Client Lake Victoria Environment Management Project Phase 2 (LVEMP II)

Assignment: Carrying out Environmental and Social Impact Assessment on the Proposed Rehabilitation of Kisumu Sewage Treatment Plant

Report Title: Environmental Impact Assessment Project Report

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Acronyms

AMREF	African Medical and Research Foundation
CBD	Central Business District
EA	Environmental Audit
EAC	East African Community
EAFFRO	East African Freshwater Fisheries Research Organization
ECD	Early Childhood Development
EIA	Environmental Impact Assessment
EMCA	Environmental Management and Coordination Act
ESIA	Environmental and Social Impact Assessment
EMP	Environmental Management Plan
ESMF	Environmental and Social Management Framework
GOK	Government of Kenya
HIV/AIDS	Human Immune Virus/Acquired Immune Deficiency Syndrome
IDA	International Development Association
KAA	Kenya Airports Authority
KCAA	Kenya Civil Aviation Authority
KIDP	Kisumu Integrated Development Programme
KMTC	Kenya Medical Training College
KIWASCO	Kisumu Water and Sewerage Company
LBDA	Lake Basin development Authority
LVEMP	Lake Victoria Environmental Management Plan
LVB	Lake Victoria Basin
LVSWSB	Lake Victoria South Water Services Board
MCI	Millenium City Initiative
MDGs	Millennium Development Goals
NEMA	National Environmental Management Authority
NGO	Non-Government Organization
NEAP	National Environment Action Plan
SESA	Strategic Environmental and Social Assessment
WRMA	Water Resource Management Authority
WRUA	Water Resource Users Association
VIP	Ventilated Improved Pit Latrines

Executive Summary

Introduction

The sewerage system for Kisumu City is earmarked for expansion to be able to serve the Western Sewage District of Kisumu City, which is currently un-served but is developing at a high rate. As part f this improvement, Kisat Conventional Sewage treatment plant is set to undergo rehabilitation while Nyalenda Sewage treatment lagoons are already on a progressive rehabilitation. These interventions are necessary as the performance of the existing facilities is inadequate to serve the populations of the city that has increased dramatically over the last two decades. The low performance is a combination of poor maintenance, overloading and inefficiency of certain components. The level of sewer connection in Kisumu is also extremely low (standing at 10%). Consequently, raw sewage is often discharged into Lake Victoria directly from unconnected sources through open drains or partially treated sewage from the treatment systems. In addition to the expansion of the sewerage system, the project also intends to support construction of a constructed wetlands as a tertiary treatment for the final wastewater from Kisat Sewage Treatment Plant.

In compliance with the laws and regulations governing environmental management, it is required that environmental and social impact assessments are done in order to achieve sustainable development. This is also in line with the World Bank Safeguards and the Kenyan Environmental Management and Coordination Act (EMCA), 1999. The expansion of the sewerage system and the construction of artificial wetland is likely to trigger environmental and social impacts. These potential impacts have to be mitigated for the project to be environmentally friendly, socially acceptable and economically viable.

The Project

The LVEMP was initiated as an all-inclusive program meant at rehabilitation of the lake ecosystem for the benefit of the people living near the catchment, global community and the general economy of the country, which they are partisans. The program objectives are to achieve sustainable benefits to riparian communities from using resources within the basin to generate food, employment and income, supply safe water, and sustain a disease free environment. Conserve biodiversity and genetic resources for the benefit of the global community was also a key objective.

The Kenya Government has received a credit from the International Development Association (IDA) towards the implementation of the second phase of Lake Victoria Environmental Management Project (LVEMP II). The second phase of Lake Victoria Environmental Management Project will contribute towards the achievement of the EAC's Lake Victoria Basin Development Vision and Strategy. Implementation of the various project activities at the local level involves a host of agencies and partners, including local government entities, NGOs, CBOs, universities and research institutions, and private sector agencies. Memoranda of Understanding and/or other contractual arrangements will be entered into between the Accounting Officer of the Focal Point Ministry, through the National Project Coordinator, and the implementing institutions/partners.

