN-Habitat Kisii Nov 2005, Item 2.2.1 and Annex 4 estimates –$15,000 per building w/ 10 stalls & wash basins.	
			TREATMENT										$ 160,000
SWW-3	2008	2008	TREATMEN	**Suneka WWTF - Lab and office facilities**	Lab facilities were intended but were never installed.	Install laboratory facilities to take basic daily measurements at Suneka facility. Upgrade offices.	UN-Habitat includes under Item 2.3.3 (b), but references their costs under the water section.	Sum	1	$ 25,000	$ 25,000	Engineering estimate.	
SWW-4	2008	2010	TREATMEN	**Suneka WWTF - Algae Control Baffles**	No algae control baffles ere installed at facility effluent resulting in high algae load to receiving stream. Floats near discharge seem to indicate such a baffle existed in the past.	Install (or re-install) algae control baffles.		Sum	1	$ 10,000	$ 10,000	Engineering estimate.	
SWW-5	2008	2010	TREATMEN	**Suneka WWTF - Automatic sludge removal valves**	Automatic sludge removal valves appear to not be working.	Repair and utilize automatic sludge removal valves if not operational. Institute program for regular exercising and maintenance.		Sum	1	$ 10,000	$ 10,000	Engineering estimate.	
SWW-6	2008	2010	TREATMEN	**Suneka WWTF - Sludge removal**	Sludge not removed from sludge drying beds. Beds filled with water, hyacinths. Primary ponds may require desludging to increase capacity.	Desludge primary and sludge drying lagoons as required. Prior to desludging ponds, a simple tube water core sampler (such as NASCO Sludge Judge) should be purchased and used to determine sludge depth. Such a device could be operated from a small boat launched in the pond. This information could be used to prioritize which basins are desludged first and how sludge may be removed. Consideration should be given to obtaining a gasoline driven pump to desludge some ponds without draining.	During our visit sludge was manually being removed from the primary ponds by laborers. Any sludge removal activities should be directed by a trained lead operator and a clear chain of command should be established.	Sum	1	$ 40,000	$ 40,000	UN-Habitat Item 2.3.1 (a) (Immediate) includes $3,288 for removing 1,200 CM of sludge from primary ponds. UN-Habitat Item 2.3.1 (b) (Medium) is "Dredge and empty sludge drying beds, incl. safe disposal, esp. water hyacinth, 10,000 CM, total $34,247". Round up.	
SWW-7	2008	2010	TREATMEN	**Suneka WWTF - Sludge drying lagoon covers**	Sludge drying lagoons filled with water, from rain or runoff.	Add open-sided transparent enclosures for drying beds as installed in Kericho reduce rain entering ponds. More information required on design intent of existing drying beds and anoxic lagoons.		m2	3,000	$ 4	$ 10,500	Engineering estimate.	
SWW-8	2008	2010	TREATMEN	**Suneka WWTF - Sludge composting / reuse**	Sludge is an unused resource which could be used to create a soil amendment or compost either directly from the sludge or using a supplement form the solid waste stream (including agricultural wastes, bagasse).	Design and construct sludge handling and composting facility for WWTF. Utilize simple drying beds, composting techniques. Develop program to create soil amendment / compost and use for on-site planting (bougainvillea), off-site plantings (at public toilets or other public facilities), access road stabilization, or other uses. On-site plantings may serve as an on-site demonstration of one option for sludge re-use in anticipation of a future large-scale program. This will involve both engineering and marketing tasks.		Sum	1	$ 50,000	$ 50,000	Assume $10,000 for study, $40,000 for adding facilities.	
SWW-9	2008	2010	TREATMEN	**Suneka WWTF - Plant bougainvillea**	Odors may be reduced by planting bougainvillea around WWTF.	Plant bougainvillea around sewage treatment plant, 1.0 m apart.	UN-Habitat Item 2.4.1. Note: This should be combined with sludge re-use program.	m	600	$ 3	$ 1,714	UN-Habitat Nov 2005	
SWW-10	2008	2010	TREATMEN	**Suneka WWTF - Effluent reuse**	Potential exists for reusing wastewater effluent for irrigation, aquaculture or other uses downstream of Suneka WWTF.	Obtain information on predominant crops, water and nutrient needs, and proximity (downgradient preferred) of Suneka works. Evaluate feasibility of re-use. Explore options for effluent reuse / polishing including aquaculture, constructed wetlands, sugar cane, bamboo grown downstream of treatment facilities.		Sum	1	$ 5,000	$ 5,000	Engineering estimate.	

APPENDIX 6-3

Kisii Immediate Action Items

KISII

Recommended Immediate Gusii Actions

NO.	SUMMARY TITLE	IMMEDIATE ACTION
IW-1	**Mapping**	Compile central file and list of all existing maps for use in creation of comprehensive water and wastewater system mapping. Mapping showing roads, land use, population distribution, and all water and wastewater infrastructure including facilities layouts should be assembled. Sources may include physical development plans prepared by national, regional, and municipal government, KISII and its consultants, and other sources. STATUS: Partially complete. Several maps were provided as part of current feasibility study, but most maps, including water system map, were not-to-scale sketches. Copy of wastewater collection system layout was obtained by project team in Nairobi and copy provided to Gusii. Water system map should be redrawn on Survey of Kenya map and UN-Habitat satellite image. UN-Habitat satellite image map does not cover entire water and wastewater system coverage.
IW-4	**System Inventory, Asset Management Plan**	Compile a list of all major equipment, piping, tanks, and treatment systems required for creation of a system inventory. Available data such as age, expected useful life, condition, service history, and nameplate data should be included. Financial value of assets and list of depreciated assets should be included.
IW-5	**Preventative Maintenance Plan**	Compile manufacturer's recommendations for equipment maintenance; compile list of current preventative maintenance schedules / practices.
IW-6	**O&M Manuals, Information on Existing Infrastructure**	Collect all available O&M manuals for existing facilities and equipment. Catalog this information and determine which systems lack proper manuals. Make copies of existing manuals and store at a centralized location. Obtain equipment manufacturer's manuals or design engineer manuals / reports for all equipment and facilities.
IW-7	**Illegal Connections**	Develop a list of the neighborhoods (and indicate on map) where the highest number of illegal connections are expected to exist. Estimate expected number of illegal connections in each area. This information will be used in developing a strategy to remedy this problem.
IW-9	**Staffing Planning**	Compile list of all staff, titles, duties, and salaries for use in proposed staffing planning study. STATUS: Partially complete. Gusii provided list of 39 water staff names and titles.
IW-11	**Watershed Protection Program**	Develop list of suspected and known threats to existing and proposed future water supplies in Gucha and Nyakomisaro watersheds as initial step in developing watershed protection plan. Include list of specific farming operations, industries, etc.. including location and description of activities. Initiate discussions with farming community about implementing best management practices to protect water supplies.

NO.	SUMMARY TITLE	IMMEDIATE ACTION
IW-12	**Public Education**	Develop ideas for most effective ways to distribute public education materials. Identify schools that should be targeted for public education campaigns. Begin developing ideas ("brainstorm") for public education materials to be distributed with bills. Review examples of U.S. Consumer Confidence Reports and consider developing similar materials. Review available public education materials on USEPA's website at http://www.epa.gov/epahome/educational.htm.
IW-18	**Computerize record-keeping and billing**	An electronic database of all water and sewer customers should be created including customer name, account number, active/inactive status, location, meter age, all meter readings, bills sent, payments received. Gather all information required to create database and begin to create database if computers available.
IW-25	**Source Augmentation Study**	Establish flow and water quality monitoring station at proposed intake and dam location on Gucha River near Bunyunyu. Begin taking measurements in accordance with GOK requirements. Compile electronic database of historic data on Gucha flow and water quality data (may need to obtain historic data from WRMA). Ensure historic data is from closest station to proposed intake and dam location, obtain latitude/longitude of station. Gather any other existing data regarding previous dam investigations (possibly performed at national level) and create file of all previous studies. Determine status of existing water withdrawal permits. Determine permitting needs for dam and increased withdrawal from Gucha River. If possible, determine exact elevations of Bobaracho, Kegati, and proposed dam site at Bunyunyu.
IW-28	**WTP sampling data**	Begin program for regularly collecting water quality samples at water treatment facility influent and effluent in accordance with permit requirements, including QA/QC. Testing may initially be done at LVSWSB lab in Kisumu.
IW-57	**Leak Detection and Repair**	Create list of known largest water leaks (and indicate on map) in the system in order to begin to prioritize rehabilitation and replacement programs. Include size and age of water main, and type of pipe.
SW-6	**New WTP at Bobaracho (Ph I)**	Determine availability of land at Bobaracho for constructing new water treatment facility. Evaluate cost to purchase surrounding parcels.
IWW-1	**On-Site Wastewater Management**	Begin to develop database of existing on-site wastewater disposal systems including, at a minimum: property address, owner's name, type and size of system, year installed, last time sludge was pumped, and whether or not a private drinking water well exists on-site. Consider a survey mailing.
IWW-2	**Public Latrines / Toilets - Inventory, Rehab / Commercialization Plan**	Create inventory of existing facilities. Collected information should include location, size (number of stalls), if water flush or latrine, if water is available, security and lighting, and current condition. STATUS: According to Gusii 12/10/06 comments, this has begun.

NO.	SUMMARY TITLE	IMMEDIATE ACTION
IWW-3	**Sewer Connections Infill - Incentive Program**	Develop incentive program for encouraging / requiring sewer connections, possibly with LVSWSB financing assistance. Program elements should include: Reduction in 10,000 Ksh domestic connection fee and provisions for payment over time; increase tariff per m3 - current fee of ~2.5 Kshs/m3 is too low; an "early-connect" discount on connection fees; public outreach including well-publicized awards to local businesses who connect; require all new developments to connect if within sewer service area; etc... STATUS: Gusii has begun implementing a program to reduce up-front costs. Domestic connection fees have been reduced from 10,000 Kshs to 5,000; commercial connection fee remains at 10,000 and fees for institutions and industries have been raised to 20,000 and 50,000, respectively.
IWW-5	**Large Users Discussions**	Begin discussions / negotiations with any large water users not connected to sewer system regarding incentives to connect them to sewer. Include all hospitals and clinics; CBD; existing latrines / public toilets near sewers; all schools and universities; all public buildings; sports stadiums; hotels; restaurants; etc... According to Gusii 12/10/06 comments, they have already begun this process.
IWW-6	**Kisii Bottlers effluent monitoring**	Upgrade effluent monitoring station for simple effluent monitoring. Work with Kisii Bottlers / Coca Cola / LVSWSB to determine pre-treatment system and sampling requirements.
IWW-9	**Lockable Manhole Covers**	Compile list of the exact number of lockable manhole covers required and note locations on existing sewer network layout map. A copy of the sewer network layout map was provided by U.S. project team in August 2006. Existing copy at town was tattered and illegible.
IWW-16	**Suneka WWTF - O&M Improvements**	Measure cross section dimensions of influent flow constriction in order to develop depth-flow relationship. Immediately begin measuring depth of flow at the influent flow constriction using a simple graduated measuring stick. Train an operator or security guard to use measuring stick to measure depth and record in a field notebook. If an operator or security guard is present all day, take measurements hourly to establish flow pattern. Otherwise, take hourly measurements whenever on-site.
IWW-17	**Suneka WWTF - Influent and Effluent Sampling**	Implement influent and effluent sampling program in accordance with recommendations in 'Waste Stabilization Ponds: A Design Manual for Eastern Africa' and existing wastewater discharge permit. Until laboratory facilities are functioning, samples should be sent to LVSWSB lab in Kisumu for analysis. Operators should immediately begin to become familiar with sampling techniques and establish a regular pattern of sample collection and a system for sending samples to Kisumu labs for analysis.
SWW-6	**Suneka WWTF - Sludge removal**	Purchase and use a simple tube water core sampler (such as NASCO Sludge Judge) to determine sludge depth in primary lagoon and sludge drying lagoons. Such a device could be operated from a small boat launched in the pond. This information will be used to prioritize which basins are desludged first and how sludge may be removed.
SWW-10	**Suneka WWTF - Effluent reuse**	Obtain information on predominant crops, water and nutrient needs, and proximity (downgradient preferred) to Suneka works for future evaluation of feasibility of water re-use.

APPENDIX 6-4

Letter to UN-Habitat containing comments on UN-Habitat's immediate intervention recommendations in Kisii (5/15/2006)

COLER & COLANTONIO INC
ENGINEERS AND SCIENTISTS

15 May 2006

Mr. Graham Alabaster
United Nations Human Settlements Programme
P.O. Box 30030 GPO
Nairobi 00100
Kenya

Dear Mr. Alabaster:

Based on discussions during our meeting on 28 April 2006 in Nairobi, we understand UN-Habitat will soon move forward with tendering for immediate improvements in Kisii as described in the November 2005 Consolidated Final Field Report. *As promised during our meeting*, we offer the following comments focused on the proposed immediate interventions with the hope that a fresh perspective may enhance the immediate improvements.

The comments below reference Section 6.3 – Detailed budget for immediate activities.

1. Water Supply

We recommend a watershed protection program be included in the immediate interventions. Such a program can be implemented concurrently with the immediate interventions. The program should include assessment of existing and anticipated threats to public and private water quality and mitigation measures.

We do not have raw and finished water quality sampling data from the two water treatment facilities. Is such data available? If so, could you please provide us with any data you have? If sufficient data is not available, we suggest that a program of raw and finished water quality sampling be added to the immediate interventions. A regular schedule for sampling should be established so that the operators become accustomed to sampling with regularity. Until laboratory equipment is installed locally, testing could be done at the LVSWSB laboratories in Kisumu. Such sampling data would prove invaluable for evaluating system performance and planning future improvements. In your equipment purchase program, you may wish to consider inclusion of raw and finished water sampling equipment if not already available.

Does UN-Habitat have river gauging information for the Gucha (a.k.a. Kuja) River and Nyakomisaro Stream? If so could you please provide us with this information?

1.1 Control unaccounted-for-water

Installing and replacing bulk water meters at treatment facilities, pumping stations, and at key locations in the distribution network should be a priority. Data gained from such meters will be very helpful in designing long-term interventions.

Installing residential water meters is included in the medium to long term interventions. An incentive program to encourage flat rate customers to install water meters should be included with provisions for deferment of up-front costs and other incentives. The approach outlined in the report is to require flat

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rate customers to purchase their own meters within a stipulated period. Without commensurate incentives and cost deferment, such a program may not be successful.

1.2 Increase pressure in the water supply system

We are still formulating our understanding of system operation and are not as yet able to comment on these improvements. However, additional water pressure may cause unintended leaks or exacerbate existing leaks and cause further water loss. We recommend coordination of these improvements with a leak detection program.

1.3 Increase flow of water into the water supply system

As noted above, additional flow may cause unintended leaks or exacerbate existing leaks and cause further water loss. We recommend coordination of these improvements with a leak detection program.

No mention is made of the existing electrical power supply and voltage fluctuation problem. Without addressing the power problem, some interventions may be ineffective. We suggest consideration of providing standby generators as part of immediate interventions. We are currently investigating possible remedies for the voltage fluctuation issue and hope to make further recommendations in this regard.

1.4 Increase water accessibility in specific areas

A program for commercialization of public water kiosks should be included, as is included for public toilets. Such a program should be formal and professional to ensure that participants take pride in their work and strive to maintain high quality service. Only one water kiosk is included in the immediate interventions. Could more be included?

Does a map exist showing the locations of all water kiosks in Kisii? If so, could we be provided with a copy? If no such map exists, one should be created showing existing water kiosks, population density, and piped water availability. These factors will be important in determining the location of future proposed water kiosks.

In addition, UN-Habitat may want to consider a rainwater harvesting program including design and equipment support as an interim measure for people not connected to the water system or who have a dry connection.

1.5 Reduce overall expenditure on the water supply system

When making any changes such as the recommended connection of Kisii High School Tanks to lower Jogoo, such changes should be reviewed within the context of the entire system operation to avoid detrimental impact to existing service areas.

We do not presently have maps showing the proposed improvements. Do such maps exist and if so could we get a copy?

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1.6 Capacity building for improved overall management efficiency

Training of staff in meter repair and calibration and computer facilities operation should be included. Consideration should be given to computer security issues to ensure that people's information and the computers themselves are secure. Consideration should also be given to how power availability may present a problem for computer use. Raw and finished water sampling equipment should be included if not already available.

2. Sewerage and on-site sanitation

2.1 Increase flow in the sewage system
Promote sewer connections in upper Jogoo

We will provide suggestions on developing a program to increase sewer connections including financial assistance and reduced up-front costs (with a program similar to the one noted above for residential water customer meters). Such a program could be piloted in Kisii and successful elements applied in other communities.

Could the installation of lockable manhole covers be moved from medium-term to immediate interventions?

Number 2.2 is missing.

2.3 Increase sewage treatment efficiency and effectiveness
2.3.1 (a) Primary treatment (screens, desludging)
Install finer screens at the grit chamber to hold polythene
Desludge the primary ponds

Finer screens should be sized appropriately to avoid unnecessary clogging. Desludging of the first primary pond was apparently underway during our visit. The desludging was being accomplished manually by shoveling. We were uncertain who requested that the ponds be desludged. A trained lead operator should make such decisions and a clear chain of command should be established.

Prior to desludging ponds, we recommend that a simple tube water core sampler (such as the NASCO Sludge Judge® or similar) be purchased and used to determine sludge depth. Such a device could be operated from a small boat launched in the pond. This information could be used to prioritize which basins are desludged first and how sludge may be removed. A gasoline driven pump may be used to desludge some ponds without draining. Existing sludge wasting valves should be inspected to ensure they work properly. If they are not functioning, they should be repaired and a program instituted for regular maintenance.

2.3.3 (a) Management of treatment throughput (immediate)
Replace ultrasonic flow meter at the sewage treatment works

It is our understanding that an ultrasonic flow meter was purchased during the facility's construction and is now in storage. The meter may only need to be installed. In addition to the installation and regular maintenance of the ultrasonic flow meter, we recommend that an operator be trained to

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manually take flow measurements by determining depth of flow in the flume with a simple graduated stick and converting this measurement to flow. Flow measurements should be taken multiple times daily.

We also recommend that a program of influent and effluent sampling should be added to the immediate interventions. A regular schedule for sampling should be established so that the operator(s) become accustomed to sampling with regularity. Until the laboratory equipment is installed locally, testing could be done at the LVSWSB laboratories in Kisumu. Such sampling data would prove invaluable for evaluating system performance and planning future improvements including constructed wetlands.

During our visit, it appeared that a floating baffle may have previously existed around the discharge pipe in the final lagoon. Floats used to hold the baffle were still in the pond. It is assumed that such a baffle may have been intended to remove algae from the effluent stream. The baffle was not functioning and the effluent was bright green due to algae. We recommend installing (or re-installing) a floating baffle at the discharge from the final lagoon to remove algae from effluent stream.

2.4 Protect sewage treatment plant from environmental risks
2.4.1 Plant bougainvillea around the sewage treatment plant, 1.0 m apart

We suggest using the material excavated from the desluged ponds and drying beds as potting soil for the bougainvillea. Such use would serve as an on-site demonstration of one option for sludge re-use in anticipation of a future large-scale program. The excavated material could also be used for similar plantings at public toilets or other public facilities.

2.5.1 Rehab and commercialize existing 4 No. public toilets
2.5.2 Lease agreements for existing public latrines

We agree that rehabilitation and commercialization of public toilets should be a priority. Does a map exist showing the locations of all public toilets in Kisii? If so, could we be provided with a copy? If no such map exists, one should be created showing existing public toilets, population density, and piped water availability. These factors will be important in determining the location of future proposed public toilets. Consideration should be given to installing latrines that can be easily converted to public toilets when water and sewer become available.

2.5.3 Income Generation / On-Site Sanitation

- *SANPLAT program*
- *Integrated School Sanitation – construction of sanitation facilities for selected health centers at 10 primary schools.*

Without additional detail, we are unable to comment on these programs. However, it should be noted that schools and public institutions should be connected to the existing sewer system whenever possible and should serve as an example to private entities. Also, as noted above, consideration should be given to installing latrines that can be easily converted to public toilets when water and sewer become available.

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2.7 Capacity building
2.7.1 Tools and equipment for effective clearing of sewer lines

UN-Habitat may wish to consider ensuring that adequate water via a tap / spigot / hydrant is available at all locations where septage exhausters discharge. This will ensure sewers can easily be flushed at those locations, possibly by the exhauster drivers.

We recommend adding another item (2.71 (b) – Provide tools and equipment for wastewater treatment facility monitoring). This equipment should include:

- Sludge Judge® or similar tube water core sampler
- Measurement stick for determining flume water level / flow rate
- Sampling bottles and grab sampler for taking influent and effluent samples (some of this may be available from LVSWSB)

These items are relatively low cost, but will provide information important for determining facility performance and future decisions regarding facility improvements.