The sewerage system for Kisumu city is earmarked for expansion to be able to serve the Western Sewage District, which is currently un-served but is developing at a high rate. At the same time the sewage treatment plants for Kisumu (Kisat Conventional Sewage treatment plant and the Nyalenda Sewage Treatment Lagoons) are currently undergoing rehabilitation. These interventions are necessary as the existing facilities are inadequate and cannot serve the populations of the city that has increased dramatically over the last two decades with the result that, even when the plants are operating at full capacity, the existing infrastructures are overloaded. Consequently raw sewage is

now frequently discharged into Lake Victoria. In addition to the expansion of the sewerage system, the project also intends to support construction of artificial wetlands as a tertiary treatment for the final waste from the treatment plant.

ESIA Justification

The expansion of the sewerage system and the construction of an artificial wetland is likely to trigger environmental and social impacts. These potential impacts have to be mitigated for the project to be environmentally friendly, socially acceptable and economically viable. In accordance with the EMCA, 1999, all new projects must undergo environmental impact assessment study such as to comply with the EIA Regulation, 2003. The proposed intervention projects are expected to have an overall positive impact to the people and the environment. However, construction phases and certain aspects of the operations are anticipated to have environmental and social impacts that would require to be mitigated.

Water related project including sewage disposal are listed in the 2nd schedule of EMCA, 1999 as among project that should undergo EIA. The magnitude of the projects further justifies the EIA study to provide an environmental management plan (EMP) for integration into implementation process. In addition to the National Policy on Water Resources as well as the Water Rules established under the Water Act, 2002 calls for environmental impact assessment on water related projects for long-term sustainability and acceptability by the beneficiaries.

EIA Objective and Scope

The main objective of this consultancy is to carry out Environmental and Social Impact Assessment for the expansion of Kisumu city sewerage system and the construction of artificial wetlands, in accordance with National Environment Management Authority (NEMA) and World Bank Safeguards requirements. Specific objectives are to:

(i) Establish baseline information on both natural and built environment including socio-economic conditions of the proposed project;
(ii) Predict and evaluate foreseeable impacts, both beneficial and adverse, of the proposed project;
(iii) Analyze alternatives to the proposed project; and
(iv) Develop mitigation measures that aim at eliminating or minimizing the potential negative impacts and promote positive ones.

In accordance with the terms of reference, the scope of this assessment covered the following;

(i) To undertake Environmental and Social Impact Assessment as per the Legal Notice No. 101of 2003, the Environmental (Impact Assessment and Audit) Regulations.
(ii) Analysis of project alternatives
(iii) If OP 4.12 is triggered, identify potential impacted community/households, loss of assets, livelihood and services and prepare a Resettlement Action Plan.
(iv) Assist the Client to get Environmental Impact Assessment license

General Findings

The current coverage of water supply in Kisumu City is estimated at 44% for domestic consumers, 57% for institutions and about 50% for commercial premises (an average of about 50% overall water supply coverage). The current estimated water demand for the City of Kisumu is estimated at over 50,000m^3/day against a production of approximately 18,700m^3/day (project to be expanded to

about 68,000m^3/day) with Dunga water treatment plant producing 17,000m^3/day and Kajulu supplying 1,700m^3/day, leaving Kisumu with a supply deficit of over 30,000m^3/day. However, only just above 10,000m^3/day is supply currently (without even considering transmission losses that could lead to even lower actual supply at points of consumption). This illustrates a serious water supply deficit that continues to grow as the population increases without a matching expansion in the water production capacity.

This implies about 50%, mainly the domestic users, of the city goes without a public water supply such as to rely on other sources among them rivers/streams (23%), springs (2%), shallow wells (9%), boreholes (14%) and roof catchments (7%) while still a significant number draws their water directly from the lake. Water Vending is also big business to satisfy a section of the residents with no access to the piped water. There are still others in the outskirts of the city observed to obtain their water from stagnant pool waters and open drains. Due to this scenario, health challenges associated with water quality are a major concern for the City of Kisumu.