UN-Habitat may wish to consider phasing of the proposed immediate interventions. Will the immediate wastewater improvements be implemented before or after LVSWSB takes over operation from the city? If the improvements will be implemented before LVSWSB takes over operation, measures should be in place to ensure handover of all equipment and knowledge associated with the improvements. We recommend delaying purchase of equipment associated with wastewater treatment plant operation until a qualified wastewater treatment facility operator is in place.

2.7.2 Materials and training for sewage management personnel

The operation manual and training should include how to use water core sampler, how to determine flow from flume water level measurements (manual or with ultrasonic flow meter), and basic infludnet and effluent sampling procedures.

2.7.3 Purchase computers, printers and software

Training of staff in computer operation should be included. Consideration should be given to computer security issues to ensure that people's information and the computers themselves are secure. Consideration should also be given to how power availability may present a problem for computer use.

2.7.4 Transport facilities (motor cycles)

No comments.

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We hope these comments may offer some enhancement of your immediate interventions. If you have any questions, please do not hesitate to contact me at mdevine@col-col.com or +1 781 982 5468.

Sincerely,

COLER & COLANTONIO, INC.

Mr. Mark Devine, P.E.
Water & Wastewater Division Manager

cc: Kalyan Ray, UN-Habitat
Karen Levine, Permanent U.S. Representative to UNEP and UN-Habitat
Eng. Patrick Ombogo, CEO, Lake Victoria South Water Services Board
Eng. Petronilla Ogut, Technical Manager, Lake Victoria South Water Services Board
Mr. Mark Ongonge, Kisii Area Manager
Peter Wanday, CAPEconsult

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APPENDIX 7-1

Migori Detailed Water Demand and Wastewater Flow Estimates

Migori Domestic Water Consumption and Wastewater Flow Projections

Part A. Domestic Service Connection Projections

	Initial (2005)		Future (2015)		Ultimate (2025)	
Population	**100%**	**124,300**	**100%**	**180,527**	**100%**	**235,573**
High/Medium Income	**53%**	**65,879**	**60%**	**108,316**	**70%**	**164,901**
IWC	15%	9,882	40%	43,326	50%	82,451
NWC, ISA	64%	42,163	39%	42,243	29%	47,821
NWC, NISA	21%	13,835	21%	22,746	21%	34,629
ISC	0%	-	25%	27,079	35%	57,715
NSC, ISA	50%	32,940	25%	27,079	15%	24,735
NSC, NISA	50%	32,940	50%	54,158	50%	82,451
Low Income	**47%**	**58,421**	**40%**	**72,211**	**30%**	**70,672**
IWC	0%	-	20%	14,442	30%	21,202
NWC, ISA	50%	29,211	28%	20,219	17%	12,014
NWC, NISA	50%	29,211	52%	37,550	53%	37,456
ISC	0%	-	15%	10,832	25%	17,668
NSC, ISA	40%	23,368	25%	18,053	15%	10,601
NSC, NISA	60%	35,053	60%	43,326	60%	42,403
		-		-		-

TOTALS FOR ALL INCOME GROUPS

IWC	8%	9,882	32%	57,769	44%	103,652
NWC, IWSA	57%	71,373	35%	62,462	25%	59,836
NWC, NISA	35%	43,045	33%	60,296	31%	72,085
ISC	0%	-	21%	37,911	32%	75,383
NSC, ISA	45%	56,308	25%	45,132	15%	35,336
NSC, NISA	55%	67,992	54%	97,485	53%	124,854
Pop. in Water Service Area*	65%	81,255	67%	120,231	69%	163,488
Pop. in Wastewater Service Area**	45%	56,308	46%	83,042	47%	110,719

NOTES:

IWC	Individual Water Connection	ISC	Individual Wastewater Connection
NWC, ISA	No Water Connection, In Water Service Area	NSC, ISA	No Wastewater Connection, In Wastewater Service Area
NWC, NISA	No Water Connection, Not in Water Service Area	NSC, NISA	No Wastewater Connection, Not in Wastewater Service Area

*Based on population distribution mapping presented in JICA 2001, approximately 65% of Migori population lives within proposed service area.

Projections of Service Area Population are in line with LVSWSB projections for Migori Urban Center population from MIWASCO Rapid Assessment.

**Based on population distribution mapping presented in JICA 2001, approximately 45% of Migori population lives within proposed service area.

Migori Domestic Water Consumption and Wastewater Flow Projections

Part B. Domestic Water Consumption and Wastewater Flow Projections

	Per Capita Water Consumption or WW Flow (m^3/d)*	Initial (2005) Water Consumption (m^3/d)	Initial (2005) Wastewater Flow (m^3/d)	Future (2015) Water Consumption (m^3/d)	Future (2015) Wastewater Flow (m^3/d)	Ultimate (2025) Water Consumption (m^3/d)	Ultimate (2025) Wastewater Flow (m^3/d)
High/Medium Income							
IWC**	0.120	1,186		5,199		9,894	
NWC, ISA	0.020	843		845		956	
NWC, NISA	-	-		-		-	
ISC	0.10		-		2,600		5,541
NSC, ISA	0.016		527		433		396
NSC, NISA	-		-		-		-
Low Income			-		-		-
IWC	0.075	-		1,083		1,590	
NWC, ISA	0.020	584		404		240	
NWC, NISA	-	-		-		-	
ISC	0.06		-		650		1,060
NSC, ISA	0.016		374		289		170
NSC, NISA	-		-		-		-
TOTAL		**2,613**	**901**	**7,532**	**3,972**	**12,681**	**7,166**

NOTES:

IWC	Individual Water Connection	ISC	Individual Wastewater Connection
NWC, ISA	No Water Connection, In Water Service Area	NSC, ISA	No Wastewater Connection, In Wastewater Service Area
NWC, NISA	No Water Connection, Not in Water Service Area	NSC, NISA	No Wastewater Connection, Not in Wastewater Service Area

* Based on per capita values presented in 2005 Design Manual and WHO Report #9, except where noted.

** Due to very low present per capita water use in Migori, assume use for High/Med category 120 lpcd, not 150 lpcd as per GOK guidelines.

Migori Large Water Users Consumption Projections

	Initial (2005)** m^3/d	Future (2015)*** m^3/d	Ultimate (2025)*** m^3/d	Notes
Market Day Additional Demands*	250	370	522	Assumes 50,000 people @ 5 l/h/d
Prinsal Fish Factory*	55	81	115	Current use varies from 70 m3/d to 40 m3/d
Migori Teacher's College*	86	127	179	Aug 2005 Wastewater Disposal System Report Aug 2005
Migori District Hospital	10	15	21	Based on Migori Water Supply 2005 records**
St. Joseph's Mission Hospital*	45	67	94	Est. 200 beds @ 200 l/bed/d + 5,000 l/d outpatient
Migori Secondary School	3	4	6	Based on Migori Water Supply 2005 records**
Fisheries Department	8	12	16	Based on Migori Water Supply 2005 records**
G.K. Prison	16	24	34	Based on Migori Water Supply 2005 records**
Shops	24	36	51	JICA 2001 report table 4.3 - assumes 242 shops @100 l/d
Low Class Hotels	2	3	4	JICA 2001 report table 4.3 - assumes 40 beds @ 50 l/d
Garages	7	10	14	JICA 2001 report table 4.3 - assumes 13 @ 500 l/d
Other Schools	55	81	115	JICA 2001 report table 4.3 - assumes 11,000 students @ 5 l/d
Dispensiaries	70	104	146	JICA 2001 report table 4.3 - assumes 14 @ 5,000 l/d
Bakery				Unknown water use. Cited by Mikutra as large user.
TOTAL Large User Water Consumption	631	933	1,317	

Notes:

* Not currently connected to Migori water supply.

** MIKUTRA records may be inaccurate due to unknown meter age/condition.

*** Future and Ultimate year projections assume growth of 4% per anum initially, then 3.5% during 2015-2025.

Migori Total Water Consumption Projections

	Initial (2005)* m^3/d	Future (2015) m^3/d	Ultimate (2025)** m^3/d
Total Domestic Water Consumption	2,613	7,532	12,681
Total Large User Water Consumption	631	933	1,317
TOTAL Water Consumption	3,244	8,465	13,997

Notes:

* Actual present water production is approximately 450 m^3/d. Water consumption is presently estimated at 227 m3/d.

** It is expected that by 2025 the proposed new Oyani River intake may be capable of producing 16,000 m^3/d based on low flow information from MIKUTRA. UfW is assumed to be 15% by 2025. Therefore, the entire projected water demand may not be met in 2025.

Migori Wastewater Flows From Large Users Projections

	Initial (2005)* m^3/d	Future (2015)** m^3/d	Ultimate (2025)** m^3/d	Notes
Market Day Additional Demands	200	296	418	
Prinsal Fish Factory	44	65	92	
Migori Teacher's College	68	101	143	
District Hospital	8	12	17	
St. Joseph's Mission Hospital	36	53	75	
Migori Secondary School	2	3	5	
Fisheries Department	6	9	13	
Migori Prison	13	19	27	
Shops	19	29	40	
Low Class Hotels	2	2	3	
Garages	5	8	11	
Other Schools	44	65	92	
Dispensiaries	56	83	117	
TOTAL Large User Wastewater Flow	105	156	220	

Notes:

* No municipal sewer system presently exists in Migori.

** Flow projections assume 80% of water use converted to wastewater (per WHO Report #9) and that all above facilities are connected to wastewater system.

Migori Total Wastewater Flow Projections

	Initial (2005)* m^3/d	Future (2015) m^3/d	Ultimate (2025) m^3/d
Total DomesticWastewater Flow	901	3,972	7,166
Total Large User Wastewater Flow	105	156	220
TOTAL Wastewater Flow	1,006	4,127	7,386

Notes:

* No municipal sewer system presently exists in Migori.

APPENDIX 7-2

Migori Detailed Projects, Phasing, and Cost Estimation Matrix

MIGORI

Recommended Immediate MIKUTRA Actions

Recommended Projects and Preliminary Cost Estimates

WATER | WASTEWATER | 1 USD = 70 Kshs

WATER & WASTEWATER

NOTES / UNUSED

Ph	NO.	YR STRT	YR FIN	TYPE	SUMMARY TITLE	OBSERVED PROBLEM / NEED	PROPOSED SOLUTION(S)	NOTES	UNITS	QUAN.	EST. UNIT PRICE (USD)	EST. COST (USD)	COST NOTES	EST. CATEGORY COST (USD)
				IMMEDIATE WATER PROJECTS / ACTIONS (Within ~1 Year)										
IW				MANAGEMENT										$ 670,000
IW	IW-1	2007	2007	MANAG	**Mapping**	System map and town maps provided by MIKUTRA and Migori require updating and should be digitized. Proposed improvements are very difficult to conceptualize, cost, and prioritize without being shown on updated, scale maps. Mapping is very important for almost all future activities.	Procure updated physical development plan for Town through Physical Planning Department. Based on this mapping, create up-to-date water system map in GIS using mapping currently being prepared by UN-Habitat and the Regional Center for Mapping and Development. Clearly show all existing and proposed water and wastewater systems on GIS map with satellite photo, Survey of Kenya, and GIS polygon and point layers included. Layers should include: existing land use; streets; neighborhoods; population density; water system features including intakes, treatment facilities, piping network, and storage facilities; wastewater collection system piping and treatment facility; water kiosks; public toilets; bulk water meters. All water and wastewater systems included in system inventory should be included in mapping. Clarify existing and proposed service areas. Use mapping for all future planning activities.	UN 2004 report included $50,000 for mapping.	sum	1	$ 100,000	$ 100,000	Based on UN-Habitat Estimate for Kisii of $137,000	
IW	IW-2	2007	2007	MANAG	**Bulk / Master Water Meters**	Bulk meters are required to quantify UfW, assess system integrity, and reduce losses. There are no master meters in the existing distribution system. According to UN-Habitat 2004, only BH 3&4 have working master meters. There are no master meters in distribution system. According to JICA 2001, there are no meters at BH. According to December 2006 notes from MIKUTRA, BH3 and BH4 have working master meters.	Calibrate existing master meters at wells 3 & 4. Install master meter at outlet of main storage tanks. Install master meters et strategic locations in distribution system.	UN 2004 (Sec 5.3, Rec 1.8) recommends two 75 mm diam. master meters; five 50 mm meters; five 32 mm dam meters; ten 25 mm diam. meters; 200 3/4" consumer meters and 500 1/2" consumer meters (all above with fittings) at cost of $67,945. Note discrepancy - UN text recommends 1,000 consumer meters be installed. Text recommends bulk meters on rising main to storage and outlet of storage. JICA, 2001 (Sec 4.3.7) recommends 700 1/2" consumer domestic meters @ $41/ea. (JICA 2001, Table 4.5)	ea	10	$ 1,400	$ 14,000	UN 2005 Kisii Report 6" meter cost $1,370. Avg cost likely will be less (~$1000, largest main only 4"), but include funds for consultancy, contingency.	
IW	IW-3	2007	2007	MANAG	**Consumer Water Meters**	MIKUTRA's August response to Project Team questions noted 197 metered connections and 538 active / billed connections. UN-Habitat 2004 report estimated only 30 of 400 active consumers have working water meters. JICA, 2001 (Sec 3.7.1.2) found that only 34 of 577 bills included metered data. MIKUTRA noted that Prisons meter replaced in 2005 and monthly consumption is now approximately double previous consumption (250 m^3/month -> ~500 m^3/month). Expect many meters are similarly under-registering consumption. Assume all meters require replacement.	Replace / Install Consumer Meters for all active customers. Estimate 700 meters will be required to replace all existing meters, with extras for expected illegal connections.		ea	700	$ 100	$ 70,000	Various estimates from $40 to $100. UN 2005 Kisii Report uses $100.	
IW	IW-4	2007	2007	MANAG	**System Inventory, Asset Management Plan**	An accurate water and wastewater system inventory is required before meaningful planning can be accomplished. The inventory will be important for almost all future work including O&M plans, infrastructure planning, mapping, tariff analysis, staffing planning, accounting and other activities. An inventory is the first step towards creating an asset management plan. Once the inventory is created, assets should be valued and prioritized into an asset management plan for future rehabilitation, replacement, or upgrade. Specific distribution system component requirements will be analyzed in system improvement plan included separately.	Develop water and wastewater system inventories and asset management plans. Utilize toolkit proposed to be created by LVSWSB. Inventory should include major equipment, piping, tanks, and treatment systems. Available data such as age, expected useful life, condition, service history, and nameplate data should be included. Financial value of assets and list of depreciated assets should be included. Develop or use available standard forms, or purchase and customize available software (recommended) to create inventories and convert to an asset management plan by prioritizing assets and estimating future needs and costs. Priority should be given to critical infrastructure at or past the end of its useful life.	Limited expenditure required due to limited amount of equipment / infrastructure.	Sum	1	$ 15,000	$ 15,000	Due to limited amount of equipment in Migori, only $15,000 allotted for this task.	
IW	IW-5	2007	2007	MANAG	**Preventative Maintenance Plan**	In order to maximize equipment lifespan and operating efficiency, MIKUTRA should document a preventative maintenance plan, follow it closely, and be vigilant about recording maintenance histories for equipment.	Develop preventative maintenance plan and maintenance tracking system, including all inventory components. Utilize toolkit proposed to be created by LVSWSB. The system may incorporate traditional maintenance card techniques, "out-of-the box" software, or customized software. Software packages are now readily available to schedule and track all required preventative maintenance and are recommended.	Limited expenditure required due to limited amount of equipment / infrastructure.	Sum	1	$ 10,000	$ 10,000	Due to limited amount of equipment in Migori, only $10,000 allotted for this task.	
IW	IW-6	2007	2007	MANAG	**O&M Manuals, Information on Existing Infrastructure**	Layout drawings, O&M manuals do not exist for most equipment and facilities.	Prepare O&M manuals for facilities including layout drawings and regular maintenance requirements. Obtain manufacturer's manuals for all existing equipment, incorporate recommended maintenance into preventative maintenance plan.	UN 2004 cost est. $87,500 for this task, but includes survey and mapping activities as well as compiling information on existing infrastructure. UN also includad a aeparate mapping task, $50,000.	Sum	1	$ 10,000	$ 10,000	Engineering estimate.	
IW	IW-7	2007	2007	MANAG	**Data on Existing Private Boreholes**	Lack information on water produced by large private BH in Town.	Gather data on production capacity and quality from BH at Teachers' College, St. Joseph's Hospital (JICA 2001 6.24 m3/hr in 1977), Prinsal Enterprises, Migori Boys Secondary School (JICA 2001 6.18 m^3/hr in 1987), District Hospital. Note St. Joseph's 2ndary school production total > 200 m^3/d. Town produces < 500 m^3/d.	DONE - INFO PROVIDED BY MIKUTRA AUG 2006.	N/A			$ -		

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IW	IW-8	2007	2007	MANAG	**Illegal Connections**	Number of existing illegal connections is unknown. Revenue and water losses from illegal connections may be significant.	Implement comprehensive program to investigate and register / remove illegal connections. If any registered but "non-active" customers are drawing water from the system, register and meter the connections. Utilize proposed toolkit and model by-law for handling illegal connections produced at LVSWSB level.	Limited expenditure recommended due to limited distribution system and expected future major system upgrades.	Sum	1	$ 15,000	$ 15,000	Engineering estimate.	
IW	IW-9	2007	2007	MANAG	**Water Audit**	Comprehensive lack of knowledge regarding water quantities and losses in existing system.	Perform system-wide water audit to determine capacity, UfW, and identify problem areas. May only be possible after installation of master and consumer meters.	Limited expenditure recommended due to limited distribution system and expected future major system upgrades.	Sum	1	$ 10,000	$ 10,000	Engineering estimate.	
IW	IW-10	2007	2007	MANAG	**Staffing Planning**	Current staff levels will require adjustment as facilities expand. Merger with NWSA possible. Study required to determine appropriate staffing levels.	Conduct staff rationalization study by an external HR consultant. Include consideration of merger with NWSA. Study should include organizational chart development, task analysis, determination of staffing requirements, creation of job descriptions, and implementation plan for staffing changes.		sum	1	$ 15,000	$ 15,000	Engineering estimate.	
IW	IW-11	2007	2007	MANAG	**Nyasare Water Supply Association (NWSA) Merger Discussions**	NWSA may be more effectively managed as part of a municipal system, though currently operated as separate registered WSP and no plans exist to change this. Records show NWSA produces similar water volume as the municipal system.	Begin discussions / negotiations with NWSA regarding possible future merge of systems. Consider recruiting Mgr. Maurice Otieno and other NWSA staff for MIKUTRA staff.	Initial discussions can be done by MIKUTRA staff. [What is LVSWSB's opinion re MIKUTRA/NWSA merger? Would make sense if Oyani River option selected because water will pass NWSA service area.]					To be done by MIKUTRA staff and in Staffing Planning study.	
IW	IW-12	2007	2007	MANAG	**Tariffs Analysis**	MIKUTRA currently uses national tariff rates. Revisions to existing rates as service improves and expands will be required. JICA 2001 (Sec 2.3.7) survey clearly showed strong willingness to pay more than current levels for improved service. The same sentiment was expressed in Pre-Visit survey in January 2006.	Evaluate current tariff structure in conjunction with proposed new projects and costs. Revise tariff structures appropriately, including provisions for supplying water at low cost for poor residents.		Sum	1	$ 20,000	$ 20,000	Engineering estimate.	
IW	IW-13	2007	2007	MANAG	**Watershed Protection Program**	Encroachment within recharge zones of boreholes and watersheds of proposed surface water supplies is expanding. Need to curb and reverse trend of encroachment, pollution, and erosion.	Implement program to assess present land use and monitor and restrict development within the water source watersheds. Utilize toolkit proposed to be developed at LVSWSB. Special focus should be on identifying threats, removing squatters, reducing erosion/development, and working with farmers to implement BMPs within the watersheds of existing and proposed boreholes, Nyasare springs, and Oyani and Migori River watersheds. Purchasing land may be required to protect watershed. The program will require cooperation with other town departments, agricultural and public health officials, and local politicians.		sum	1	$ 50,000	$ 50,000	Engineering estimate.	
IW	IW-14	2007	2008	MANAG	**Public Education Program**	No public education programs in place. Public needs to be informed of the health and economic benefits of water conservation, metering, source protection / contamination, and sanitation. Many homes are expected to have wells and pit latrines co-located. Expect that many residents' water sources are contaminated, including small streams, wells, and the Migori River. Promotion of water conservation and installation of water-saving devices in homes could save additional water, allowing MIKUTRA to serve additional customers with limited supplies.	Implement program to inform residents about the importance of water conservation, water quality, source protection, sanitation, and potential resultant financial savings. Utilize public education toolkit proposed to be developed at LVSWSB. Couple latrine rehabilitation and construction with public education program for both public and private facilities. Work with local environmental and health groups on public education programs, including new Migori NEMA office and newly formed Town Environment Committee (currently working on replacing latrines with septic tanks). Begin school programs addressing water, water conservation, health and hygiene. Consider publishing and distributing annual informational reports to customers similar to Consumer Confidence Reporting in U.S. for educating customers about water and watershed protection. Designate staff responsible for public education and public relations including informing customers of any expected service disruptions and handling complaints.		sum	1	$ 50,000	$ 50,000	Engineering estimate.	
IW	IW-15	2007	2007	MANAG	**Commercialization / Entrepreneurship Opportunities**	Need for additional income-generating activities and reduced demands on MIKUTRA staff.	Consider commercialization of water kiosks; private operation of MIKUTRA-owned exhauster truck(s); Compost production and distribution; Utilize sludge at one of several existing or possible new seedling nurseries; algae harvesting from lagoons; monitoring of public toilets and latrines; irrigated sugar cane/bamboo/other; aquaculture with WWTF effluent.		Sum	1	$ 10,000	$ 10,000	Engineering estimate. Consultancy to consider commercialization / entrepreneurship.	
IW	IW-16	2007	2007	MANAG	**Regionalization**	Economies of Scale may be attained by regionalization.	MIKUTRA should become part of Kisumu-based training, equipment repair/rehab, spare parts, chemical procurement, bulk purchases incl. water meters, leak detection equipment, purchasing in-home water saving devices, water bowser, etc..		Sum	1	$ 10,000	$ 10,000	Engineering estimate. Consultancy to consider commercialization / entrepreneurship.	
IW	IW-17	2007	2007	MANAG	**Water Conservation Program**	Promotion of water conservation and installation of water-saving devices in homes could save additional water, allowing MIKUTRA to serve additional customers and extending time before additional supplies are needed.	Implement a water conservation education and assistance program to inform residents about the importance of conservation and potential money savings. Include bulk purchase of water saving devices including sink aerators, low flow showerheads, and similar devices for free distribution.		Sum	1	$ 20,000	$ 20,000	Engineering estimate.	
IW	IW-18	2007	2007	MANAG	**Computer hardware, software**	Need computer hardware and software to adequately manage system and convert to electronic record-keeping system. The new equipment will require additional security.	Purchase computers, software, and security. Software should include readily available billing and database software.		Sum	1	$ 23,000	$ 23,000	UN-Habitat Item 1.6.2 included ~$200/computer. Too low. Assume five (5) computers and printers @ $1,500 / workstation with computer, printer, security. Assume additional $15,000 for software, round up.	
IW	IW-19	2007	2007	MANAG	**Other Office Equipment, Furniture**	Need updated desks, fax, copiers, printers, etc. for offices. A small portable generator or solar panels would also alleviate the frequent power outages experienced at MIKUTRA offices.	Upgrade office equipment including desks, fax, copier, etc.. Purchase small generator or solar panels.		Sum	1	$ 10,000	$ 10,000	Assume $5,000 for desks, chairs; $300 for fax; $2,500 for copier; $2,000 for small generator or solar panels; round up.	

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IW	IW-20	2007	2007	MANAG	**Equipment and Data Security**	Additional security should be added for computers, office equipment, and data.	Add additional door locks, fencing, cords locking computers to desks, safe, etc.. to ensure security. Include provisions for surge protectors and electronic and hardcopy data backup due to frequent power outages.		Sum	1	$ 5,000	$ 5,000	Engineering estimate.	
IW	IW-21	2007	2007	MANAG	**Computer Training**	Need training for staff in computer use and records management.	Hire trainer for local staff in computer use. Expect to utilize "circuit rider" trainer via LVSWSB.		Sum	1	$ 20,000	$ 20,000	Engineering estimate.	
IW	IW-22	2007	2007	MANAG	**Computerize Record keeping and billing**	Recordkeeping at the municipal water system is poor. Records are not computerized and all data recording is done manually with paper files. Data provided for large water users was hand written. Initial goals include increasing revenue through accurate metering and billing. Accurate records are required for this to occur.	A database of all customers should be created including active / inactive status, location, meter age, all meter readings, bills sent, payments received, etc... All billing should be computerized. Computer hardware and software included in other tasks. Reported active connections ~600. Several families typically served from one connection (>10 persons / connection). < 20% of Town population estimated to be served by public water supply.		sum	1	$ 20,000	$ 20,000	Engineering estimate.	
IW	IW-23	2007	2007	MANAG	**Large Users Survey**	Additional clarity needed on existing and potential new large water users.	Clarify water use from existing large water users. Prioritize list of future large water users. Expected large users include: Migori Teachers' College, Prinsal Enterprises Ltd. (fish factory), St. Joseph's Mission Hospital, District Hospital, Municipal offices and police station, prison, markets, schools, sports stadium.	Can be done by MIKUTRA staff within existing budget.	N/A			$ -		
IW	IW-24	2007	2007	MANAG	**Large Users Discussions**	Some existing large water users currently rely on their own water sources but some expressed interest in switching to municipal supply. Lack of adequate water supply has been cited as main reason for businesses and other institutions leaving or not coming to Migori.	Begin discussions / negotiations with Prinsal Enterprises Ltd (fish factory), Migori Teacher's College, St. Joseph's Mission Hospital and others regarding connecting to a future municipal water system.	Can be done by MIKUTRA staff within existing budget.	N/A			$ -		
IW	IW-25	2007	2007	MANAG	**Training / Certification for Water Vendors, Kiosk Operators, Public Toilet Operators**	Water vendors should be recognized as providing a service to the community currently unmet by local WSP. Vendors should be trained / certified to ensure water provided by vendors is safe until more permanent service can be provided. Kiosk operators and public toilet operators require training in financial management and operation of the stations to protect public health.	Implement vendor, kiosk, and public toilet operator training and certification program. Encourage residents to only purchase water from registered vendors. Encourage vendors to become trained as kiosk operators as kiosks come on-line.		Sum	1	$ 20,000	$ 20,000	Engineering estimate.	
IW	IW-26	2007	2007	MANAG	**Staff Training**	Staff needs to be trained in system operation and O&M performance indicators. Technical, management, and financial training programs should be implemented.	Set up regular staff training program, including training of staff on performance indicators and technical, financial, and managerial skills. Take part in "circuit training" program proposed to be administered at LVSWSB.		Sum	1	$ 10,000	$ 10,000	UN-Habitat Item 1.6.6 included ~$4,100. Increase budget.	
IW	IW-27	2007	2007	MANAG	**Temporary Laboratory & Equipment**	Laboratory, equipment and chemicals required for basic water quality sampling / monitoring. Basic temporary laboratory facility required to serve until new WTP / laboratory constructed. Expect this facility will serve as a satellite laboratory for distribution system sampling and other activities after WTP laboratory constructed.	Laboratory tools, equipment and chemicals required for basic water quality sampling / monitoring. Expect to construct small laboratory building on existing MIKUTRA offices land.	Recommended by UN-Habitat 2004, but no cost given.	Sum	1	$ 52,000	$ 52,000	JICA Table 4.5 included ~$137,000 for new lab and offices (400 m2 @ 25,000 Kshs/m2). Assume $40,000 for laboratory only, update to 2005 cost.	
IW	IW-28	2007	2007	MANAG	**Vehicles**	Need transport for O&M staff. Exact number of vehicles needed unclear.	Determine need for vehicles and purchase. Expect to purchase two 4WD trucks and five motor cycles.		Sum	1	$ 85,000	$ 85,000	Engineering estimate.	
IW	IW-29	2007	2007	MANAG	**Assorted Equipment - Dipper Tubes, Tools, Pump Removal Equipment**	Dipper tubes required for BH water level measurement. Require tools for basic plumbing and electrical work. Require chain block and pulley system for well work.	Purchase dipper tubes. Purchase tools for basic plumbing and electrical work. Chain block and pulley tackle with tripod.	UN-Habitat, 2004,Sec 5.3, Rec 1.9 estimated costs for computer, software, dipper tubes, toolkit, tripod/tackle, and bicycles was $21,500. JICA also recommended dipper tubes and other line item costs below. Also see MIKUTRA recommended items for office section 6.4.	Sum	1	$ 6,000	$ 6,000	Engineering estimate.	
IW				SOURCE										$ 610,000
IW	IW-30	2007	2008	SOURC	**Source Augmentation Study**	It is estimated that less than 20% of Migori's population is served by a public water supply. Existing boreholes are incapable of meeting present or future demand. Installation of additional boreholes to meet future demand is not practical or cost-effective, as fifty or more boreholes would likely be required to meet expected 2015 demand. Existing boreholes should be upgraded to meet immediate needs, but a large surface water supply is required. Preliminary investigation shows Oyani River holds most promise for future water source to meet immediate and long term demands. A comprehensive study is required to select the best option and estimate costs based on preliminary design.	Conduct study, preliminary design and cost estimation to compare available options and determine if Oyani River is best option for source augmentation. Include evaluation of option to site intake on Oyani River near Dyani Bridge tree nursery with pumped raw water to a new treatment facility adjacent to Kakrao school, followed by gravity flow to town. Study should include gathering quantity and quality data for Oyani River as required by GOK, and a watershed sanitary survey. Other options to be evaluated should include: Dam on Oyani at Kakremba with storage at Got Kachola; Dam and WTF at Nyasare springs; Dam on Ragana River south of C13 Road; Migori River intake upstream of Town; Conversion of existing Dam at Nyamume (Okechi) into public water supply. Determine reliability of power available at each site. Consider hydropower options and costs to provide a portion of pumping power requirements, possibly utilizing Sigira stream (tributary to Oyani) or Oyani itself. Consider adding hydropower capacity at Gogo dam, ~ 30 km downstream at Oyani / Kuja confluence. Also consider a biomass g		sum	1	$ 80,000	$ 80,000	Assume ~$150,000 for comprehensive study for all source options, potential new service areas, use of existing plant, etc.. Now broken down into multiple studies.	

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IW				SOURC	**Oyani River Quantity & Quality Data**	Need at least a year of data on water quality in rivers, plus historical flows, in order to site weir/intake. Section 3.5.1 of 2005 Design Manual states sampling for new sources should cover all regimes of river including rainy seasons.	Establish gauges on rivers to determine available flows. Migori Water Supply Staff noted gauge data at Oyani River data is available. Data provided Aug 2006 shows Oyani available low flow 0.188 m^3/s (162,432 m^3/d - note mistake in MIKUTRA notes - actually 16,243 m^3/d). Unclear where gauge data was taken. Clearly define regulatory requirements for obtaining water rights for withdrawal.	Nov 2006 MIKUTRA notes Adino and Gor to avail current data and proposal for collecting data over next year.	N/A			$ -	Included in Water Source Augmentation Study	
IW				SOURC	**Oyani Watershed Sanitary Survey, Land Acquisition, Agricultural BMPs, Power Availability**	Extent of development and discharges of wastewater / fertilizer upstream of proposed intake not well understood. Require land acquisition for intake, watershed protection. Three phase power reportedly available, but need to know reliability.	Determine what is necessary to acquire land at proposed weir/intake site. Conduct sanitary survey of watershed above proposed intake to identify potential pollution sources including domestic and agricultural. Evaluate feasibility of acquiring additional land in watershed to protect resource. Work with Farm Institute and Agricultural Offices located near proposed intake to inatitute BMPs for farms in watershed. Determine power reliability.	Information provided during Aug 06 Visit: Lowest flow 162,432 m^3/d @ Oyani Bridge; Land owned by late Tobias Okiro, survived by 6 sons; should approach landowner through DDC and follow govt land acquisition procedures to acquire land title deeds; tobacco farms in watershed are main pollution source; watershed has 5,000 residents covering 4 sq km; Additional land with different owners available in watershed; 3 ph power at site; can work with local farms, tree nursery, etc.. on BAT	N/A			$ -	Included in Water Source Augmentation Study	
IW				SOURC	**Collect Data on Tributary Stream (Sigira) to Oyani for possible hydropower**	Hydropower may be required to provide a portion of power required for raw water pumping.	Investigate possibility of utilizing nearby stream to provide micro hydropower. Sigira stream identified during Aug 2006 visit as potential hydropower source due to relatively large elevation change. Stream empties into Oyani River several hundred meters west of Oyani Bridge.		N/A			$ -	Included in Water Source Augmentation Study	
IW				SOURC	**Investigate Hydropower opportunities**	Hydropower potential not utilized. Micro hydropower may be feasible by diversions of Migori River, Oyani River, or others.	Investigate hydropower feasibility by collecting additional data, contacting micro hydro companies.		N/A			$ -	Included in Water Source Augmentation Study	
IW				SOURC	**Dam on Oyani at Kakremba and treatment / storage at Got Kachola**	Discussed briefly in April. Requires ~ 16 km cross country pipeline. (7.3 km from dam site to Got Kachola, then additional 8+ km to town). Distanca and access are excessive.			N/A			$ -	Included in Water Source Augmentation Study	
IW				SOURC	**Dam at Nyasare Springs with WTF**	Discussed briefly with staff. Springs area is now densely developed by squatters with small farms and is undesirable as a large source. Yield has declined from 350 m^3/d in 1194 to 230 m^3/d in 2000 due to poor catchment management. Could potentially be developed by NWSA in future. High cost associated with dam construction is a problem, but elevation (~1,500 m) is favorable for gravity flow to treatment works.			N/A			$ -	Included in Water Source Augmentation Study	
IW				SOURC	**Ragana River south of C13 Road in Ragana.**	Discussed briefly in April. Requires pumping and does not have high flow available. Discussed again in Aug - quality poor due to siltation resulting from erosion, drainage in area to river.			N/A			$ -	Included in Water Source Augmentation Study	
IW				SOURC	**Data on possible Migori River intake upstream of town**	Proposed by JICA 2001 (Sec 4.5.3) including recommendation for 700 mm main 6.9 km long, all gravity. Recommends further feasibility studies. Disadvantage of this option is reducing flow of Migori River for downstream use, low flows in Migori river seasonally, plus overdevelopment in watershed. JICA 2001 Env. Impact section (7.4) notes "Migori River is polluted as it passes through town and cannot be economically used as source of water for the town". Discussed with MIKUTRA in Aug 06 - not suitable due to high variability of flow - low flows too low for public water supply.			N/A			$ -	Included in Water Source Augmentation Study	
IW				SOURC	**Existing Dam at Nyamume (Okechi). Use existing impoundment for public water supply.**	According to MIKUTRA, this dam is used for irrigation. It is heavily silted and therefore has limited volume. It has a very small watershed and is only supplied by limited surface inflow. MIKUTRA states not appropriate for a public water supply.			N/A			$ -	Included in Water Source Augmentation Study	
IW	IW-31	2007	2007	SOURC	**Boreholes Testing, Evaluation**	Eight Ministry BH and four ENEP BH (intended to replace Ministry BH) exist. Only Ministry BH 3, 4, and one of two new wells ('tree nursery' and 'New') are currently operating as of November 2006. BH5 was recently abandoned due to contamination suspected from Migori Teacher's College wastewater. Current BH capacity unknown due to lack of operating meters. Capacity may be quickly increased by repairing and refitting existing non-operational BH. Testing and evaluation are required to determine the most cost-effective method, keeping in mind boreholes will eventually be replaced by a surface water source.	Review JICA 2001 (Sec. 4.3) and UN-Habitat 2004 (Sec. 5.3, Rec 1.1) recommendations to repair and refit BH, improve headworks, and test capacity and quality of BH. Evaluate all BH including capacity and water quality testing. Each BH should include a flow meter, sampling tap, dipper tubes, pressure gauges, and non-return valves. Determine which BH should be refitted/upgraded and which should be decommissioned. Determine if either Original BH3 or adjacent ENEP BH3 should be primarily utilized, depending on which has greater yield, with other to serve as standby. Evaluate ENEP BH4 - refit if greater capacity than Ministry BH4 or if Ministry BH4 not functioning. Consider continued operation of Ministry BH5, and required re-equip efforts. JICA 2001 determined BH 1,7,8 and ENEP 1 and 2 are not viable (Sec. 4.3.1). Ministry BH2 was installed 1956 (probably not viable) and no information is available on BH6. Recommend capping/decommissioning all unviable wells to prevent contamination of aquifer.	UN (Sec 5.3, Rec 1.1) recommended investigating possibility of rehabbing Ministry Boreholes 1,2,5,6,7,8 & ENEP 1,2,4. Also rec'd decommission and cap unviable boreholes. Also test pump ENEP BH3. If yield >17 m^3/hr, then add pump and use Ministry #3 as standby. Est. cost of UN Recs $31,875. UN (Sec 5.1) notes at least two new boreholes should be drilled. JICA, 2001 (Sec. 4.3.8) specifically recommends capping BH 8.	sum	1	$ 20,000	$ 20,000	Engineering estimate.	

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IW	IW-32	2007	2008	SOURC	**Refit / Decommission Boreholes**	Based on review of previous studies and field evaluation, refit or decommission boreholes.	As recommended by JICA Table 4.5, assume the following tasks: Equip ENEP BH 3 to deliver to chlorine contact tank, incl. pump, riser and headworks pipe work and electrical installation ; Equip ENEP BH 4; Re-equip existing BH 5; Cap original BH 3 and BH 8;		Sum	1	$ 270,000	$ 270,000	JICA 2001 included ~$290,000 for recommended improvements including new pipe work to connect boreholes 4&5, end to connect borehole 4 to east side of river. JICA recommendation for connector pipe from west side of river to east side is excessive in light of *proposed new surf. water intake and treatment.* Do not plan to connect wells 4&5 to east side of river, so cost est. ~$150,000. Update to present cost using KCECI, add 35% engineering, contingency, round up.	
IW	IW-33	2007	2008	SOURC	**Auxiliary Power for Boreholes**	Auxiliary power not provided at BH. Frequent power outages and voltage drops lower water production. According to pre-visit survey, outages occur hourly and 75% of day facilities are without power.	As recommended by JICA 2001 (Sec 4.3.4) and UN-Habitat 2004 (Sec. 5.1), install auxiliary power for BH. JICA recommends installation of 10 kava diesel generator for BH 4 and 5, located in switchgear building for both BH. *JICA also recommends 50 kVA diesel generator for BH 3 to operate low* and high lift pumps.	UN (Sec 5.1) recommends standby generator, power upgrade and stabilization transformer, but no costs given. JICA 2001 (Sec 4.3.4) recommended one generator for BH 4 and 5, *located at switchgear in same bldg., plus one* for BH 3. No costs given. Town recommends 80 KVA diesel generator for BH3, tree nursery borehole, and new borehole; 50 KVA for BH4.	ea	4	$ 60,000	$ 240,000	*Assume average ~$40,000 each, plus 35%* eng & cont., round up.	
IW				TREATMENT										$ 300,000
IW	IW-34	2007	2007	TREAT	**Disinfection, pH Adjustment Study**	Disinfection and pH adjustment may be required for main storage site at *Kadika Hill (fed by BH3) and new wells on east side of river, and for BH4 on* west side of river which pump directly into distribution system. Anecdotal information suggests the groundwater is aggressive and is having detrimental affects on distribution system. Existing calcium hypochlorite feed system at main storage site only treats water from BH3 on east side of Migori River, dosing is arbitrary (may not even be in use), and it is old (constructed ~1950s).	Perform updated water quality testing and evaluation of existing equipment *to evaluate need for new chlorination, pH adjustment.* Develop plan to meet immediate chlorination, pH adjustment needs, keeping in mind major system overhaul with new treatment facility likely. Measures will likely be temporary. Include all existing wells, wells proposed to be re-commissioned, and the two new wells.	JICA 2001 recommends a new contact tank on east side of river, fed by new connector from boreholes BH 4&5 on west side of river, plus BH3 on east side. Also recommends additional pumping units, water mains for total cost of ~$160,000. UN (Sec 5.3, rec 1.4) recommends new chlorine mixing/dosing at existing main storage site on east side of river (Kadika Hill) and also on prop. tank site on Oruba Hill at cost of $2,500. In UN text (Sec 5.1) UN recs pH correction.	Sum	1	$ 20,000	$ 20,000	Engineering estimate.	
IW	IW-35	2007	2008	TREAT	**Add Disinfection, pH Adjustment**	Based on study results, add disinfection and pH adjustment as recommended as interim measure until new surface water source developed.	Replace existing calcium hypochlorite feed system at Kadika Hill tank site for east side boreholes and install new chlorine contact system for west side boreholes. Also add pH adjustment if required. Install additional pumping, pipe work, as required.	JICA 2001 recommends a new contact tank on east side of river, fed by new connector from boreholes BH 4&5 on west side of river, *plus BH3 on east side. Also recommends* additional pumping units, water mains for total cost of ~$160,000. UN (Sec 5.3, rec 1.4) recommends new chlorine mixing/dosing at existing main storage site on east side of river (Kadika Hill) and also on prop. tank site on Oruba Hill at cost of $2,500. In UN text (Sec 5.1) UN recs pH correction.	sum	1	$ 280,000	$ 280,000	Assume $160,000 from JICA estimate, update to present cost using KCECI, add 35% for eng, *cont., round up.*	
IW				DISTRIBUTION										$ 140,000
IW	IW-36	2007	2008	DISTRI	**Distribution System Expansion and Improvement Plan**	The results of the water audit, mapping, and system inventory (pipe ages, *size, condition) should be reviewed to develop a prioritized plan for* distribution system improvements. It is expected that almost all existing mains will need upgrading to larger size as the largest existing mains are 4". Large expansion of existing distribution network is required. Detailed cost estimates for expansion will be required. Consideration will need to be given to results of source augmentation study.	Develop a prioritized plan for distribution system improvements. Estimate costs of system expansion, including storage and pumping.		Sum	1	$ 50,000	$ 50,000	Assume ~$150,000 for comprehensive study for all source options, potential new service areas, use of existing plant, etc.. Now broken down into multiple studies.	
IW	IW-37	2007	2008	DISTRI	**Leak Detection and Repair**	Current UfW in Migori Water Supply system unknown due to lack of meters. NWSA UfW is estimated at ~50%. MIKUTRA estimates low or negative UfW, but does not have metering data to quantify estimates. Assume Migori Water Supply UfW may be similar to that of NWSA, ~50% or greater. Need to immediately reduce UfW to increase water availability in system.	Perform System-Wide Leak Detection and Repair. Program should initially focus on known leaks, then utilize remote leak detection equipment. Program should be coupled with investigating and registering / removing *illegal connections. Note that most mains are undersized and will require* replacement. The goal is to immediately boost available water by repairing leaks which are large and cost effective to repair. Encourage NWSA to perform a coordinated similar program in parallel. Utilize LVSWSB-owned and operated leek detection equipment and "circuit-rider" (proposed).	Note that most of existing system will eventually be replaced due to undersized mains. Cost includes 'rental' of circuit rider leak detection equipment and operator from LVSWSB. Expect *initial cost to be part of capital funding program, but future leak* detection / repair to be covered by operation budget. Assume $10,000 for leak detection study, $40,000 to repair leaks. Actual cost will depend on number of leaks found. It should be noted that any programs to increase water pressure in the system may execerbate existing leaks or create new leaks. Coordination of flow increases should be coupled with the leak detection and repair program.	Sum	1	$ 50,000	$ 50,000	*Engineering estimate. Costs expected to be* relatively low due to small system size.	
IW	IW-38	2007	2007	DISTRI	**Water Kiosks Planning**	Water is needed in informal settlements, markets, and other unserved areas. Many residents in unserved arees currently rely on vendors who provide questionable quality water at high cost. Many Migori residents obtain water from wells, springs, and streams, many of which are expected to be contaminated. Communal water points are preferred solution for quickly increasing access to water, especially in informal settlements. Plan required for extensive building of water kiosks.	Utilize Kiosk and Public Toilet Toolkit (proposed to be created by LVSWSB) to create plan for building, managing, and maintaining kiosks. Include training for kiosk operators. Goal is to ensure residents in informal settlements have access to water within a minimum of 400 meters. Utilize mapping for optimal location of kiosks. Number of kiosks able to be constructed will be dependent on current water supplies, but short term system upgrades *should increase available supply.*		Sum	1	$ 15,000	$ 15,000	Engineering estimate. Costs expected to be relatively low due to small system size.	
IW	IW-39	2007	2008	DISTRI	**Water Kiosks Pilot Program**	Several kiosks should be constructed immediately to serve as pilot program and assist in planning for future kiosks.	Construct three kiosks immediately as pilot program in very dense areas (market, bus park, for example)		Nr.	3	$ 5,000	$ 15,000	Normal cost expected to be ~$3,000 each. Assume first pilot kiosks more expensive.	
IW	IW-40	2007	2007	DISTRI	**Storage Tank Shutoff**	Elevated water storage tanks lack shutoff valves.	Install float operated shutoff valves at elevated tanks (JICA 2001, Table 4.5)	As per JICA Table 4.5.	nr.	2	$ 1,500	$ 3,000	As per JICA Table 4.5, update to 2005 cost, round up.	
				SUBTOTAL										**$ 1,720,000**
				SHORT TERM WATER PROJECTS (2008-2015)										