The sewerage system in Kisumu serve an extensive network of sewers lines which were laid in three phases between 1955 – 1965, 1965 – 1975 and 1975 – 1985. The current sewered area is approximately 358Ha but under the Long term Action Plan, it is proposed to increase coverage to 5,140Ha. To-date, just about 26% of population connections (with ~10% of the land area coverage) around the city has been achieved and though settlement areas including Kibuye, Manyatta and Nyalenda have reached the flow thresholds for connection, the sewerage systems has not been expanded for higher reach. The sewer reticulation system is served by three pumping stations namely Sunset Hotel pumping station, Mumias Road pumping station and Kendu Lane pumping station. In addition, there are two pumping stations at the Kisat Sewerage treatment works, one of which is a sludge pumping station and the other is a re-circulation pumping station.

The combined design capacity of the sewerage system for Kisumu City is estimated at 17,800m^3 (Nyalenda Lagoons 11,000m^3/day and Kisat Plant 6,800m^3/day) against an estimated sewage generation of 34,000m^3. However, only about 11,000m^3/day of the sewage generated reaches both facilities. Currently, Nyalenda Lagoons are operating at 30% capacity while Kisat plants capacity has been operating at about 32% below its design capacity, mainly due to low feed of raw sewage. The capacity discrepancies may be associated to design, operations and maintenance as well as increasing demand.

Proposed Interventions

With increasing population and hence sewage generation, the capacity of the existing sewerage capacity needs to be expanded. In view of this analysis, there is clear justification for improved performance and enhanced capacity of wastewater management for the City of Kisumu. The ongoing rehabilitation of Nyalenda Sewage Lagoons, the proposed sewer improvement and expansion as well as the intended rehabilitation and improvement of Kisat Sewage treatment plant are overdue. There is also a proposal to construct a new wastewater treatment plant at Otonglo to serve the Western zone of the city extending to Kisian, sections along Busia road, Kodiaga Prison and the surrounding areas.

The proposed long term interventions are described as follows;

(i) Laying trunk sewer running from Mamboleo through Kibos, Migosi and Manyatta areas to discharge into Nyalenda ponds. This will also include connection reticulation for the residents and premises in the eastern zone of the city,
(ii) Laying a trunk sewer from Bandani and Obunga areas to discharge into Kisat wastewater treatment plant,

(iii) Additional sewer sections in the central zone to improve collection into Kisat wastewater treatment plant
(iv) Construct a new sewerage system at Otonglo area to cover the Western Zone of the city such as Kisian, Kodiaga Prison areas and parts of the Kisumu International Airport, Kenya Pipeline areas, Coca-Cola areas and the area around Spectre factory.

The long term interventions may take a considerable duration to realise due to the resources involved, land requirements and associated social and economic linkages. For this reason, it became necessary that Kisat Convectional Treatment Plant be evaluated to determine its operational capacity and what should be done to optimize and ultimately expand its performance for a short term intervention.

Kisat Convectional wastewater treatment plant, designed for 6.800m^3/day can allow expansion to Accommodate an additional 3,400m^3/day of sewage. To achieve, it requires 2No. Primary Settlement Tanks, 2No. Secondary Settlement Tanks, 2No. Trickling Filters, 2No. Sludge Thickeners and 1No. Set of sludge drying beds. The additional components would be backed up with increased pumping capacity at Sunset and Busia Road sumps. However, this would only be possible if the performance of the current components are optimized.

A constructed wetland has also been considered for Kisat Waste Water Treatment Plant for the improvement of the biological content of the final sewage effluent. Due to constraints of land at the site, It has been proposed that the section earmarked for the additional sludge drying bed be utilised for a constructed wetland.

Impacts Overview

Effects associated with municipal wastewater are varied and dependent on two main factors namely the quality of the wastewater and the receptor environmental and social setting. Raw or partial municipal wastewater may contain organic and chemical pollutants in excess of the established standards for effluent disposal into natural environments and also for drinking water. On the other the receiving environments poses different characteristics ranging from supporting aquatic systems, supplying environmental water and water for social and economic requirements.

Kisat River is the recipient of effluent discharging from Kisat Convectional treatment plant. The river arises from the highland to the north of Kisumu City and runs through a densely populated residential estate before picking the plant's effluent and discharging into Lake Vitoria about 3km west of the plant. At the point of the effluent discharge into the river, the river water seems to he already highly polluted from social and economic activities upstream and has no social value. The river seems to be the main pollutant conveyor into Lake Victoria, some previous reports indicating that it is a major contributor to the Lake's water degradation.