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SW				MANAGEMENT										$ 240,000
SW	SW-1	2007	2008	MANAG	**Office Expansion / Upgrade**	Upgrades and expansion of existing MIKUTRA offices required.	Upgrade / expand existing office facilities. Replace existing corrugated staff offices with masonry buildings or expand existing office building. Size required to be determined based on Staffing Study. Add security and lighting.	JICA 2001 Table 4.5 included ~$137,000 for new lab and offices (400 m2 @ 25,000 Kshs/m2). NOTE: Nov 2006 MIKUTRA notes extension of the office is ongoing presently.	Sum	1	$ 130,000	$ 130,000	JICA Table 4.5 included ~$137,000 for new lab and offices (400 m2 @ 25,000 Kshs/m2). *Assume $100,000 for offices only, update to* 2005 cost.	
SW	SW-2	2008	2009	MANAG	**Meter Repair / Calibration Bench**	Migori does not have means to repair and calibrate meters.	Construct and equip meter repair and calibration bench at MIKUTRA offices location.	Alternatively could do this task at Kisumu regional facility until sufficient number of meters to justify equipment and training.	Sum	1	$ 10,000	$ 10,000	UN-Habitat Nov 2005 Kisii report estimates *$3,425 - inadequate. Assume $10,000 to* provide quality testing and repair facilities.	
SW	SW-3	2008	2008	MANAG	**Watershed Protection Land Purchase**	Source waters require continued and increased protection to prevent contamination due to development pressure/encroachment.	Purchase land required for source water protection.		*Sum*	1	*$ 100,000*	*$ 100,000*	*Engineering estimate.*	
SW				SOURCE										$ 3,330,000
SW	SW-4	2008	2010	SOURC	**Oyani River Weir / Intake**	Large water source needed. Boreholes incapable of meeting demand.	Reported available low flow 0.188 m^3/s (162,432 m3/d - mistake in MIKUTRA notes - actually 16,243 m^3/d). Design and Construct weir and intake at Oyani River - initial capacity 0.11 m^3/sec (10,000 m^3/d) with capacity to expand to 16,000+ m^3/d by 2025.		sum	1	$ 450,000	$ 450,000	UN (Sec 5.3, Rec.1.2) suggests investigation of groundwater potential and installation of new boreholes at cost $37,500. Also notes surface water scheme needed medium to long term but no specific recs. JICA 2001 (Table 4.7) notes cost of intake on Migori River cost 25 million KShs or ~$340,000. Using 1998 Aftercare est. for intake, adding 35% for eng/cont, adjusting for KCECI change to 2005 results in cost of $ 360,000 for 10,000 m^3/d intake or $530,000 for full 16,000 m3/d capacity. Assume cost 450K *now with provisions for expansion. Additional* cost to be paid in future.	
SW	SW-5	2008	2010	SOURC	***Power Generation***	Limited power availability and large power requirements to pump to Kakrao *necessitates need for auxiliary power.*	Construct electricity generating station for pumping power utilizing hydropower on Sigira, Oyani, or Kuja (at Gogo Dam) or biomass gasification as determined in source augmentation study.		sum	1	$ 1,000,000	$ 1,000,000	Engineering estimate. Cost to be refined during source augmentation study.	
SW	SW-6	2008	2010	SOURC	**Oyani Intake Pumping Station with Generator Backup**	Need to convey water from intake uphill to Kakrao WTP site	Design and construct raw water pumping station with diesel generator auxiliary power. Size pumping station for 2015 demand, with expansion area for 2025 demand.	Kakrao School Proposed WTP Site Elev 1,540 m, Oyani Bridge 1,402 m (4,600'). Difference = 138 m (453'). Therefore ~158 kW pumping power required. (10,000 m^3/d = 7 m3/min). Pw=jQH = 0.163 * 7 m^3/min * 138 m.	sum	1	$ 780,000	$ 780,000	JICA 2001 included 6 clear water pumps @7 mill KShs = 42 mil Kshs for pumping to service areas and storage. *Assume cost similar.* Adjust to 2005 cost.	
SW	SW-7	2008	2010	SOURC	**Pipeline from Oyani Intake to WTP**	Need to convey water from intake uphill to Kakrao WTP site	Design and Construct pipeline from Oyani River Intake to Kakrao School WTP site. Assume sized for 2015 demand, with capacity for expansion.	Kakrao School Proposed WTP Site Elev 1,540 m, Oyani Bridge 1,402 m (4,600'). Difference = 138 m (453'). Horizontal distance Bridge to School ~5.5 km. Note main storage site at 1,463 m.	m	5,500	$ 200	$ 1,100,000	*JICA 2001 Table 4.6 assumed > $350/m for* 600 mm gravity main. This is excessive. Assume $200/m as recommended by CAPE for *Kericho raw water main,* which includes allowance for stream crossings, contingency, etc... Round up.	
SW				TREATMENT										$ 2,130,000
SW	SW-8	2008	2008	TREAT	**Water Treatment Study**	Treatment location and technology options will need to be evaluated in-depth once source augmentation study is complete.	Conduct study for constructing new water treatment facility. Estimate costs, *determine permitting requirements, develop preliminary design. Include* recommendations for laboratory. [This is in SHORT TERM to allow sufficient time for Source Augmentation Study, which will require a year of *flow/quality data.]*		sum	1	$ 30,000	$ 30,000	Assume ~$150,000 for comprehensive study for all source options, potential new service areas, use of existing plant, etc.. Now broken down into multiple studies.	
SW	SW-9	2009	2010	TREAT	**New WTP (Ph I)**	Full treatment will be required for Oyani River water if Oyani selected source.	Design and Construct full treatment facility on available land near Kakrao School (if selected site) with capacity for 2015 demand (~10,000 m^3/d) and *expansion capability to 2025 expected demand (~17,000 m3/d). Include* laboratory facilities.		sum	1	$ 2,100,000	$ 2,100,000	2005 Design Manual App G7 states cost is ~5,700 Kshs/m3/d for that size. Update to 2005 cost, add 35% eng/cont, round up = $2 million. Add $100,000 for land purchase. Note JICA 2001 (Sec 4.5.4) assumed upward flow clarifiers and rapid gravity filters, capacity 21,000 m^3/d for 2010 (high flow estimate) at cost of 260 Million KShs (~3.7 mil USD), adjust to 2005 cost ~4.8 million. Assuming initial stage (2015 demand) *cost for Kakrao WTP 50% of JICA estimate, or* ~2.4 million.	
SW				DISTRIBUTION										$ 6,400,000
SW	SW-10	2008	2015	DISTRI	**Water Kiosks**	No operating public water kiosks currently exist in the Migori Water Supply system. Water is needed in informal settlements, markets, and other areas to prevent exploitation by water vendors and health impacts associated with collecting water from contaminated sources.	Install public water kiosks (final number to be based on planning study) and commercialize. Utilize results of pilot study to optimize kiosk location and management. Kiosks should be located at all active markets (Open Market just south of Migori River where cistern and hand pump already exist), new bus park, Urban council market north of Migori river, and in dense informal settlements. Kiosks should be well lit and secure. Assume 500 persons served / kiosk / day.	UN (Sec 5.3, Rec 1.6) recommended 8 kiosks including main market (2), bus park (1), and Soko Mjinga (1). Expected benefit to 4,000 low income consumers. Cost $24,000.	nr.	50	$ 3,000	$ 150,000	Assume ~$3,00 / kiosk.	

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SW	SW-11	2009	2010	DISTRI	**Pipeline from new WTP to Migori River Bridge**	Need to convey water from treatment facility to downtown Migori	Design and construct pipeline from Kakrao School WTP to Town Center (where flow will split and head to different tanks). Pressure reducing valves will be required.	Horizontal distance School to Bridge ~4.5 km. Another ~1.5 km to current main storage at Kadiko hill (not included).	m	4,500	$ 200	$ 900,000	JICA 2001 Tabla 4.6 assumed > $350 / m for 600 mm gravity main. Very high unit cost. Assume $200 / m as recommended by CAPE for Kericho raw water main, which includes allowance for stream crossings, contingency, etc... Round up.	
SW	SW-12	2009	2010	DISTRI	**Pressure Reducing Valves / Break Pressure Tanks**	Elevation of Kakrao School 1540 m. Elevation of downtown area 1360 m. Difference 180 m (590') requires pressure reduction. IS POWER GENERATION / RECOVERY AT PRESSURE REDUCING LOCATION POSSIBLE?	Design and construct pressure reducing device between Kakrao WTP and Town center.	JICA 2001 (Table 4.7) Included cost for break pressure tanks of 10 million KShs. Not clear for how many tanks. Assume it is for 2. Round cost est. up.	nr.	2	$ 100,000	$ 200,000	JICA 2001 (Table 4.7) cost est, update cost to 2005, round up.	
SW	SW-13	2009	2015	DISTRI	**Distribution System Expansion / Improvements (Ph 1)**	Less than 20% of Town residents are served by a piped water supply from either NWSA or Migori Water Supply. Extensive expansion of existing reticulation system required. The largest mains in the system are 4" and are undersized.	Expect approximately 30 km of trunk water mains required to provide service to projected service area. Assume 20 km constructed in short term. Extend service to all of A1 road from Onyalo to Mesari. Coverage to extend east-west near center of town to include Oruba hill and Kadiko. Coverage to include portions or all of Oruba and Milimani (includes hospital, boarding school), Ragana, Namba/Nyamue/Marindi (Prinsal Enterprises, New Girls School, Mesari Jaggery Factory Shops, Marantha Mission Hospital, other Hospital on C13), Kadiko (includes Old Girls School), Expected that service will not extend to Ngege (past Kadiko). Ngege extension suggested by staff, but low density, far outside center. Portions of Onyalo (Near NWSA offices), Kakrao (between intake and prop. treatment site), and Nyasare (portions not served by NWSA system).	UN (Sec 5.3, rec 1.3) recommends expanding service to informal settlements around Oruba hill area, including a new 100 mm main 4,000 m from BH4 to Oruba Hill, benefiting 3 to 5,000 people at est. cost of $60K. JICA recommends not expanding to Onyalo A, Midoti, Kolando and Ngege which can't be served with existing storage reservoirs (Sec 4.5.1). JICA also recommends Oruba be divided into two or more pressure zones; Marindi be divided into two or more pressure zones. UN (Sec 5.3, rec 1.7) recommends laying 1,000 m of 75 mm uPVC/HDPE pipe, 2,000 m 50 mm; 2,000 m 32 mm; 1,500 m 25 mm at cost of $51,500.	m	20,000	$ 80	$ 1,600,000	Estimate ~30,000 m of water mains will be required to serve proposed service area based on rough sketch. Assume 20,000 m of 300 mm (12") at $80/m and 10,000 m smaller mains 100-200 mm (4"-8") at cost of $35/m. Assume branch main and service costs incorporated into individual house connection costs. Assume large mains in Ph 1, smaller mains in Ph 2.	
SW	SW-14	2009	2015	DISTRI	**New Water Service Connections**	Additional water service connections will be required to keep pace with growth.	Install new water service connections.		nr.	5,100	$ 500	$ 2,550,000	Assume $500/connection. Includes branch main and service installation cost of ~$400 per connection plus ~$100 for meter. Kericho has ~92 km dist piping and 7,867 registered connections. Therefore ~12 m main / connection * main installation cost of $35/m (cost ~$20-40/m for 100 to 200 mm pipe).	
SW	SW-15	2009	2015	DISTRI	**Distribution Storage and Pumping**	Existing storage facilities inadequate. Total capacity < 400 m^3. According to MIKUTRA, storage consists of 100 m3 and 136 m3 tanks at Kadika Hill (discrepancy vs. 136 m^3 and 225 m^3 noted elsewhere), plus two 50 m^3 balancing / break pressure tanks at Ora Estate (discrepancy - two 65 m^3 break pressure tanks cited elsewhere), and two elevated plastic tanks of capacity 15 m^3 and 23 m^3 at Teacher's College. (Again discrepancy, noted elsewhere that two other tanks (13 m3 and 45 m3 serve BH 4 and 5 respectively) were constructed under ENEP programme, but are insufficiently sized.	Construct sufficient storage to provide one day's demand for 2015 (~10,000 m3). Expect ~four balancing storage reservoirs will be required. Assume tanks at Kadika (replace/upgrade/augment existing), Oruba, Marindi / Mesari, and one other location. Estimate ~2,500 m^3/each. Assume some pumping may be required for some areas.	UN (Sec 5.3, Rec.1.5) notes existing storage of 300 m^3 is inadequate and recommends 200 m^3 storage/chlorine dosing tank on Oruba Hill and three 100 m^3 tanks at Kadika Hill to bring total storage to 800 m^3. Est. cost $175K. JICA recommends new storage (10,000 m^3/ea) at 3 locations: Oruba, Marindi, plus north side of hillside at Kadika (other side of hill from main storage site). Note that JICA water demand projections >> C&C projections and therefore this amount of storage is excessive. JICA cost estimate is ~$690,000 per each 10,000 m3 storage tank, plus ~$85,000 for elevated tank and pumping system to serve Oruba Mission and high surrounding areas, allow (JICA 2001, 4.5.5, Table 4.7)	nr.	4	$ 250,000	$ 1,000,000	1998 JICA Aftercare Study Fig 5.3.4 storage cost ~9.4 million Kshs (adjusted to 2005 cost) for 2,500 m^3 storage tank. Assume 25% extra for pumping systems, access road; plus 35% engineering & contingency, resulting in cost of ~$230,000. Say $250,000 each.	
				SUBTOTAL										$ 12,100,000
				LONG TERM WATER PROJECTS (2016-2025)										
LW				MANAGEMENT										$ -
LW				SOURCE										$ 2,230,000
LW	LW-1	2016	2018	SOURC	**Additional Intake Capacity**	Intake capacity will require expansion to meet demand.	Increase capacity of Oyani Intake to 16,000 m^3/d		sum	1	$ 80,000	$ 80,000	Balance of expected cost of 530K minus initial amount paid 450K.	
LW	LW-2	2016	2018	SOURC	**Additional Pumping Capacity**	Pumping capacity will require expansion to meet demand	Increase pumping capacity 16,000 m^3/d		sum	1	$ 400,000	$ 400,000	Engineering estimate.	
LW	LW-3	2016	2018	SOURC	**Raw and finished water mains expansion**	Mains from intake will require doubling of capacity via installing parallel mains.	Install additional capacity from intake to Town		m	10,000	$ 175	$ 1,750,000	Assume additional capacity will cost slightly less per foot due to provisions included during initial stage.	
LW				TREATMENT										$ 1,470,000
LW	LW-4	2016	2018	TREAT	**New WTP (Ph II)**	Expand WTP to meet demand	Expand from 10,000 m^3/d to 17,000 m^3/d		sum	1	$ 1,470,000	$ 1,470,000	Assume Phase II cost proportional to Phase I, based on flow.	
LW				DISTRIBUTION										$ 3,470,000
LW	LW-5	2016	2025	DISTRI	**Water Kiosks**	Additional kiosks required to meet demand.	Install additional water kiosks.	UN (Sec 5.3, Rec 1.6) recommended 8 kiosks including main market (2), bus park (1), and Soko Mjinga (1). Expected benefit to 4,000 low income consumers. Cost $24,000.	nr.	22	$ 3,000	$ 66,000	Assume ~$3,00 / kiosk.	

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LW	LW-6	2016	2025	DISTRI	**Distribution System Expansion / Improvements (Ph 2)**	Additional expansion will be required to keep pace with increasing number of customers.	Extend service to areas not included in Short Term Projects.		m	10,000	$ 35	$ 350,000	Estimate ~30,000 m of water mains will be required to serve proposed service area based on rough sketch. Assume 20,000 m of 300 mm (12") at $80/m and 10,000 m smaller mains 100-200 mm (4"-8") at cost of $35/m. Assume branch main and service costs incorporated into individual house connection costs. Assume large mains in Ph 1, smaller mains in Ph 2.	
LW	LW-7	2016	2025	DISTRI	**Distribution Storage and Pumping**	Additional storage facilities will be required to meet additional demands.	Construct sufficient storage to provide one day's demand for 2025 (~17,000 m^3). Need 7,000 m^3 additional storage. Assume 3 additional tanks with 2,500 m^3 each.		nr.	3	$ 250,000	$ 750,000	1998 JICA Aftercare Study Fig 5.3.4 storage cost ~9.4 million Kshs (adjusted to 2005 cost) for 2,500 m^3 storage tank. Assume 25% extra for small pumping system, access road; plus 35% engineering & contingency, results in cost of ~$230,000. Say $250,000 each.	
LW	LW-8	2016	2025	DISTRI	**New Water Service Connections**	Additional water service connections will be required to keep pace with growth.	Install new water service connections.		nr.	4,600	$ 500	$ 2,300,000	Assume $500/connection. Includes branch main and service installation cost of ~$400 per connection plus ~$100 for meter. Kericho has ~92 km dist piping and 7,867 registered connections. Therefore ~12 m main / connection * main installation cost of $35/m (cost ~$20-40/m for 100 to 200 mm pipe).	
				SUBTOTAL										**$ 7,170,000**

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				IMMEDIATE WASTEWATER PROJECTS / ACTIONS (within ~1 year)										
IWW				MANAGEMENT										$ 30,000
IWW	IWW-1	2007	2007	MANAG	**Large Water Users / Wastewater Generator Discussions**	*Other existing and potential large water users not fully understood. Some* existing large water users currently rely on their own water sources and wastewater treatment. Existing treatment is poor and these could represent important customers.	*Prioritize list of future sewer connections based on major water* users. Expected large users include: Migori Teachers' College, Prinsal Enterprises Ltd., St. Joseph's Mission Hospital, District Hospital, Municipal offices and police station, prison, markets, schools, sports stadium. Begin discussions / negotiations with Prinsal Enterprises Ltd (fish factory), Migori Teacher's College (has land for potential satellite WWTF, proposed facility already), St. *Joseph's Mission Hospital and others regarding connecting to a future* municipal water and wastewater system.	*To be accomplished by MIKUTRA.* MIKUTRA has already begun this process and noted during November 2006 that most large users have stated willingness to connect once system is operational.	N/A			$ -	To be accomplished by MIKUTRA	
IWW	IWW-2	2007	2007	MANAG	**St. Joseph's Mission Hospital *Lagoons take-*over**	St. Joseph's Mission Lagoons may be more effectively managed as part of a municipal system and could potentially be expanded or upgraded.	Begin discussions / negotiations with St. Joseph's Mission Hospital regarding possible takeover of operation and maintenance of the lagoons and possible expansion to accept wastewater from other users.	Nov 2006 MIKUTRA notes it will initiate negotiations with the Board of Directors.	N/A			$ -	To be accomplished by MIKUTRA	
IWW	IWW-3	2007	2007	MANAG	**On-Site Wastewater Management**	Many on-site wastewater systems (latrines, septic systems, tight tanks, etc..) are expected to be failing and represent an acute public health hazard and a public nuisance. Failing on-site systems contaminate local public and private groundwater and surface water supplies. On-site systems can adequately protect public health and are often more cost effective than public sewers. However, these systems must be appropriately designed and maintained in order to protect public health.	Develop on-site wastewater system inventory, tracking system, and program for mandatory periodic inspections and pump-outs including model by-laws. Utilize toolkit proposed to be developed at LVSWSB. The system should be integrated with electronic mapping systems to the extent feasible. "Off-the-shelf" software programs may be used, but should be customized for local conditions. The system should include provisions for management of private septage haulers including a manifest system and requiring discharge only at approved facilities.		Sum	1	$ 20,000	$ 20,000	Engineering estimate.	
IWW	IWW-4	2007	2007	MANAG	**Public Latrines / Toilets - Inventory, Rehab / Commercializatio n Plan**	Public latrines and toilets are an important piece of wastewater management infrastructure and should be appropriately regulated, managed, maintained, and expanded. Number, location, and status provided by MIKUTRA Aug 2006. No public toilets exist, but three sets of *public latrines exist (Soko mjinga, Bus Park, Main Market). Most unused or* improperly maintained.	Augment initial inventory provided by MIKUTRA, evaluate current condition, and determine requirements for bring facilities up to standards set forth in toolkit proposed to be created by LVSWSB (including signage, lighting, security, certified operator, etc..). Collected information should include *location, size (number of stalls), if water flush or latrine, if water is available,* security and lighting, and current condition. Facilities should be ranked based on facilities easiest to rehabilitate and most frequently used (or potential to be most frequently used once rehabilitated). Develop a plan for rehabilitation and commercialization of the facilities, using the toolkit proposed to be created by LVSWSB.		Sum	1	$ 10,000	$ 10,000	To be partially completed by local staff. Budget included for limited consultancy.	
IWW				COLLECTION										$ 80,000
IWW	IWW-5	2007	2008	COLLE	**Wastewater Collection Study**	Need preliminary study to further define wastewater collection requirements for Migori.	Perform conceptual design of gravity collection system, estimate customers served and estimate costs including permitting. Utilize GIS mapping developed in earlier work. Include consideration of expanded use of St. *Joseph's Mission Hospital lagoons as part of overall wastewater* management for Migori.		sum	1	$ 25,000	$ 25,000	Engineering estimate.	
IWW	IWW-6	2007	2007	COLLE	**Public Latrines / Toilets - Rehabilitate / Commercialize**	Existing public toilets and latrines are in need of rehabilitation and should be commercialized to ensure sustainability and income generation. Facilities should be brought up to standards as set out in proposed LVSWSB toolkit.	Rehabilitate and commercialize facilities utilizing priority list and proposed LVSWSB toolkit. Commercialization should include lease agreements as appropriate.		nr.	3	$ 2,000	$ 6,000	UN-Habitat Kisii Rpt. Item 2.5.1 and 2.5.2 include rehabilitation and commercialization of 4 public toilets @ 100,000 Kshs each for rehab, 20,000 for lease agreements, or about $1,700 *each. Assume ~$1,700 each, round up to* include limited consultancy, contingency.	
IWW	IWW-7	2007	2008	COLLE	**Public toilets / latrines pilot *program***	Insufficient or no latrines at key locations.	Install / replace public toilets or latrines at key locations according to plan and in accordance with LVSWSB toolkit. Include provisions for future conversion to water flush systems, commercialize by establishing fees and an operator to maintain facilities and ensure they are pumped (if latrine). Include provisions for security and lighting (solar?). Assume will construct at markets, stadium, new bus park, and other locations. Some may have more or less stalls, which could change price. Construct as pilot program, with balance of facilities to be constructed in short term.		Building with ~10 stalls, wash basins	3	$ 15,000	$ 45,000	UN-Habitat Kisii Nov 2005, Item 2.2.1 end Annex 4 estimates ~$15,000 per building w/ 10 stalls & wash basins. Number assumed for pilot program.	
IWW				TREATMENT										$ 70,000
IWW	IWW-8	2007	2007	TREAT	**Characterize effluent discharges from private facilities**	Discharge water quality and impacts unknown.	Sample effluent from Prinsal Enterprises Ltd. (fish factory) and St. Joseph's Mission Hospital lagoons; Sample river water upstream and downstream of discharges. Evaluate wastewater management at GK Prison (noted in JICA 2001 Env. Impact section as problematic) and other large users. Work with new WRMA who is implementing Polluter Pays principle.		Sum	1	$ 3,000	$ 3,000	Engineering estimate.	
IWW	IWW-9	2007	2007	TREAT	**Disinfection at St. Joseph's Mission Hospital Wastewater Lagoons**	Lagoons discharge directly to Migori River without disinfection. Migori River used by many residents for drinking, cleaning, and bathing. Expect disinfection required.	Depending on effluent sampling results, add disinfection at St. Joseph's Mission Lagoons		Sum	1	$ 10,000	$ 10,000	Engineering estimate.	

Ph	NO.	YR STRT	YR FIN	TYPE	SUMMARY TITLE	OBSERVED PROBLEM / NEED	PROPOSED SOLUTION(S)	NOTES	UNITS	QUAN.	EST. UNIT PRICE (USD)	EST. COST (USD)	COST NOTES	EST. CATEGORY COST (USD)
IWW	IWW-10	2007	2007	TREAT	**St. Joseph's Mission Hospital Wastewater Lagoons Expansion Feasibility**	Evaluate potential for increasing lagoon capacity.	Obtained record drawings from MIKUTRA. Estimate potential capacity increase resultant from adding roughing filter and supplemental aeration. Area north of lagoons not occupied.		Sum	1	$ 5,000	$ 5,000	Engineering estimate.	
IWW	IWW-11	2007	2007	TREAT	**Maintenance of St. Joseph's Mission Hospital Wastewater Lagoons**	According to MIKUTRA, the pond was last dredged in 2001. May need de-sludging again or other maintenance.	De-sludge first (anaerobic) lagoon if needed, perform basic system maintenance.		Sum	1	$ 2,000	$ 2,000	Engineering estimate.	
IWW	IWW-12	2007	2007	TREAT	**Septic System at Migori Teacher's College**	Overflowing into river and represents acute public health threat.	Perform temporary *rehabilitation. Contact* Education Ministry and halt progress on separate lagoons for College.		Sum	1	$ 5,000	$ 5,000	Engineering estimate.	
IWW	IWW-13	2007	2008	TREAT	**Wastewater Treatment Study**	Need preliminary study to further define wastewater treatment system requirements for Migori.	Determine actual size and availability of preferred treatment site "A". Squatters on proposed treatment site - devise and institute program to relocate squatters. MIKUTRA notes the issue has been addressed with local authority and DDC and they shall be relocated when appropriate. Take soil samples and conduct survey as required. Determine effluent discharge standards and clarify permitting process. Perform conceptual design of treatment facility and identify permitting requirements. Estimate costs. Include consideration of expanded use of St. Joseph's Mission Hospital lagoons as part of overall wastewater management for Migori.		sum	1	$ 25,000	$ 25,000	Engineering estimate.	
IWW	IWW-14	2007	2008	TREAT	**Effluent Reuse**	Effluent from proposed wastewater treatment facility is a potentially valuable resource.	Explore options for effluent reuse / polishing including aquaculture, constructed wetlands, sugar cane, bamboo grown downstream of treatment facilities.	See WSP Design Manual for E. Africa re aquaculture.	Sum	1	$ 5,000	$ 5,000	Engineering estimate.	
IWW	IWW-15	2007	2007	TREAT	**Septage Disposal Site Inspection, Upgrade Design**	Present septage disposal site at Lichota Ranch is important as a temporary means of disposing of septage. However, it should be inspected and evaluated to determine how best to ensure the site is safe for continued use until wastewater collection and treatment system constructed.	Inspect Lichota Ranch site to determine adequacy to continue to serve as temporary disposal site. Site should meet minimum criteria (level ground, include fencing, trenching, etc...), Prepare design to bring site up to reasonable standard for interim use, estimate cost.	November 2006 MIKUTRA notes they will approach local authority through DDC to allocate an appropriate site.	sum	1	$ 10,000	$ 10,000	Engineering estimate.	
				SUBTOTAL										$ 180,000
				SHORT TERM WASTEWATER PROJECTS (2008-2015)										
SWW				MANAGEMENT										$ -
SWW				COLLECTION										$ 3,930,000
SWW	SWW-1	2008	2015	COLLE	**Establish public toilets / latrines at key locations**	Insufficient or no latrines exist at key locations.	Install / replace public toilets or latrines at key locations according to plan and in accordance with LVSWSB toolkit. Ensure latrines are constructed to be easily converted to flush toilets when water and sewer are available.		Building with ~10 stalls, wash basins	30	$ 15,000	$ 450,000	UN-Habitat Kisii Nov 2005, Item 2.2.1 and Annex 4 estimates ~$15,000 per building w/ 10 stalls & wash basins.	
SWW	SWW-2	2008	2010	COLLE	**Exhausters for latrines / septic systems**	Town does not own an exhauster truck. Kisii exhauster is booked once a week to pump waste from Prinsal Enterprises.	Consider viability of purchasing a Vacutug for informal settlements and one or more exhauster trucks for Town. Equipment could be operated by private citizens but owned by Town or some other arrangement to encourage entrepreneurship.		Sum	1	$ 100,000	$ 100,000	UN-Habitat Sec 5.3, Rec 2.2, recommends purchasing 7-ton tractor and two 5 m^3 exhauster vehicles with sewage pumps and separate portable sewage pump set for less accessible areas. Cost $83,250. MIKUTRA Rapid Assessment recommended purchase of two exhausters. Assume UN cost estimate, round up to include consultancy, contingency.	
SWW	SWW-3	2010	2015	COLLE	**Gravity Wastewater Collection System (Ph 1)**	No wastewater collection system exists.	Design and Construct gravity collection system to serve central Migori.	UN (Sec 5.3, Rec 2.1) recommends study, design, construct collection and treatment for at least 10,000 people. Cost $2 Million. JICA 2001 (Sec 6.6, 12.4), recommends similar system for main institutions and central part of town at cost of ~2.6 Million.	m	14,000	$ 106	$ 1,480,000	Assume 70% length of water mains, corresponding to expected proportional coverage. 1998 Aftercare Study average cost for sewer main installation, adjusted to 2005 cost, is $106/m.	
SWW	SWW-4	2010	2015	COLLE	**Sewer Connections - Short Term**	Expect several thousand sewer connections will need to be made in short term.	Design and construct lateral sewers and house connections.		nr.	3,800	$ 500	$ 1,900,000	Assume $500/connection. Includes branch sewer installation and house connection.	
SWW				TREATMENT										$ 2,700,000
SWW	SWW-5	2008	2009	TREAT	**St. Joseph's Mission Wastewater Lagoons**	Lagoons may be expandable, depending on results of preliminary investigation.	Expand capacity by adding roughing filter, supplemental aeration, and possible algae baffle.		Sum	1	$ 60,000	$ 60,000	Assume one Solar Bee @ $30,000+ 30% for international application; Assume roughing filer & algae baffles $5,000; add 35% engineering and contingency, round up.	

Ph	NO.	YR STRT	YR FIN	TYPE	SUMMARY TITLE	OBSERVED PROBLEM / NEED	PROPOSED SOLUTION(S)	NOTES	UNITS	QUAN.	EST. UNIT PRICE (USD)	EST. COST (USD)	COST NOTES	EST. CATEGORY COST (USD)
SW W	SWW-6	2008	2009	TREAT	**Septage Disposal Site**	Present disposal site may require upgrades to ensure minimum level of safety to be used as an interim disposal site until treatment plant constructed.	Make required upgrades to ensure safety. Require all exhauster trucks to discharge at the site and report all discharges to Town. Inspect site periodically.		Sum	1	$ 40,000	$ 40,000	UN (Sec 5.3, Rec 2.2) recommends identifying suitable site for septage disposal and *constructing temporary facility until WSPs* operational. Est. Cost $37,500. Round up.	
SW W	SWW-7	2009	2010	TREAT	**WWTF and Sludge Handling Facility (Ph 1)**	No wastewater treatment facility exists. Also require sludge handling facility to enable safe disposal or re-use.	Design and *Construct WWTF with septage receiving station. Capacity* ~5,000 m^3/d. Expect traditional three-stage lagoons, possibly with roughing filter and supplemental aeration as area requirements dictate. Acquire sufficient land and construct facility to allow for future expansion. Incorporate sludge gas collection for electricity generation if cost-effective or if electricity grid still deficient. Include sludge handling facility with sludge drying beds, composting.	*2005 Design manual per capita values* used for estimation, which are likely overestimating flow. Will need to re-evaluate flow before proceeding with Phase 2.	Sum	1	$ 2,600,000	$ 2,600,000	1998 Aftercare Study Figure 4.2.4. Cost ~$1,000,000 for construction, adjust to 2005, add 35% for eng. cont., round up. Add $100,000 for land purchase.	
				SUBTOTAL										$ 6,630,000
				LONG TERM WASTEWATER PROJECTS (2016-2025)										
LWW				MANAGEMENT										$ -
LWW				COLLECTION										$ 2,590,000
LWW	LWW-1	2016	2025	COLLE	**Gravity *Wastewater* Collection System (Ph 2)**	Expand wastewater collection system to unserved areas.	Design and construct Phase II of gravity collection system.	UN (Sec 5.3, Rec 2.1) recommends study, design, construct collection and treatment for at least 10,000 people. Cost $2 Million. JICA 2001 (Sec 6.6, 12.4), recommends similar system for main institutions and central part of town at cost of ~2.6 Million.	m	7,000	$ 106	$ 740,000	Assume 70% length of water mains, corresponding to expected proportional coverage. *1998 Aftercare Study average cost* for sewer main installation, adjusted to 2005 cost, is $106/m.	
LWW	LWW-2	2016	2025	COLLE	**Sewer Connections - Long Term**	Expect several thousand additional sewer connections will need to be made in long term.	Construct lateral sewers and house connections.		nr.	3,700	$ 500	$ 1,850,000	Assume $500/connection. Includes branch sewer installation and house connection.	
LWW				*TREATMENT*										$ 500,000
LWW	LWW-3	2016	2018	TREAT	**WWTF and Sludge Handling Facility (Ph 2)**	WWTF expected to require expansion in long term. Actual required expansion will depend on actual flows. Expect that predicted flows will prove to be overestimates based on GOK per-capita figures.	Design and construct assumed 1,000 m3/d expansion. 2005 Kenya Design Manual per capita values used in flow estimates. Based on these figures, a 4,000 m^3/d expansion could be required. *Expect that values overestimate* flow. Will need to re-evaluate flow before proceeding with Phase 2.		Sum	1	$ 500,000	$ 500,000	See Aftercare Study Figure 4.2.4. Cost ~$200,000 for construction, adjust for 1998 costs, add 35% for engineering and contingency, round up.	
				SUBTOTAL										**$ 3,090,000**

APPENDIX 7-3

Migori Immediate Action Items

MIGORI

Recommended Immediate MIKUTRA Actions

NO.	SUMMARY TITLE	IMMEDIATE ACTION
IW-1	**Mapping**	Compile central file and list of all existing maps for use in creation of comprehensive water and wastewater system mapping. Mapping showing roads, land use, population distribution, and all water and wastewater infrastructure including facilities layouts should be assembled. Sources include physical development plans prepared by national, regional, and municipal government, MIKUTRA and its consultants, and other sources. STATUS: Partially complete. Several maps were provided as part of current feasibility study.
IW-4	**System Inventory, Asset Management Plan**	Compile a list of all major equipment, piping, tanks, and treatment systems required for creation of a system inventory. Available data such as age, expected useful life, condition, service history, and nameplate data should be included. Financial value of assets and list of depreciated assets should be included.
IW-5	**Preventative Maintenance Plan**	Compile manufacturer's recommendations for equipment maintenance; compile list of current preventative maintenance schedules / practices.
IW-6	**O&M Manuals, Information on Existing Infrastructure**	Collect all available O&M manuals for existing facilities and equipment. Catalog this information and determine which systems lack proper manuals. Make copies of existing manuals and store at a centralized location. Obtain equipment manufacturer's manuals or design engineer manuals / reports for all equipment and facilities.
IW-7	**Data on Existing Private Boreholes**	Gather data on production capacity and quality from largest private boreholes in town. STATUS: Complete. Data provided August 2006.
IW-8	**Illegal Connections**	Develop a list of the neighborhoods (and indicate on map) where the highest number of illegal connections are expected to exist. Estimate expected number of illegal connections in each area. This information will be used in developing a strategy to remedy this problem.
IW-10	**Staffing Planning**	Compile list of all staff, titles, duties, and salaries for use in proposed staffing planning study. STATUS: Partially complete. MIKUTRA confirmed current staffing is as described in 11 April 2006 letter from Mr. Njenga. Need to clarify which staff are for Migori gazetted water supply and which are for entire district.
IW-13	**Watershed Protection Program**	Develop list of suspected and known threats to existing and proposed future water supplies as initial step in developing watershed protection plan. Include list of specific farming operations, industries, etc.. including location and description of activities. Initiate discussions with farming community about implementing best management practices to protect water supplies. STATUS: Partially complete. MIKUTRA noted tobacco growing farms are the only pollution source in Oyani River watershed. However, MIKUTRA also noted some livestock operations in the watershed. Need to clarify details of expected threats.

NO.	SUMMARY TITLE	IMMEDIATE ACTION
IW-14	**Public Education Program**	Develop ideas for most effective ways to distribute public education materials. Identify schools that should be targeted for public education campaigns. Begin developing ideas ("brainstorm") for public education materials to be distributed with bills. Review examples of U.S. Consumer Confidence Reports and consider developing similar materials. Review available public education materials on USEPA's website at http://www.epa.gov/epahome/educational.htm.
IW-22	**Computerize Record keeping and billing**	An electronic database of all water and sewer customers should be created including customer name, account number, active/inactive status, location, meter age, all meter readings, bill sent, payments received. Gather all information required to create database and begin to create database if computers available.
IW-23	**Large Users Survey**	Clarify water use from existing large water users. Expected largest users include: Gilly Hotel, Girango Lodge, Highway Hotel, Migori District Headquarters, Kadika Girls High School, Migori Teachers' College, Prinsal Enterprises Ltd. (fish factory), St. Joseph's Mission Hospital, District Hospital, Municipal offices and police station, prison, markets, other schools, sports stadium. Limited information was provided on District Hospital, Fisheries Dept., Migori Secondary School, and Prisons.
IW-30	**Source Augmentation Study**	Establish flow and water quality monitoring station at proposed intake location at Oyani Bridge. Begin taking measurements in accordance with GOK requirements. Compile electronic database of historic data on Oyani flow and water quality data (may need to obtain historic data from WRMA). Ensure historic data is from closest station to proposed intake and dam location, obtain latitude/longitude of station. Gather any other existing data regarding previous dam investigations (possibly performed at national level) and create file of all previous studies. Determine status of existing water withdrawal permits on Oyani River and availability of required water withdrawal. Determine permitting needs for dam and increased withdrawals. Also begin monitoring flow on Sigira stream for potential hydropower.
IW-31	**Boreholes Testing, Evaluation**	Provide update on installation status and production capacity (m3/d) of the two new wells (forest and new borehole).
IW-37	**Leak Detection and Repair**	Create list of known largest water leaks (and indicate on map) in the system in order to begin to prioritize rehabilitation and replacement programs. Include size and age of water main, and type of pipe.
IWW-2	**St. Joseph's Mission Hospital Lagoons take-over**	Begin discussions / negotiations with St. Joseph's Mission Hospital regarding possible takeover of operation and maintenance of the lagoons and possible expansion to accept wastewater from other users. STATUS: MIKUTRA has had discussions with St. Joseph's Mission but not the Diocese of Homa Bay.
IWW-3	**On-Site Wastewater Management**	Begin to develop database of existing on-site wastewater disposal systems including, at a minimum: property address, owner's name, type and size of system, year installed, last time sludge was pumped, and whether or not a private drinking water well exists on-site. Consider a survey mailing.