In addition to discharging effluent into Kisat River, the sewage treatment plant has other linkages to the local environment and social factors. Surrounded with residential houses on one side, industrial premises on the other and public amenities on the other, impacts levels from operations of the plant will be varied during construction and post-construction.

Environmental Management Plan

This project is geared towards enhancing social and economic benefits to the people living in the City of Kisumu. The project, however, should also observe environmental protection requirements in accordance to the established laws and regulations to ensure sustainability. To realize this goal, acceptability by a majority of the beneficiaries and minimal effects to the physical environment will

require to be integrated in the project through constant consultations, evaluations and review of the design aspects throughout the project coverage. It is recommended that guiding principles specific to this project and the regulations governing water resources management be developed that will allow integration of environmental management considerations in the construction, maintenance of the facility components and public amenities. Among the factors that need to be considered in this particular project implementation will include;

(i) Ensure prevention of pollutants discharge into the drainage systems and pollution of public water bodies including Lake Victoria,
(ii) Enhance integration of environmental, social and economic functions in the project implementation,
(iii) Consider preventive measures towards possible social and economic disruptions that may arise from the project implementation in accordance with the laid down guidelines,
(iv) The contractors and other players in the project activities be prevailed upon to implement the EMP through a sustained supervision and continuous consultations

In order to implement the management plan, it is recommended that a supervisor is identified to oversee environment and management aspects including the water abstraction sustainability, pollution control, water loss control and equity access, management of sanitation and hygiene measures throughout the project area. The supervisor would also be expected to co-ordinate and monitor environmental management during construction and provide monitoring schedules during operations. Other recommended participants could include the respective Environmental Officers, Water Offices and the Physical Planning Offices among others.

Upon completion and commissioning of the water and sanitation facilities, it will be necessary to establish appropriate operational guidelines on environmental conservation and social linkages to enable the operations' management identify critical environmental and social issues and institute appropriate actions towards minimizing associated conflicts. Basically, the guidelines should cover among other areas environmental management programmes, standard operation procedures, compliance monitoring schedule and environmental audit schedules as required by law. Social harmony of the facilities and associated component will be achieved through collaborations with the stakeholders or community management committees at various water points and ablution blocks

Conclusions

(i) The proposed rehabilitation of Kisumu Sewerage system is long overdue considering the physical expansion of the City boundaries for the last 3 – 4 decades, increasing population and rising demand for connectivity.
(ii) It is noted that the existing infrastructure is not only inadequate by also operating far below the design capacity calling not only expansion but also intensive rehabilitation .
(iii) While appreciating that sewage generation is associated with water consumption, it is noted that at the moment, the two elements may not be correlated. Reason, water supply coverage from the public supply is short of the demand and hence other sources of unquantifiable water delivery are applied. Similarly, sewage disposal facilities are variant across the city on the face of low coverage.
(iv) Kisat Convectional Sewage Treatment Plant is generally serviceable. However, the plant is operating far below its design capacity as a result of breakdown of key components, some requiring re-orientation.
(v) With low or no connectivity in the neighbourhoods of the sewerage systems, the communities do not seem to effectively identify themselves with the facilities. The low sense of ownership impacts negatively to the operations and maintenance of the system

(vi) The cost of connecting to the sewer might be prohibitive to a majority of the residents, especially in the residential areas (part of which may require reorientation of the public configurations)

(vii) Internal health and safety provisions are either absent or none existent, especially at the treatment plant premises. In this regard critical components seem to have been omitted for inclusion in the proposed intervention measures among them internal sanitation, hygiene and waste management provisions.