NO.	SUMMARY TITLE	IMMEDIATE ACTION
IWW-8	**Characterize effluent discharges from private facilities**	Sample effluent from Prinsal Enterprises Ltd. (fish factory) and St. Joseph's Mission Hospital lagoons; Sample river water upstream and downstream of discharges. Evaluate wastewater management at GK Prison (noted in JICA 2001 Env. Impact section as problematic) and other large users. Send samples to LVSWSB lab in Kisumu for analysis.
IWW-13	**Wastewater Treatment Study**	Investigate availability of land suitable for wastewater treatment facilities downstream of preferred site "A".
IWW-15	**Septage Disposal Site Inspection, Upgrade Design**	Determine if Lichota Ranch site may be modified to serve as temporary disposal site. In November 2006, MIKUTRA noted they would approach local authority through DDC to allocate an appropriate site for this purpose.

APPENDIX 9-1

LVSWSB Financial Modeling

LVSWSB USD	2008	2009	2010	2011	2012	2013	2014	2015
	June 30 yr end							
Revenues								
Kisii Licensee Fees	$ 21,159	$ 30,168	$ 39,288	$ 55,488	$ 76,512	$ 98,206	$ 125,454	$ 159,524
Migori Licensee Fees	$ 22,482	$ 45,489	$ 55,221	$ 84,708	$ 102,669	$ 116,586	$ 134,024	$ 156,017
Kericho Licensee Fees	$ 136,730	$ 149,230	$ 160,065	$ 169,920	$ 180,607	$ 192,207	$ 204,793	$ 218,462
Water Meter Rent Revenue	$ 26,616	$ 40,358	$ 50,563	$ 62,502	$ 76,513	$ 92,956	$ 111,979	$ 134,596
New Lease Fees (Cost of Capital for New WSP Investments)	$ 146,268	$ 321,404	$ 619,658	$ 859,529	$ 1,160,569	$ 3,775,625	$ 3,945,105	$ 3,991,910
Existing LVS Revenue (less License Fees year 1, grow @3%)	$ 4,622,209	$ 4,760,875	$ 4,903,701	$ 5,050,612	$ 5,202,337	$ 5,358,407	$ 5,519,159	$ 5,684,734
Maintenance Fund From WSPs (percentage of cost of capital)	$ 182,650	$ 247,820	$ 603,357	$ 681,760	$ 410,696	$ 226,362	$ 187,973	$ 165,483
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
Expenses	(5,060,104)	(5,136,006)	(5,213,046)	(5,291,242)	(5,370,610)	(5,451,169)	(5,532,937)	(5,615,931)
EBITDA	(101,169)	238,626	990,565	1,427,653	1,611,879	4,160,156	4,444,891	4,642,476
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
Cash	1,613,524	1,941,570	2,620,305	3,008,180	2,068,101	2,137,168	2,884,006	3,628,451
Debt Service Reserve Account (Cash)	201,918	399,057	561,227	781,346	1,796,275	1,924,793	1,935,349	2,153,535
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]

Key results for the LVSWSB in US $.

LVSWSB Kenyan Schillings '000s	2008	2009	2010	2011	2012	2013	2014	2015
	June 30 yr end							
Revenues								
Kisii Licensee Fees	1,481	2,112	2,750	3,864	5,356	6,874	8,782	11,167
Migori Licensee Fees	1,574	3,184	3,865	5,930	7,187	8,161	9,382	10,921
Kericho Licensee Fees	9,571	10,446	11,205	11,894	12,642	13,454	14,336	15,292
Water Meter Rent Revenue	1,863	2,825	3,539	4,375	5,356	6,507	7,839	9,422
New Lease Fees (Cost of Capital for New WSP Investme	14,489	18,567	21,360	26,083	30,541	34,997	40,337	46,802
Existing LVS Revenue (less License Fees year 1, grow @3%)	323,555	333,261	343,259	353,557	364,164	375,088	386,341	397,931
TOTAL REVENUES	**352,533**	**391,674**	**450,230**	**487,530**	**506,093**	**690,224**	**715,994**	**735,751**
Expenses	**(354,207)**	**(359,520)**	**(364,913)**	**(370,387)**	**(375,943)**	**(381,582)**	**(387,306)**	**(393,115)**
EBITDA	**(7,082)**	**16,704**	**69,340**	**99,936**	**112,832**	**291,211**	**311,142**	**324,973**
NET INCOME	**(26,499)**	**(28,170)**	**(30,638)**	**(52,712)**	**(87,273)**	**55,926**	**58,709**	**65,824**
Cash	**112,947**	**135,910**	**183,421**	**210,573**	**146,167**	**149,602**	**201,880**	**253,992**
Debt Service Reserve Account (Cash)	14,134	27,934	39,286	54,694	125,739	134,736	135,474	150,747
ENDING CASH BALANCE	**127,081**	**163,844**	**222,707**	**265,267**	**271,906**	**284,337**	**337,355**	**404,739**
TOTAL ASSETS	**515,979**	**884,200**	**1,747,712**	**2,670,920**	**3,159,084**	**3,469,648**	**3,676,757**	**3,859,503**

Key results for the LVSWSB in Kenyan Shillings

LVSWSB USD Income Statement	2008	2009	2010	2011	2012	2013	2014	2015
Revenues								
Kisii Licensee Fees	21,159	30,168	39,288	55,488	76,512	98,206	125,454	159,524
Migori Licensee Fees	22,482	45,489	55,221	84,708	102,669	116,586	134,024	156,017
Kericho Licensee Fees	136,730	149,230	160,065	169,920	180,607	192,207	204,793	218,462
Water Meter Rent Revenue	26,616	40,358	50,563	62,502	76,513	92,958	111,979	134,596
New Lease Fees (Cost of Capital for New WSP Investments)	146,268	321,404	619,658	859,529	1,180,569	3,775,625	3,945,105	3,991,910
Existing LVS Revenue (less License Fees year 1, grow @3%)	4,622,209	4,760,875	4,903,701	5,050,812	5,202,337	5,358,407	5,519,159	5,684,734
Maintenance Fund From WSPs (percentage of cost of capital)	182,650	247,820	603,357	681,760	410,696	226,362	187,973	165,483
TOTAL REVENUE	**5,158,115**	**5,595,345**	**6,431,853**	**6,954,719**	**7,229,902**	**9,860,349**	**10,228,487**	**10,510,726**
3%								
EXPENSES								
Board Lease Fees								
Municipality Rent								
Total Infrastructure Leases	**(97,977)**	**(117,993)**	**(123,982)**	**(140,000)**	**(140,000)**	**(140,000)**	**(140,000)**	**(140,000)**
Gross Margin	**5,060,138**	**5,477,352**	**6,307,871**	**6,824,719**	**7,089,902**	**9,720,349**	**10,088,487**	**10,370,726**
Annual O&M Costs (Existing)	(5,060,104)	(5,136,006)	(5,213,046)	(5,291,242)	(5,370,610)	(5,451,169)	(5,532,937)	(5,615,931)
Total O&M Expenses	**(5,060,104)**	**(5,136,006)**	**(5,213,046)**	**(5,291,242)**	**(5,370,610)**	**(5,451,169)**	**(5,532,937)**	**(5,615,931)**
Additional O&M Costs (2% of existing)	(101,202)	(102,720)	(104,261)	(105,825)	(107,412)	(109,023)	(110,659)	(112,319)
EBITDA	(101,169)	238,626	990,565	1,427,653	1,611,879	4,160,156	4,444,891	4,642,476
Less Depreciation	(117,083)	(275,942)	(676,730)	(1,121,109)	(1,368,142)	(1,497,013)	(1,604,175)	(1,696,920)
Interest on Cash in Bank		38,725	46,598	62,887	72,196	50,114	51,292	69,216
(-) Interest (Senior Debt)	(160,300)	(403,837)	(798,114)	(1,122,454)	(1,562,692)	(1,914,318)	(2,053,311)	(2,074,423)
(-) Interest (Capitalized -Construction)	-							
EBT	**(378,552)**	**(402,429)**	**(437,682)**	**(753,023)**	**(1,246,758)**	**798,940**	**838,698**	**940,348**
(-) Taxes	-	-	-	-	-	-	-	-
Net Income	**(378,552)**	**(402,429)**	**(437,682)**	**(753,023)**	**(1,246,758)**	**798,940**	**838,698**	**940,348**

LVSWSB Income Statement in US $

LVSWSB *Balance Sheet*	2008	2009	2010	2011	2012	2013	2014	2015
	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Cash	1,613,524	1,941,570	2,620,305	3,008,180	2,088,101	2,137,168	2,884,006	3,628,451
Debt Service Reserve Account (Cash)	201,918	399,057	561,227	781,346	1,796,275	1,924,793	1,935,349	2,153,535
Receivables	644,764	699,418.17	803,981.68	870,590	903,738	1,232,544	1,278,561	1,313,841
Current Assets	**2,460,207**	**3,040,046**	**3,985,514**	**4,660,116**	**4,788,114**	**5,294,505**	**6,097,916**	**7,095,826**
Long Term Assets	**4,910,917**	**9,591,379**	**20,981,794**	**33,495,890**	**40,341,664**	**44,271,895**	**46,427,184**	**48,039,927**
Total Assets	**7,371,124**	**12,631,425**	**24,967,308**	**38,156,006**	**45,129,778**	**49,566,400**	**52,525,100**	**55,135,753**
Payables	421,675	428,000	434,420	440,937	447,551	454,264	461,078	467,994
Working Capital Line	-	-	-	-	-	-	-	-
Senior Debt	5,496,000	9,738,304	19,313,662	29,765,066	35,925,502	34,129,227	32,332,952	30,536,677
Debt 2	-	-	-	-	-	4,884,519	8,403,037	11,518,734
Debt 3	-	-	-	-	-	-	-	-
Total Liabilities	**5,917,675**	**10,166,304**	**19,748,083**	**30,206,003**	**36,373,053**	**39,468,011**	**41,197,067**	**42,521,406**
GRANT	1,832,000	3,246,101	6,437,887	9,921,689	11,975,167	12,517,892	12,908,838	13,254,805
Retained Earnings	(378,552)	(780,980)	(1,218,662)	(1,971,685)	(3,218,443)	(2,419,503)	(1,580,805)	(640,457)
Total Equity (or equivalent)	**1,453,448**	**2,465,121**	**5,219,225**	**7,950,004**	**8,756,724**	**10,098,389**	**11,328,033**	**12,614,348**
Total Equity & Liabilities	**7,371,124**	**12,631,425**	**24,967,308**	**38,156,006**	**45,129,778**	**49,566,400**	**52,525,100**	**55,135,753**

LVSWSB Balance Sheet in US $

LVSWSB Cash Flow Statement	2008	2009	2010	2011	2012	2013	2014	2015
Cash Flow from Operating Activities								
Net Income	(378,552)	(402,429)	(437,682)	(753,023)	(1,246,758)	798,940	838,698	940,348
(+) Depreciation	117,083	275,942	676,730	1,121,109	1,368,142	1,497,013	1,604,175	1,696,920
(+) Capitalized Interest	-	-	-	-	-	-	-	-
(-) Increase in Receivables	(644,764)	(54,654)	(104,564)	(66,808)	(33,148)	(328,806)	(46,017)	(35,280)
(-) Increase in Inventory								
(+) Increase in Payables	421,675	6,325	6,420	6,516	6,614	6,713	6,814	6,916
Net Operating Cash Flow	**(484,558)**	**(174,815)**	**140,904**	**307,994**	**94,850**	**1,973,860**	**2,403,669**	**2,608,905**
Cash Provided (Used) by Investing Activities								
Initial Project Capital & WSP Start-up Costs	(5,028,000)							
New Capital Costs	-	(4,956,405)	(12,067,145)	(13,635,205)	(8,213,916)	(5,427,244)	(3,759,464)	(3,309,664)
Net Cash Flow from Investing Activities	**(5,028,000)**	**(4,956,405)**	**(12,067,145)**	**(13,635,205)**	**(8,213,916)**	**(5,427,244)**	**(3,759,464)**	**(3,309,664)**
Cash Provided (Used) by Financing Activities								
(+) Senior Debt	5,496,000	4,242,304	9,575,359	10,451,404	6,160,437	-	-	-
(+) Debt 2	-	-	-	-	-	4,884,519	3,518,517	3,113,697
(+) Debt 3		-	-	-	-	-	-	-
(+) DSRA From WSPs								
(+)Grant	1,832,000	1,414,101	3,191,786	3,483,801	2,053,479	542,724	390,946	345,986
(+) Working Capital Line	-	-	-	-	-	-	-	-
(-) Working Capital Line	-	-	-	-	-	-	-	-
(-) Senior Debt Payments	-	-	-	-	-	(1,796,275)	(1,796,275)	(1,796,275)
(-) Dividends			-	-	-	-	-	-
Net Cash Flow from Financing Activities	**7,328,000**	**5,656,405**	**12,767,145**	**13,935,205**	**8,213,916**	**3,630,969**	**2,113,189**	**1,663,389**
Increase (Decrease) in DSRA	201,918	197,139	162,170	220,119	1,014,929	128,518	10,556	218,185
Net Change in Cash Flow	**1,613,524**	**328,046**	**678,734**	**387,875**	**(920,079)**	**49,067**	**746,838**	**744,445**
Ending Cash Balance	**1,613,524**	**1,941,570**	**2,620,305**	**3,008,180**	**2,088,101**	**2,137,168**	**2,884,006**	**3,628,451**

LVSWSB Cash Flow Statement in US $

APPENDIX 9-2

Kisii Financial Modeling

LVSWSB - Kisii Kenyan Schillings '000s	2008	2009	2010	2011	2012	2013	2014	2015
Revenues								
Water Kiosk Revenue	1,550	3,682	5,033	6,901	9,333	12,538	16,870	22,569
Public Toilet Revenue	1,422	2,971	3,795	4,829	6,115	7,700	9,630	11,944
Water Meter Rent Revenue	578	1,115	1,530	2,018	2,591	3,268	4,068	5,018
Individual Water Connection Tariff Revenue	14,801	19,825	26,219	39,827	57,331	73,939	94,818	121,012
Total Water Revenues	**18,351**	**27,593**	**36,577**	**53,574**	**75,369**	**97,444**	**125,386**	**160,542**
Wastewater Tariff Revenue	6,335	7,603	9,259	11,162	13,894	17,130	20,976	25,570
Additional Revenue	4,937	7,039	9,167	12,947	17,853	22,915	29,273	37,222
TOTAL REVENUES	**29,623**	**42,236**	**55,004**	**77,683**	**107,117**	**137,488**	**175,636**	**223,334**
Expenses	**(26,858)**	**(22,248)**	**(34,286)**	**(40,626)**	**(41,633)**	**(47,044)**	**(54,471)**	**(61,364)**
EBITDA	**2,765**	**19,988**	**20,717**	**37,057**	**65,484**	**90,444**	**121,165**	**161,970**
-	-	-	-	-	-	-	-	-
NET INCOME	**(775)**	**13,617**	**1,686**	**4,050**	**17,181**	**6,153**	**20,345**	**44,389**
-	-	-	-	-	-	-	-	-
Cash	**80,655**	**107,904**	**132,964**	**153,453**	**173,790**	**170,507**	**193,241**	**231,390**
Debt Service Reserve Account (Cash)	2,257	4,387	6,272	8,881	26,974	48,261	49,474	59,973
ENDING CASH BALANCE	**82,911**	**112,291**	**139,237**	**162,334**	**200,763**	**218,768**	**242,715**	**291,363**
-	-	-	-	-	-	-	-	-
TOTAL ASSETS	**147,404**	**250,014**	**490,103**	**775,973**	**937,724**	**1,063,338**	**1,186,441**	**1,297,468**

LVSWSB - Kisii USD Income Statement	2007	2008	2009	2010	2011	2012	2013	2014	2015
Water Revenues									
Water Kiosk Revenue	22,148	52,598	71,904	98,583	133,324	179,108	241,006	322,408	428,193
Public Toilet Revenue	20,318	42,442	54,215	68,880	87,354	109,997	137,569	170,825	215,235
Water Meter Rent Revenue	8,256	15,935	21,862	28,824	37,017	46,682	58,115	71,687	86,370
Individual Water Connection Tariff Revenue	211,437	283,214	374,553	568,959	818,010	1,056,266	1,354,546	1,728,737	2,197,267
Total Water Revenue	**262,159**	**394,189**	**522,534**	**765,346**	**1,076,705**	**1,392,053**	**1,791,236**	**2,293,457**	**2,927,065**
Wastewater									
Wastewater Tariff Revenue	90,496	108,617	132,271	159,454	198,492	244,713	299,664	365,280	437,962
Additional Revenue	70,531	100,561	130,961	184,960	255,039	327,353	418,180	531,747	673,005
TOTAL REVENUE	**423,186**	**603,368**	**785,766**	**1,109,761**	**1,530,237**	**1,964,119**	**2,509,079**	**3,190,484**	**4,038,032**
Board Lease Fees									
Municipality Rent									
Total Infrastructure Leases	**(21,159)**	**(30,168)**	**(39,288)**	**(55,488)**	**(76,512)**	**(98,206)**	**(125,454)**	**(159,524)**	**(201,902)**
Gross Margin	**402,027**	**573,199**	**746,478**	**1,054,273**	**1,453,725**	**1,865,913**	**2,383,625**	**3,030,960**	**3,836,131**
		95%	95%	95%	95%	95%			
Annual Personnel Costs	(231,730)	(139,000)	(231,730)	(276,192)	(326,253)	(382,824)	(459,203)	(533,856)	(619,259)
Annual O&M Costs (Existing Proj., not personnel)	(95,138)	(96,090)	(97,051)	(98,021)	(99,001)	(99,991)	(100,991)	(102,001)	(103,021)
Annual O&M Costs (New Proj. not personnel)	(18,392)	(32,334)	(95,780)	(120,604)	(61,977)	(56,517)	(53,803)	(38,359)	(324,766)
Total O&M Expenses	**(345,261)**	**(267,424)**	**(424,561)**	**(494,818)**	**(487,231)**	**(539,332)**	**(613,998)**	**(674,216)**	**(1,047,046)**
Additional Management Costs	(17,263)	(20,231)	(25,954)	(30,072)	(31,009)	(34,518)	(38,703)	(42,887)	(62,328)
EBITDA	39,503	285,544	295,963	529,383	935,484	1,292,062	1,730,925	2,313,857	2,726,756
Less Depreciation	(19,650)	(54,195)	(170,544)	(306,748)	(356,729)	(400,878)	(445,026)	(472,675)	(607,313)
Interest on Cash in Bank		27,653	36,996	45,588	52,612	59,585	58,459	66,254	79,334
(-) Interest (Senior Debt)	(30,930)	(64,472)	(125,350)	(179,203)	(253,754)	(815,537)	(897,223)	(931,861)	(1,231,837)
(-) Interest (Capitalized -Construction)	-								
EBT	**(11,077)**	**194,530**	**37,065**	**89,020**	**377,614**	**135,233**	**447,135**	**975,576**	**966,939**
(-) Taxes	-	-	(12,973)	(31,157)	(132,165)	(47,331)	(156,497)	(341,452)	(338,429)
Net Income	**(11,077)**	**194,530**	**24,092**	**57,863**	**245,449**	**87,901**	**290,638**	**634,124**	**628,511**

Kisii	2007	2008	2009	2010	2011	2012	2013	2014	2015
Balance Sheet									
Cash	1,152,210	1,541,488	1,899,492	2,192,182	2,482,708	2,435,811	2,760,586	3,305,567	3,815,813
Debt Service Reserve Account (Cash)	32,236	62,675	89,602	126,877	385,338	689,448	706,767	856,755	1,025,786
Receivables	52,898	75,421	98,221	138,720	191,280	245,515	313,635	398,811	504,754
Current Assets	**1,237,345**	**1,679,584**	**2,087,314**	**2,457,779**	**3,059,325**	**3,370,774**	**3,780,987**	**4,561,132**	**5,346,353**
Long Term Assets	**868,430**	**1,892,046**	**4,914,154**	**8,627,551**	**10,336,732**	**11,819,765**	**13,168,169**	**13,974,125**	**24,192,345**
Total Assets	**2,105,775**	**3,571,630**	**7,001,468**	**11,085,330**	**13,396,058**	**15,190,539**	**16,949,157**	**18,535,257**	**29,538,698**
Payables	28,772	22,285	35,380	41,235	40,603	44,944	51,166	56,185	87,254
Working Capital Line	-	-	-	-	-	-	-	-	-
Senior Debt	1,568,060	2,524,419	5,066,907	6,084,016	9,833,449	9,151,776	8,670,104	8,188,431	7,706,759
Debt 2	-	-	-	-	-	1,856,324	3,508,240	4,722,578	13,924,279
Debt 3									
Total Liabilities	**1,594,832**	**2,546,704**	**5,104,287**	**8,125,251**	**9,674,051**	**11,053,044**	**12,229,510**	**12,987,192**	**21,718,292**
GRANT	522,020	841,473	1,689,636	2,694,672	3,211,150	3,538,736	3,830,251	4,044,545	5,668,375
Retained Earnings	(11,077)	183,453	207,545	265,408	510,857	598,758	889,396	1,523,520	2,152,031
Total Equity (or equivalent)	**510,943**	**1,024,926**	**1,897,181**	**2,960,080**	**3,722,006**	**4,137,494**	**4,719,647**	**5,568,065**	**7,820,406**
Total Equity & Liabilities	**2,105,775**	**3,571,630**	**7,001,468**	**11,085,330**	**13,396,058**	**15,190,539**	**16,949,157**	**18,535,257**	**29,538,698**

Cash Flow Statement	2007	2008	2009	2010	2011	2012	2013	2014	2015
Cash Flow from Operating Activities									
Net Income	(11,077)	194,530	24,092	57,863	245,449	87,901	290,638	634,124	628,511
(+) Depreciation	19,650	54,195	170,544	306,748	358,729	400,678	445,026	472,675	607,313
(+) Capitalized Interest	-	-	-	-	-	-	-	-	-
(-) Increase in Receivables	(52,898)	(22,523)	(22,800)	(40,499)	(52,559)	(54,235)	(68,120)	(85,176)	(105,943)
(-) Increase in Inventory									
(+) Increase in Payables	28,772	(6,488)	13,095	5,855	(632)	4,342	6,222	5,018	31,069
Net Operating Cash Flow	**(15,554)**	**219,716**	**184,931**	**329,966**	**548,986**	**438,885**	**673,766**	**1,026,641**	**1,160,950**
Cash Provided (Used) by Investing Activities									
Initial Project Capital Costs	(888,080)								
New Capital Costs	-	(1,077,811)	(3,192,651)	(4,020,145)	(2,065,910)	(1,883,910)	(1,793,430)	(1,278,630)	(10,825,533)
Net Cash Flow from Investing Activities	**(888,080)**	**(1,077,811)**	**(3,192,651)**	**(4,020,145)**	**(2,065,910)**	**(1,883,910)**	**(1,793,430)**	**(1,278,630)**	**(10,825,533)**
Cash Provided (Used) by Financing Activities									
(+) Senior Debt	1,566,060	958,359	2,544,489	3,015,109	1,549,433	-	-	-	-
(+) Debt 2	-	-	-	-	-	1,856,324	1,651,916	1,214,336	9,201,703
(+) Debt 3									
(+) Mezzanine Capital									
(+)Grant	522,020	319,453	846,163	1,005,036	516,478	327,587	291,515	214,295	1,623,830
(+) Working Capital Line	-	-	-	-	-	-	-	-	-
(-) Working Capital Line	-	-	-	-	-	-	-	-	-
(-) Senior Debt Payments	-	-	-	-	-	(481,672)	(481,672)	(481,672)	(481,672)
(-) Dividends			-	-	-	-	-	-	-
Net Cash Flow from Financing Activities	**2,088,080**	**1,277,811**	**3,392,651**	**4,020,145**	**2,065,910**	**1,702,238**	**1,461,758**	**946,958**	**10,343,861**
Increase (Decrease) in DSRA	32,236	30,439	26,927	37,275	258,461	304,110	17,319	149,988	169,031
Net Change in Cash Flow	**1,152,210**	**389,277**	**358,004**	**292,690**	**290,525**	**(46,897)**	**324,775**	**544,981**	**510,246**
Ending Cash Balance	**1,152,210**	**1,541,488**	**1,899,492**	**2,192,182**	**2,482,708**	**2,435,811**	**2,760,586**	**3,305,567**	**3,815,813**

APPENDIX 9-3

Migori Financial Modeling

LVSWSB - Migori USD	2007	2008	2009	2010	2011	2012	2013	2014	2015
	Construction								
Revenues									
Water Kiosk Revenue	9,175	20,937	26,841	34,410	44,116	56,561	72,519	92,982	119,221
Public Toilet Revenue	15,307	31,197	38,853	48,446	60,248	75,010	93,962	117,682	147,353
Water Meter Rent Revenue	3,177	7,342	9,424	11,922	14,939	18,555	22,571	27,398	33,100
Individual Water Connection Tariff Revenue	30,797	43,331	59,618	228,052	459,181	607,957	798,805	1,043,124	1,351,056
Total Water Revenues	**58,455**	**102,806**	**134,736**	**322,831**	**578,485**	**758,083**	**987,857**	**1,281,186**	**1,650,731**
Wastewater Tariff Revenue	85,662	188,792	219,244	255,633	299,327	351,690	412,535	485,758	572,229
Additional Revenue	28,823	58,320	70,796	115,693	175,562	221,955	280,078	353,389	444,592
TOTAL REVENUES	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Expenses	**(183,052)**	**(234,581)**	**(362,633)**	**(427,920)**	**(390,286)**	**(433,377)**	**(462,020)**	**(524,569)**	**(659,677)**
EBITDA	**(10,112)**	**115,336**	**62,143**	**266,237**	**663,088**	**898,351**	**1,218,450**	**1,595,764**	**2,007,874**
NET INCOME	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Cash	**1,151,902**	**1,347,047**	**1,389,460**	**1,164,794**	**922,432**	**724,170**	**522,452**	**625,212**	**1,017,132**
Debt Service Reserve Account (Cash)	67,297	133,036	186,727	253,345	622,791	685,293	692,171	749,068	807,035
ENDING CASH BALANCE	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
TOTAL ASSETS	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

LVSWSB - Migori Kenyan Schillings '000s	2007	2008	2009	2010	2011	2012	2013	2014	2015
	Constructio	Construction	Construction	Construction	Construction	Construction			
Revenues									
Water Kiosk Revenue	642	1,466	1,879	2,409	3,088	3,959	5,076	6,509	8,345
Public Toilet Revenue	1,071	2,184	2,720	3,391	4,217	5,251	6,577	8,238	10,315
Water Meter Rent Revenue	222	514	660	835	1,046	1,299	1,580	1,918	2,317
Individual Water Connection Tariff Revenue	2,156	3,033	4,173	15,964	32,143	42,557	55,916	73,019	94,574
Total Water Revenues	**4,092**	**7,196**	**9,432**	**22,598**	**40,494**	**53,066**	**69,150**	**89,683**	**115,551**
Wastewater Tariff Revenue	5,996	13,215	15,347	17,894	20,953	24,618	28,877	34,003	40,056
Additional Revenue	2,018	4,082	4,956	8,098	12,289	15,537	19,605	24,737	31,121
TOTAL REVENUES	**12,106**	**24,494**	**29,734**	**48,591**	**73,736**	**93,221**	**117,633**	**148,423**	**186,729**
Expenses	**(12,814)**	**(16,421)**	**(25,384)**	**(29,954)**	**(27,320)**	**(30,336)**	**(32,341)**	**(36,720)**	**(46,177)**
EBITDA	**(708)**	**8,074**	**4,350**	**18,637**	**46,416**	**62,885**	**85,291**	**111,703**	**140,551**
-	-	-	-	-	-	-	-	-	-
NET INCOME	**(8,355)**	**(8,998)**	**(33,365)**	**(39,233)**	**(25,405)**	**(20,674)**	**(5,918)**	**16,707**	**30,378**
-	-	-	-	-	-	-	-	-	-
Cash	**80,633**	**94,293**	**97,262**	**82,936**	**64,570**	**50,692**	**36,572**	**43,765**	**71,199**
Debt Service Reserve Account (Cash)	4,711	9,313	13,071	17,734	43,595	47,970	48,452	52,435	56,492
ENDING CASH BALANCE	**85,344**	**103,606**	**110,333**	**100,670**	**108,166**	**98,662**	**85,024**	**96,200**	**127,692**
-	-	-	-	-	-	-	-	-	-
TOTAL ASSETS	**211,631**	**358,884**	**704,096**	**1,059,354**	**1,177,957**	**1,271,359**	**1,305,182**	**1,361,793**	**1,569,312**

LVSWSB - Migori USD Income Statement	2007	2008	2009	2010	2011	2012	2013	2014	2015
Water Revenues									
Water Kiosk Revenue	9,175	20,937	26,841	34,410	44,116	56,561	72,519	92,982	119,221
Public Toilet Revenue	15,307	31,197	38,853	48,446	60,248	75,010	93,962	117,682	147,353
Water Meter Rent Revenue	3,177	7,342	9,424	11,922	14,939	18,555	22,571	27,398	33,100
Individual Water Connection Tariff Revenue	30,797	43,331	59,618	228,052	459,181	607,957	798,805	1,043,124	1,351,056
Total Water Revenue	**58,455**	**102,806**	**134,738**	**322,831**	**578,485**	**758,083**	**987,857**	**1,281,186**	**1,650,731**
Wastewater									
Wastewater Tariff Revenue	**85,662**	**188,792**	**219,244**	**255,833**	**299,327**	**351,690**	**412,535**	**485,758**	**572,229**
Additional Revenue	28,823	58,320	70,796	115,693	175,562	221,955	280,078	353,389	444,592
TOTAL REVENUE	**172,940**	**349,917**	**424,776**	**694,157**	**1,053,375**	**1,331,728**	**1,680,470**	**2,120,333**	**2,667,551**
Board Lease Fees									
Municipality Rent									
Total Infrastructure Leases	**(22,482)**	**(45,489)**	**(55,221)**	**(84,708)**	**(102,669)**	**(116,586)**	**(134,024)**	**(156,017)**	**(183,378)**
Gross Margin	***150,458***	***304,428***	***369,555***	**609,449**	**950,706**	**1,215,142**	**1,546,447**	**1,964,316**	**2,484,174**
Annual Personnel Costs	(76,206)	(89,548)	(106,838)	(124,588)	(178,439)	(207,157)	(240,304)	(278,586)	(322,200)
Annual O&M Costs (Existing Proj., not personnel)	(32,320)	(32,643)	(32,970)	(33,299)	(33,632)	(33,969)	(34,308)	(34,651)	(34,998)
Annual O&M Costs (New Proj. not personnel)	(44,398)	(57,897)	(152,966)	(168,982)	(61,850)	(60,580)	(37,765)	(37,765)	(96,421)
Total O&M Expenses	**(152,923)**	**(180,088)**	**(292,773)**	**(326,869)**	**(273,921)**	**(301,706)**	**(312,378)**	**(351,003)**	**(453,619)**
Additional Management Costs	*(7,646)*	*(9,004)*	*(14,639)*	*(16,343)*	(13,696)	(15,085)	(15,619)	(17,550)	(22,681)
EBITDA	(10,112)	115,336	62,143	266,237	663,088	898,351	1,218,450	1,595,764	2,007,874
Less Depreciation	(47,433)	(109,289)	(272,714)	(453,250)	(519,329)	(584,051)	(624,399)	(664,746)	(767,760)
(-) Interest (Senior Debt)	(61,816)	(134,593)	(266,072)	(373,455)	(506,689)	(609,643)	(678,595)	(692,352)	(806,148)
(-) Interest (Capitalized -Construction)	-								
EBT	**(119,361)**	**(128,546)**	**(476,643)**	**(560,468)**	**(362,930)**	**(295,343)**	**(84,544)**	**238,666**	**433,968**
(-) Taxes	-	-	-	-	-	-	-	-	-
Net Income	**(119,361)**	**(128,546)**	**(476,643)**	**(560,468)**	**(362,930)**	**(295,343)**	**(84,544)**	**238,666**	**433,968**

Migori Balance Sheet	2007	2008	2009	2010	2011	2012	2013	2014	2015
Cash	1,151,802	1,347,047	1,389,460	1,184,794	922,432	724,170	522,452	625,212	1,017,132
Debt Service Reserve Account (Cash)	67,297	133,036	186,727	253,345	622,791	685,293	692,171	749,068	807,035
Receivables	21,618	43,740	53,097	86,770	131,672	166,466	210,059	265,042	333,444
Current Assets	**1,240,816**	**1,523,823**	**1,629,284**	**1,524,908**	**1,676,895**	**1,575,928**	**1,424,682**	**1,639,322**	**2,157,611**
Long Term Assets	**1,782,487**	**3,603,091**	**8,429,237**	**13,608,714**	**15,151,056**	**16,586,338**	**17,220,773**	**17,814,860**	**20,261,134**
Total Assets	**3,023,303**	**5,126,914**	**10,058,521**	**15,133,622**	**16,827,951**	**18,162,267**	**18,645,455**	**19,454,182**	**22,418,745**
Payables	12,744	15,007	24,398	27,239	22,827	25,142	26,031	29,250	37,802
Working Capital Line	-	-	-	-	-	-	-	-	-
Senior Debt	2,347,440	4,019,860	8,069,005	12,293,550	13,839,804	13,147,814	12,455,823	11,763,833	11,071,843
Debt 2	-	-	-	-	-	2,319,333	3,578,167	4,837,000	8,051,033
Debt 3						-	-	-	-
Total Liabilities	**2,360,184**	**4,034,867**	**8,093,403**	**12,320,789**	**13,862,631**	**15,492,289**	**16,060,022**	**16,630,083**	**19,160,678**
GRANT	782,480	1,339,953	2,689,868	4,097,850	4,613,268	4,613,268	4,613,268	4,613,268	4,613,268
Retained Earnings	(119,361)	(247,907)	(724,550)	(1,285,017)	(1,647,947)	(1,943,291)	(2,027,834)	(1,789,169)	(1,355,201)
Total Equity (or equivalent)	**663,119**	**1,092,047**	**1,965,119**	**2,812,833**	**2,965,321**	**2,869,977**	**2,585,434**	**2,824,099**	**3,258,067**
Total Equity & Liabilities	**3,023,303**	**5,126,914**	**10,058,521**	**15,133,622**	**16,827,951**	**18,162,267**	**18,645,455**	**19,454,182**	**22,418,745**

Migori
Cash Flow Statement

	2007	2008	2009	2010	2011	2012	2013	2014	2015
Cash Flow from Operating Activities									
Net Income	(119,361)	(128,546)	(476,643)	(560,468)	(362,930)	(295,343)	(84,544)	238,666	433,968
(+) Depreciation	47,433	109,289	272,714	453,250	519,329	584,051	624,399	664,746	767,760
(+) Capitalized Interest	-	-	-	-	-	-	-	-	-
(-) Increase in Receivables	(21,618)	(22,122)	(9,357)	(33,673)	(44,902)	(34,794)	(43,593)	(54,983)	(68,402)
(-) Increase in Inventory									
(+) Increase in Payables	12,744	2,264	9,390	2,841	(4,412)	2,315	889	3,219	8,551
Net Operating Cash Flow	**(80,801)**	**(39,115)**	**(203,896)**	**(138,049)**	**107,085**	**256,229**	**497,151**	**851,647**	**1,141,877**
Cash Provided (Used) by Investing Activities									
Initial Project Capital Costs	(1,829,920)								
New Capital Costs	-	(1,929,893)	(5,098,860)	(5,632,727)	(2,061,672)	(2,019,333)	(1,258,833)	(1,258,833)	(3,214,033)
Net Cash Flow from Investing Activities	**(1,829,920)**	**(1,929,893)**	**(5,098,860)**	**(5,632,727)**	**(2,061,672)**	**(2,019,333)**	**(1,258,833)**	**(1,258,833)**	**(3,214,033)**
Cash Provided (Used) by Financing Activities									
(+) Senior Debt	2,347,440	1,672,420	4,049,145	4,224,545	1,546,254	-	-	-	-
(+) Debt 2	-	-	-	-	-	2,319,333	1,258,833	1,258,833	3,214,033
(+) Debt 3									
(+) Mezzanine Capital									
(+)Grant	782,480	557,473	1,349,715	1,408,182	515,418	-	-	-	-
(+) Working Capital Line	-								
(-) Working Capital Line	-	-	-	-	-	-	-	-	-
(-) Senior Debt Payments	-	-	-	-	-	(691,990)	(691,990)	(691,990)	(691,990)
(-) Dividends			-	-	-	-	-	-	-
Net Cash Flow from Financing Activities	**3,129,920**	**2,229,893**	**5,398,860**	**5,632,727**	**2,061,672**	**1,627,343**	**566,843**	**566,843**	**2,522,043**
Increase (Decrease) in DSRA	67,297	65,740	53,691	66,617	369,447	62,502	6,878	56,897	57,967
Net Change in Cash Flow	**1,151,902**	**195,145**	**42,413**	**(204,666)**	**(262,362)**	**(198,262)**	**(201,717)**	**102,760**	**391,920**
Ending Cash Balance	**1,151,902**	**1,347,047**	**1,389,460**	**1,184,794**	**922,432**	**724,170**	**522,452**	**625,212**	**1,017,132**

APPENDIX 9-4

Kericho Financial Modeling

LVSWSB - Kericho USD	2007	2008	2009	2010	2011	2012	2013	2014	2015
	Construction								
Revenues									
Water Kiosk Revenue	7,365	7,835	8,870	9,586	10,599	11,719	12,959	14,332	15,934
Public Toilet Revenue	273	617	984	1,152	1,323	1,549	1,779	2,085	2,404
Water Meter Rent Revenue	14,160	15,183	17,081	19,276	21,755	24,556	27,719	31,293	35,510
Individual Water Connection Tariff Revenue	802,594	877,573	1,015,929	1,165,645	1,327,883	1,503,085	1,692,981	1,898,595	2,121,258
Total Water Revenues	**824,392**	**901,207**	**1,042,865**	**1,195,659**	**1,361,360**	**1,540,909**	**1,735,438**	**1,946,305**	**2,175,106**
Wastewater Tariff Revenue	52,085	85,961	125,085	136,341	148,758	162,542	177,780	194,727	214,160
Additional Revenue	175,295	197,434	233,550	266,400	302,024	340,690	382,643	428,206	477,853
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Expenses	**(899,803)**	**(944,396)**	**(1,000,512)**	**(1,102,984)**	**(1,157,428)**	**(1,211,879)**	**(1,157,473)**	**(1,218,512)**	**(1,290,338)**
EBITDA	**151,969**	**240,206**	**400,788**	**495,416**	**654,715**	**832,263**	**1,138,388**	**1,350,727**	**1,576,782**
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Cash	766,367	1,115,335	1,525,076	1,639,707	1,483,888	1,393,183	1,299,959	1,402,435	1,666,019
Debt Service Reserve Account (Cash)	61,169	114,118	153,436	210,063	577,226	597,812	597,017	620,821	659,660
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

LVSWSB - Kericho Kenyan Schillings '000s	2007	2008	2009	2010	2011	2012	2013	2014	2015
	Constructio	Construction	Construction	Construction	Construction	Construction			
Revenues									
Water Kiosk Revenue	516	548	607	671	742	820	907	1,003	1,115
Public Toilet Revenue	19	43	69	81	93	108	125	146	168
Water Meter Rent Revenue	991	1,063	1,196	1,349	1,523	1,719	1,940	2,191	2,486
Individual Water Connection Tariff Revenue	56,182	61,430	71,115	81,595	92,938	105,216	118,509	132,902	148,488
Total Water Revenues	**57,707**	**63,085**	**72,987**	**83,696**	**95,295**	**107,864**	**121,481**	**136,241**	**152,257**
Wastewater Tariff Revenue	3,646	6,017	8,756	9,544	10,413	11,378	12,445	13,631	14,991
Additional Revenue	12,271	13,820	16,348	18,648	21,142	23,848	26,785	29,974	33,450
TOTAL REVENUES	**73,624**	**82,922**	**98,091**	**111,888**	**126,850**	**143,090**	**160,710**	**179,847**	**200,698**
Expenses	**(62,986)**	**(66,108)**	**(70,036)**	**(77,209)**	**(81,020)**	**(84,832)**	**(81,023)**	**(85,296)**	**(90,324)**
EBITDA	**10,638**	**16,814**	**28,055**	**34,679**	**45,830**	**58,258**	**79,687**	**94,551**	**110,375**
	-	-	-	-	-	-	-	-	-
NET INCOME	**3,391**	**246**	**(4,264)**	**(12,080)**	**(18,025)**	**(15,067)**	**3,456**	**16,699**	**25,807**
	-	-	-	-	-	-	-	-	-
Cash	**53,646**	**78,073**	**106,755**	**114,779**	**103,872**	**97,523**	**90,997**	**98,170**	**116,621**
Debt Service Reserve Account (Cash)	4,282	7,988	10,740	14,704	40,406	41,847	41,791	43,457	46,176
ENDING CASH BALANCE	**57,928**	**86,062**	**117,496**	**129,484**	**144,278**	**139,370**	**132,788**	**141,628**	**162,798**
	-	-	-	-	-	-	-	-	-
TOTAL ASSETS	**197,331**	**355,164**	**636,445**	**903,644**	**1,171,905**	**1,176,861**	**1,184,554**	**1,210,675**	**1,297,462**