Recommendations

(i) It recommended that within the availability of the required resources, the rehabilitation and expansion of the sewerage system for Kisumu City should be undertaken within the shortest period possible in order to catch up with the rate of rate of physical growth, increasing population and demand for water and sewer connectivity,

(ii) There should be a deliberate initiative and effort to evaluate the design capacity of the existing sewerage facility (especially Kisat Convectional Treatment Plant) first. This will enable rehabilitation interventions to optimize the efficiency before going into additional (perhaps unnecessary components). This will be economical on resources and land spaces available as well as present less challenges of potential disruption to the residents

(iii) It will be necessary for KIWASCO to harmonize and provide data on total water consumed in Kisumu City including the various sources as a criteria for planning sewage management. At the moment, there is high level assumptions on the criteria for threshold determination and design for sewage management facilities

(iv) It is also recommended that the components recommended for Kisat Convectional Treatment Plant be reviewed upon re-evaluation of the necessary rehabilitation to optimize the current design capacity

(v) KIWASCO in collaboration with other relevant Authorities may need to draw a connection plan for the residents, among them being support for the re-orientation of sewer systems that may not be in line with the new reticulation (especially where not existed before) as well as subsidizing the costs of connections,

(vi) As part of the rehabilitation interventions at Kisat Convectional Treatment plant, the following sanitation and hygiene components and initiatives should have be considered as a matter of importance;

- Provision and maintenance of staff toilets (ladies and gents),
- Provisions and maintenance of staff bathrooms (gents and ladies)
- Provision of eating rooms with fresh clean water for all staff to avoid contamination and infections
- Install a solid waste holding and drying platform for the grit recovered from raw sewage to prevent the risk to the health of the workers
- Consider a designed burning chute for solid materials (including recovered grit) at the site.
- Attempt to discourage vending of food stuffs around the sewage plant for control of potential contamination
- Sensitize and create awareness to the neighbouring communities on the coexistence with the sewage treatment plant with special focus on health and safety aspects.

Chapter 1: Project Background

1.1 Introduction

The sewerage system for Kisumu City is earmarked for expansion to be able to serve the Western Sewage District of Kisumu City, which is currently un-served but is developing at a high rate. As part of this improvement, Kisat Conventional Sewage treatment plant is set to undergo rehabilitation while Nyalenda Sewage treatment lagoons are already on a progressive rehabilitation. These interventions are necessary as the performance of the existing facilities is inadequate to serve the populations of the city that has increased dramatically over the last two decades. The low performance is a combination of poor maintenance, overloading and inefficiency of certain components. The level of sewer connection in Kisumu is also extremely low (standing at 10%). Consequently, raw sewage is often discharged into Lake Victoria directly from unconnected sources through open drains or partially treated sewage from the treatment systems. In addition to the expansion of the sewerage system, the project also intends to support construction of a constructed wetlands as a tertiary treatment for the final wastewater from Kisat Sewage Treatment Plant.

In compliance with the laws and regulations governing environmental management, it is required that environmental and social impact assessments are done in order to achieve sustainable development. This is also in line with the World Bank Safeguards and the Kenyan Environmental Management and Coordination Act (EMCA), 1999. The expansion of the sewerage system and the construction of artificial wetland is likely to trigger environmental and social impacts. These potential impacts have to be mitigated for the project to be environmentally friendly, socially acceptable and economically viable.

LVEMP II sought the services of Aquaclean Services Limited to prepare ESIA Project Report for the rehabilitation of Kisumu sewerage works and the construction of artificial wetland. The Consultant then adopted the national and international environmental and social safeguards to establish the linkages associated with the project for approval by the National Environment Management Authority (NEMA) as well as satisfy the World Bank Requirements. The categorization of the project followed the World bank Criteria as define under the Terms of Reference. These reads as follows;

1.1.1 Category “A” Projects

An ESIA is always required for projects that are in this category. Impacts are expected to be ‘adverse, sensitive, irreversible and diverse with attributes such as pollutant discharges large enough to cause degradation of air, water, or soil; large-scale physical disturbance of the site or surroundings; extraction, consumption or conversion of substantial amounts of forests and other natural resources; measurable modification of hydrological cycles; use of hazardous materials in more than incidental quantities; and involuntary displacement of people and other significant social disturbances.

1.1.2 Category “B” Projects

Category B projects are likely to have potential adverse environmental impacts on human populations or environmentally important areas – including wetlands, forests, grasslands, and other natural habitats – and are less adverse than those of category A projects. The EA process for category B projects examines the potential negative and positive environmental impacts and recommends any measures needed to prevent, minimize, mitigate, or compensate for adverse impacts and improve environmental performance. Although a full ESIA is not always required, some level environmental and social analysis is necessary. Category B projects have impacts that

are 'less significant, not as sensitive, numerous, major or diverse impacts are reversible, and remedial measures can be more easily designed.'