LVSWSB - Kericho USD Income Statement	2007	2008	2009	2010	2011	2012	2013	2014	2015
Water Revenues									
Water Kiosk Revenue	7,365	7,835	8,670	9,586	10,599	11,719	12,959	14,332	15,934
Public Toilet Revenue	273	617	984	1,152	1,323	1,549	1,779	2,085	2,404
Water Meter Rent Revenue	14,160	15,183	17,081	19,276	21,755	24,556	27,719	31,293	35,510
Individual Water Connection Tariff Revenue	802,594	877,573	1,015,929	1,165,645	1,327,683	1,503,085	1,692,981	1,898,595	2,121,258
Total Water Revenue	**824,392**	**901,207**	**1,042,665**	**1,195,659**	**1,361,360**	**1,540,909**	**1,735,438**	**1,946,305**	**2,175,106**
Wastewater									
Wastewater Tariff Revenue	52,085	85,961	125,085	136,341	148,758	162,542	177,780	194,727	214,160
Additional Revenue	175,295	197,434	233,550	266,400	302,024	340,690	382,643	428,206	477,853
TOTAL REVENUE	**1,051,772**	**1,184,602**	**1,401,300**	**1,598,400**	**1,812,143**	**2,044,141**	**2,295,861**	**2,569,239**	**2,867,120**
Board Lease Fees									
Municipality Rent									
Total Infrastructure Leases	**(136,730)**	**(149,230)**	**(160,065)**	**(169,920)**	**(180,607)**	**(192,207)**	**(204,793)**	**(218,462)**	**(233,356)**
Gross Margin	**915,041**	**1,035,372**	**1,241,235**	**1,428,480**	**1,631,536**	**1,851,934**	**2,091,068**	**2,350,777**	**2,633,764**
Annual Personnel Costs	(438,012)	(464,340)	(493,342)	(524,255)	(557,215)	(592,370)	(629,876)	(669,907)	(719,566)
Annual O&M Costs (Existing Proj., not personnel)	(243,724)	(246,161)	(248,623)	(251,109)	(253,620)	(256,156)	(258,718)	(261,305)	(263,918)
Annual O&M Costs (New Proj. not personnel)	(45,000)	(46,800)	(58,461)	(113,269)	(119,470)	(122,590)	(18,720)	(21,216)	(23,166)
Total O&M Expenses	**(726,736)**	**(757,301)**	**(800,425)**	**(888,633)**	**(930,305)**	**(971,116)**	**(907,314)**	**(952,428)**	**(1,006,650)**
Additional Management Costs	(36,337)	(37,865)	(40,021)	(44,432)	(46,515)	(48,556)	(45,366)	(47,621)	(50,332)
EBITDA	151,969	240,206	400,788	495,416	654,715	832,263	1,138,388	1,350,727	1,576,782
Less Depreciation	(50,000)	(112,458)	(233,472)	(361,111)	(492,083)	(512,083)	(534,750)	(559,500)	(607,833)
Interest on Cash in Bank									
(-) Interest (Senior Debt)	(53,523)	(122,339)	(228,236)	(306,871)	(420,126)	(535,420)	(554,262)	(552,672)	(600,280)
(-) Interest (Capitalized -Construction)	-								
EBT	**48,446**	**5,409**	**(60,920)**	**(172,566)**	**(257,494)**	**(215,241)**	**49,376**	**238,556**	**368,669**
(-) Taxes	-	(1,893)	-	-	-	-	-	-	-
Net Income	**48,446**	**3,516**	**(60,920)**	**(172,568)**	**(257,494)**	**(215,241)**	**49,376**	**238,556**	**368,669**

KERICHO
Balance Sheet

	2007	2008	2009	2010	2011	2012	2013	2014	2015
Cash	766,367	1,115,335	1,525,076	1,639,707	1,483,888	1,393,183	1,299,959	1,402,435	1,666,019
Debt Service Reserve Account (Cash)	61,169	114,118	153,436	210,063	577,226	597,812	597,017	620,821	659,660
Receivables	131,471	148,075	175,162	199,800	226,518	255,518	286,983	321,155	358,390
Current Assets	**959,008**	**1,377,529**	**1,853,674**	**2,049,570**	**2,287,632**	**2,246,512**	**2,183,959**	**2,344,411**	**2,684,069**
Long Term Assets	**1,860,000**	**3,696,242**	**7,238,403**	**10,859,625**	**14,453,875**	**14,565,792**	**14,738,242**	**14,950,942**	**15,851,108**
Total Assets	**2,819,008**	**5,073,770**	**9,092,077**	**12,909,195**	**16,741,507**	**16,812,304**	**16,922,201**	**17,295,353**	**18,535,178**
Payables	60,561	63,108	66,702	74,053	77,525	80,926	75,610	79,369	83,887
Working Capital Line	-	-	-	-	-	-	-	-	-
Senior Debt	2,032,500	3,719,025	6,775,750	9,762,500	12,827,250	12,185,888	11,544,525	10,903,163	10,261,800
Debt 2	-	-	-	-	-	924,000	1,631,200	2,403,400	3,911,400
Debt 3						-	-	-	-
Total Liabilities	**2,093,061**	**3,782,133**	**6,842,452**	**9,836,553**	**12,904,775**	**13,190,814**	**13,251,335**	**13,385,932**	**14,257,087**
GRANT	677,500	1,239,675	2,258,583	3,254,167	4,275,750	4,275,750	4,275,750	4,275,750	4,275,750
Retained Earnings	48,446	51,962	(8,958)	(181,525)	(439,019)	(654,260)	(604,884)	(366,328)	2,340
Total Equity (or equivalent)	**725,946**	**1,291,637**	**2,249,625**	**3,072,642**	**3,836,731**	**3,621,490**	**3,670,866**	**3,909,422**	**4,278,090**
Total Equity & Liabilities	**2,819,008**	**5,073,770**	**9,092,077**	**12,909,195**	**16,741,507**	**16,812,304**	**16,922,201**	**17,295,353**	**18,535,178**

KERICHO
Cash Flow Statement

	2007	2008	2009	2010	2011	2012	2013	2014	2015
Cash Flow from Operating Activities									
Net Income	48,446	3,516	(60,920)	(172,566)	(257,494)	(215,241)	49,376	238,556	368,669
(+) Depreciation	50,000	112,458	233,472	361,111	492,083	512,083	534,750	559,500	607,833
(+) Capitalized Interest	-	-	-	-	-	-	-	-	-
(-) Increase in Receivables	(131,471)	(16,604)	(27,087)	(24,638)	(26,718)	(29,000)	(31,465)	(34,172)	(37,235)
(-) Increase in Inventory									
(+) Increase in Payables	60,561	2,547	3,594	7,351	3,473	3,401	(5,317)	3,759	4,518
Net Operating Cash Flow	**27,536**	**101,917**	**149,059**	**171,258**	**211,344**	**271,244**	**547,344**	**767,643**	**943,785**
Cash Provided (Used) by Investing Activities									
Initial Project Capital Costs	(1,910,000)								
New Capital Costs	-	(1,948,700)	(3,775,633)	(3,982,333)	(4,086,333)	(624,000)	(707,200)	(772,200)	(1,508,000)
Net Cash Flow from Investing Activities	**(1,910,000)**	**(1,948,700)**	**(3,775,633)**	**(3,982,333)**	**(4,086,333)**	**(624,000)**	**(707,200)**	**(772,200)**	**(1,508,000)**
Cash Provided (Used) by Financing Activities									
(+) Senior Debt	2,032,500	1,886,525	3,056,725	2,986,750	3,064,750	-	-	-	-
(+) Debt 2	-	-	-	-	-	924,000	707,200	772,200	1,508,000
(+) Debt 3									-
(+) Mezzanine Capital									
(+)Grant	677,500	562,175	1,018,908	995,583	1,021,583	-	-	-	-
(+) Working Capital Line	-								
(-) Working Capital Line	-	-	-	-	-	-	-	-	-
(-) Senior Debt Payments	-	-	-	-	-	(641,363)	(641,363)	(641,363)	(641,363)
(-) Dividends			-	-	-	-	-	-	-
Net Cash Flow from Financing Activities	**2,710,000**	**2,248,700**	**4,075,633**	**3,982,333**	**4,086,333**	**282,636**	**65,837**	**130,838**	**866,638**
Increase (Decrease) in DSRA	61,169	52,949	39,318	56,627	367,163	20,586	(795)	23,804	38,839
Net Change in Cash Flow	**766,367**	**348,969**	**409,741**	**114,630**	**(155,819)**	**(90,705)**	**(93,223)**	**102,476**	**263,584**
Ending Cash Balance	**766,367**	**1,115,335**	**1,525,076**	**1,639,707**	**1,483,888**	**1,393,183**	**1,299,959**	**1,402,435**	**1,666,019**

APPENDIX 10-1

List of Suppliers

LAKE VICTORIA SOUTH WATER AND WASTEWATER FEASIBILITY STUDY
LIST OF POTENTIAL U.S. SUPPLIERS OF EQUIPMENT AND SERVICES

U.S. Manufacturer Name	Website	Product(s) Description	Specific Product Information
WATER-RELATED EQUIPMENT			
Water Meters			
Neptune Technology Group	www.neptunetg.com/water.cfm	Water meters	www.neptunetg.com/uploadedFiles/CondWtrCatalog3_06.pdf
Badger Meter	www.badgermeter.com	Water meters	www.badgermeter.com/http://www.badgermeter.com/g-100.pdf
Master Meter	www.mastermeter.com	Water meters	www.mastermeter.com/pdfs/MMDS_D2G.pdf
Regional Technologies	N/A	Water Meters, Africa focus	Dr. Jane Konditi (President) or Vez Nkomo (COO) , 817-937-0150
Leak Detection and Repair			
Metrotech	www.metrotech.com	Leak Detection Equipment	www.metrotech.com/pdt.asp?productselect=80
Heath	www.heathus.com/pwater.htm	Leak Detection Equipment,Training	www.heathus.com/pwater.htm
Fluid Conservation Systems	www.fluidconservation.com	Leak Detection Equipment	www.fluidconservation.com/datasheets/AccuCorr3000_datasheet.pdf
SubSurface Leak Detection	www.subsurfaceleak.com	Leak Detection Equipment	www.subsurfaceleak.com/PDFs/LD-12_brchr.pdf
Packaged Water Treatment Systems, Filters			
US Filter	www.hs.usfilter.com	Trident Packaged water treatment system	www.usfilter.com/NR/rdonlyres/DE0FA19B-E7AA-4B89-BA90-A8CDA989769F/0/TridentHSbrochure.pdf
Zenon (G.E.)	www.zenon.com	Packaged membrane water treatment systems	www.zenon.com/pdf/data_sheets/products/package_plants/z-box/pps-zbox-s-06-v3.pdf
Pall	www.pall.com	Membrane water treatment systems	www.pall.com/pdf/ARIA_apps_guide.pdf
Hungerford & Terry	www.hungerfordterry.com	Package water treatment systems	www.hungerfordterry.com/files/H&T%20Brochure.pdf
Leopold	www.fbleopold.com	Water treatment facility filters	www.fbleopold.com/library/pdf/PfPdf.pdf
Aqua Aerobic Systems Inc.	www.aqua-aerobic.com	Cloth media filtration	www.aqua-aerobic.com/LiteratureCenter/ClothMedia.pdf
Water Pumps			
Goulds Pumps	www.goulds.com	Water pumps	www.goulds.com
ITT	www.itt.com	Water pumps, variety of brands	www.itt.com/products/
Water Tanker Trucks (Bowsers)			
Klein Products	www.kleinproducts.com	Water Tanks for Tanker Trucks	www.kleinproducts.com
Caterpillar	www.cat.com	Water Tanke Trucks	www.cat.com
Chemical Feed Equipment, Controls			
LMI Milton Roy	www.lmipumps.com	Pumps, Controllers, and Accessories	www.tagteam.com/ttserverroot/Download/402671_DX6000flyer.pdf
HydroInstruments	www.hydroinstruments.com	Chemical metering equipment, Chlorination	www.hydroinstruments.com/files/LiquidFeed.pdf
Chemilizer	www.chemilizer.com	Non-electric Chemical Pumps	www.chemilizer.com/cat_jpgs/AD_CAT_0506.PDF
GPM Pumps	www.gpmpump.com	Chemical feed and water pumping equipment	www.gpmpump.com/assets/pdf/Brochures/Series LS v2 of 16.01.03.pdf
Pipe Rehabilitation			
Easy Liner	www.easy-liner.com	Multifunctional Pipe Liners	www.easy-liner.com/
Enecon	www.enecon.com	Various pipe repair solutions	www.enecon.com/pdfs/Enecon_Brochure.pdf

U.S. Manufacturer Name	Website	Product(s) Description	Specific Product Information
Disinfection Equipment (U.V., chorinators, ozonators)			
Sunlight Systems	www.sunlightsystems.com	UV disinfection equipment	www.sunlightsystems.com/products/pdfs/res/res_brochure.pdf
Norweco	www.norweco.com	Bio-Dynamic Dry Chemical Tablet Feeder	www.norweco.com/pdf/bd_broc.pdf
Wedeco (ITT)	www.wedeco.com	UV and Ozone Disinfection Systems	www.wedeco.com

WASTEWATER & SLUDGE HANDLING

Packaged Treatment Systems			
US Filter Envirex	www.usfilter.com	Orbal Packaged Wastewater Treatment System	www.usfilter.com/NR/rdonlyres/228FA519-AF4F-4B11-AA30-BF224CDB0186/0/TheOrbalSystemForBiologicalTreatment.pdf
US Filter Envirex	www.usfilter.com	RBC/Clarifier Package Plant	www.usfilter.com/NR/rdonlyres/B7C9701A-3F6E-49B0-80D9-03D7CD72EDDC/0/RBC.pdf
Zenon (G.E.)	www.zenon.com	Packaged waste water treatment	www.zenon.com/pdf/data_sheets/products/package_plants/z-mod/pps-zmod-m-06-v3.pdf
Bio-Microbics Inc.	www.biomicrobics.com	variety of ww treatment technologies	www.biomicrobics.com/downloads/BMI-Corporate-Brochure.pdf
Aqua Aerobic Systems	www.aqua-aerobic.com	Multiple barrier membrane system	www.aqua-aerobic.com/LiteratureCenter/MBProcess.pdf
Sanitaire (ITT)	www.sanitaire.com	ABJ ICEAS Sequencing Batch Process	sanitaire.com/abj/abj.asp
Aero-Mod	www.aeromod.net	Wastewater treatment systems	www.aeromod.net
Enviroquip/Eimco	www.enviroquip.com	Wastewater treatment systems	www.enviroquip.com
Smith & Loveless	www.smithandloveless.com	Packaged wastewater treatment systems	www.smithandloveless.com
Lagoon Equipment			
Solar Bee	www.solarbee.com	Solar Aerators for Water/Wastewater Treatment	www.solarbee.com
Bio-Microbics	www.biomicrobics.com	LagoonFAST pond/water treatment	www.biomicrobics.com/downloads/LGF_specsheet.pdf
Bio-Microbics	www.biomicrobics.com	SaniTHE wastewater screens	www.biomicrobics.com/downloads/SNT_specsheet.pdf
Septage Pumping and Hauling			
AquaTech	www.aquatechinc.com	Truck mounted water jets/vacuum	www.aquatechinc.com/
Vactor	www.vactor.com	Combination truck mounted cleaners	www.vactor.com/pdf/000031D.pdf
Sludge Dewatering and Sludge Handling			
Parkson Corporation	www.parkson.com	Sludge handling equipment	
Ashbrook	www.ashbrookcorp.com	dewatering technology	www.ashbrookcorp.com/dewatering/fs_belt_filter.html
US Filter	www.usfilter.com	filter press dewatering	www.usfilter.com/NR/rdonlyres/7E6833ED-74CA-4FA3-8667-7F7FE228A51B/0/SidebarFilterPress.pdf
Aqua-Zyme	www.aqua-zyme.com	dewatering equipment	www.aqua-zyme.com/
RDP	www.rdp.com	Sludge pasteurization for re-use	www.rdp.com
Aero-Mod	www.aeromod.net	Sludge dewatering systems	www.aeromod.net
On-site Sanitation			
Envirolet Composting Toilets	www.sancorindustries.com	Composting Toilets	www.sancorindustries.com/catalog/usa.pdf
Clivus Multrum	www.clivusmultrum.com	Composting Toilets and Greywater Systems	www.clivusmultrum.com/index.html
Sun-Mar	www.sun-mar.com	Composting Toilets	www.sun-mar.com/

U.S. Manufacturer Name	Website	Product(s) Description	Specific Product Information
Sewer Inspection and Rehabilitation			
RapidView	www.rapidview.com	3D Spherical Opto-Scanner System	www.rapidview.com/docs/matrix.pdf
Parson Environmental	www.parsonenvironmental.com	manhole inserts	www.parsonenvironmental.com/ManholeInsert.pdf
CONTROLS, LABORATORY, SAMPLING, and SAFETY EQUIPMENT			
Hach	www.hach.com	Chemical Test Kits	www.hach.com/fmmimghach?/CODE%3AL18014995%7C1
NASCO Sludge Samplers	www.conbar.com	Sludge Judge, Sludge Measurement	www.conbar.com/Nasco Sludge Judge.htm
Plasti-fab	www.plasti-fab.com	Storage and measurement equipment	www.plasti-fab.com
SafeApproach, Inc.	www.safeapproach.com	Fall prevention systems	www.safeapproach.com
TGO Technologies	www.tgotech.com	Chlortainer chlorine leak protection	www.tgotech.com/chlortainer/pdf/1 ton product sheet.pdf
Hach	www.hach.com	Flow and Sampling Devices	www.hach.com
Hach (Sigma)	www.hach.com	Open channel flow meters	www.hach.com/fmmimghach?/CODE%3AL3440-12059070%7C1
Foxboro Company	www.foxboro.com	Process Control Instrumentation, flow measurement	www.foxboro.com
Flotronex	www.flowtronex.com	Online Pump Station Configurator	www.flowtronex.net/pdf/configurator/configurator2005.pdf
COMPUTER HARDWARE AND SOFTWARE, MAPPING INFORMATION			
Hardware			
Dell	www.dell.com	desktop and laptop computers	www.dell.com
Apple	www.apple.com	desktop and laptop computers	http://www.apple.com/mac/
Hewlett-Packard	www.hp.com	desktop computers, printers, fax machines	http://www.hp.com/sbso/busproducts.html
Garmin	www.garmin.com	Geographic Positioning System (GPS) equipment	www.garmin.com
Software and Digital Information			
ESRI	www.esri.com	Geographic Information System (GIS) software	www.esri.com
GeoEye	www.geoeye.com	Satellite Imagery	www.geoeye.com
CUSI	www.cusi.com	Utility management software	www.cusi.com/products/pdf/cbsw_brochure.pdf
Harris Computer Systems	www.harriscomputer.com	Billing and customer information systems	www.harriscomputer.com/docs/Harris.pdf
Cartegraph	www.cartegraph.com	Utility management software	www.cartegraph.com/WATERview.pdf
AllMax Software	www.allmaxsoftware.com	Data collection and management software	www.allmaxsoftware.com
Bentley Systems	www.bentley.com	CAD software, water modeling software	www.bentley.com
Hansen Information Technologies	www.hansen.com	Utility management/billing database software	www.hansen.com
OpCon Technologies	www.opcontech.com	Utility knowledge management software	www.opcontech.com
Oracle	www.oracle.com	Database software	www.oracle.com
Coler & Colantonio	www.col-col.com	Utility data management software	www.col-col.com
Systems & Software Inc	www.systemsandsoftware.net	Water/Wastewater Utility Management software	www.systemsandsoftware.net

U.S. Manufacturer Name	Website	Product(s) Description	Specific Product Information
ENERGY SOURCES			
Generators and Power Satbilization			
General Electric	www.gepower.com	Diesel Gen Sets, Gas Engines	www.gepower.com
Caterpillar	www.cat.com	Generators	www.cat.com
Generac	www.generac.com	Generators	www.generac.com
General Electric	www.geindustrial.com	Tap Changer Controller	www.geindustrial.com/products/brochures/dtr.pdf
Utility Systems Technologies, Inc.	www.ustpower.com	Sag Fighter	www.ustpower.com/pdf_files/Sag Fighter Brochure 0604A.pdf
Alternative Power Sources			
Solar Bee	www.solarbee.com	Solar Aerators	www.solarbee.com/literature/v12091404.pdf
GE	www.ge.com	Solar Panels, Wind Turbines, hydropower	www.gepower.com
Bergey Wind Power	www.bergey.com	Wind Turbines	www.bergey.com/