1.1.3 Category "C" Projects

No EIA or other analysis is required. Category C projects result in negligible or minimal direct disturbance of the physical environment. Typical projects include education, family planning, health, and human resource development.

The intervention project is assigned an EA Category B and will be undertaken to the ESIA Project Report Level unless otherwise instructed by NEMA. This implies that the project interventions are likely to have:

(i) Limited adverse environmental impacts that are less significant with respect to the type, location, sensitivity and scale;
(ii) Impacts that are generally minimal scale and confined within the project area.

1.2 Lake Victoria Environment Management Project

The attempt by Kenya, Tanzania, Uganda, Rwanda and Burundi in a group effort in restoration and conservation of Fisheries in Lake Victoria is a key milestone undertaken a long time ago. As early as 1928 a recommendation was passed for a unified lake wide authority for regulation and for collection of fisheries statistics to be set up, and as a result in 1947 East African Freshwater fisheries Research Organization (EAFFRO) was set up and to solidifying it further East African Community was formed in 1967. In 1977, East African Community was dissolved and EAFFRO lost grounds of progressing in its operations. The preceding years saw the emergence of new organizations like Committee for Inland Fisheries of East African Community and Lake Victoria Fisheries Organization.

Each of the five riparian governments acknowledged that Lake Victoria demanded urgent attention through regional cooperation hence each state prepared a National Environmental Action Plan (NEAP) whose prime focus was to look into problems such as water pollution, biodiversity loss, land degradation, deforestation, and damage to wetlands, all central concerns for the lake and its catchments. Absence of a regional management framework was foreseen as a possible threat in the viability of the lake basin hence discussions to broaden regional environmental cooperation was started in the late 1992 and in May 1994, the five Governments jointly went into conformity to prepare and implement Lake Victoria Environmental Management Program.

The LVEMP was initiated as an all-inclusive program meant at rehabilitation of the lake ecosystem for the benefit of the people living near the catchment, global community and the general economy of the country, which they are partisans. The program objectives are to:

(i) Achieve sustainable benefits to riparian communities from using resources within the basin to generate food, employment and income, supply safe water, and sustain a disease free environment;
(ii) Conserve biodiversity and genetic resources for the benefit of the global community.

The Kenya Government has received a credit from the International Development Association (IDA) towards the implementation of the second phase of Lake Victoria Environmental Management Project (LVEMP II). The second phase of Lake Victoria Environmental Management Project will contribute towards the achievement of the EAC's Lake Victoria Basin Development Vision and Strategy. The Project development/global environmental objectives are to:

(i) Improve collaborative management of the trans-boundary natural resources of LVB for the shared benefits of the EAC Partner States; and
(ii) Reduce environmental stress in targeted pollution hotspots and selected degraded sub-catchments to improve the livelihoods of communities dependent on the natural resources of the Lake Victoria Basin.
(iii) Contribution of LVEMP II to the above objectives through
- Improving the management of Trans-boundary LVB resources;
- Protection of targeted sensitive ecosystem in LVB;
- Reduction of water pollution in the LVB, and
- Enhancement of public participation and communication.

The project is being implemented in the Western, Rift Valley and Nyanza Provinces over an eight-year period, split into two 4 year phases. The project have the following four components:-

(i) Strengthening institutional capacity for managing shared water and fisheries resources
(ii) Point source pollution control and prevention
(iii) Watershed management
(iv) Project coordination and management

The project is being implemented through a three tier structure. At the regional level, policy guidance provided by the Regional Policy Steering Committee. At the national level, project implementation is guided by the National Policy Steering Committee, the National Technical Advisory Committee, the Focal Point Ministry and the National Project Coordination Team. At the local level, implementation is coordinated by the District Project Coordination Teams.

Implementation of the various project activities at the local level involves a host of agencies and partners, including local government entities, NGOs, CBOs, universities and research institutions, and private sector agencies. Memoranda of Understanding and/or other contractual arrangements will be entered into between the Accounting Officer of the Focal Point Ministry, through the National Project Coordinator, and the implementing institutions/partners.

1.3 The Rehabilitation Project

The sewerage system for Kisumu city is earmarked for expansion to be able to serve the Western Sewage District, which is currently un-served but is developing at a high rate. At the same time the sewage treatment plants for Kisumu (Kisat Conventional Sewage treatment plant and the Nyalenda Sewage Treatment Lagoons)) are currently undergoing rehabilitation. These interventions are necessary as the existing facilities are inadequate and cannot serve the populations of the city that has increased dramatically over the last two decades with the result that, even when the plants are operating at full capacity, the existing infrastructures are overloaded. Consequently raw sewage is now frequently discharged into Lake Victoria. In addition to the expansion of the sewerage system, the project also intends to support construction of artificial wetlands as a tertiary treatment for the final waste from the treatment plant.

1.4 EIA Justification

The expansion of the sewerage system and the construction of an artificial wetland is likely to trigger environmental and social impacts. These potential impacts have to be mitigated for the project to be environmentally friendly, socially acceptable and economically viable. In accordance with the EMCA, 1999, all new projects must undergo environmental impact assessment study such as to comply with the EIA Regulation, 2003. The proposed intervention projects are expected to

have an overall positive impact to the people and the environment. However, construction phases and certain aspects of the operations are anticipated to have environmental and social impacts that would require to be mitigated.

Water related project including sewage disposal are listed in the 2nd schedule of EMCA, 1999 as among project that should undergo EIA. The magnitude of the projects further justifies the EIA study to provide an environmental management plan (EMP) for integration into implementation process. In addition to the National Policy on Water Resources as well as the Water Rules established under the Water Act, 2002 calls for environmental impact assessment on water related projects for long-term sustainability and acceptability by the beneficiaries.

1.5 Terms of Reference

1.5.1 EIA Objectives

Lake Victoria Environmental Management Project (LVEMP II), Kenya intends to support the expansion of the sewerage system and the construction of Artificial Wetland for Kisumu City to improve the final effluent quality that is discharged into River Kisat that finally discharges into Lake Victoria. It is for the foregoing that LVEMP II would like to hire consultancy services for ESIA. The main objective of this consultancy is to carry out Environmental and Social Impact Assessment for the expansion of Kisumu city sewerage system and the construction of artificial wetlands, in accordance with National Environment Management Authority (NEMA) and World Bank Safeguards requirements. The assessment study was to identify significant potential impacts anticipated from the proposed improvement works and related improved water supply to the environment and social aspects with a view to establishing appropriate recommendations on ensuring that the proposed project takes into consideration appropriate measures to mitigate any adverse effects to the environment and peoples' wellbeing

Specific objectives are to:

(v) Establish baseline information on both natural and built environment including socio-economic conditions of the proposed project;
(vi) Predict and evaluate foreseeable impacts, both beneficial and adverse, of the proposed project;
(vii) Analyze alternatives to the proposed project; and
(viii) Develop mitigation measures that aim at eliminating or minimizing the potential negative impacts and promote positive ones.

1.5.2 Scope of EIA

The scope of the consultancy work will involve preparation of ESIA for expansion of Kisumu sewerage system and will entail the following specific tasks:

(i) To undertake Environmental and Social Impact Assessment as per the Legal Notice No. 101of 2003, the Environmental (Impact Assessment and Audit) Regulations.
- Describe the context, components and activities of the project.
- Assess and report on the location of the project including the physical area that may be affected by the project.
- Identify the potential impact on the community around the proposed site for the sewage system and the artificial wetland. Assess whether the 2 activities displace and or cause loss of livelihood to the surrounding community.

- Will these activities trigger OP 4.12 Involuntary Resettlement Policy? If yes, will the impact be temporary and/or permanent?
- Assess and report the nature, design and budget of the project.
- Assess and report on the economic and socio-cultural impacts of the project to the local community and the nation in general.
- Assess and report the activities that shall be undertaken during the project construction, operation and commissioning phases.
- Assess and report the materials to be used, products and by-products, including waste to be generated especially during construction phase and the methods of their disposal.
- Identify and assess the potential adverse impacts that may result from the activities of the project on the biophysical and socio economic environment and develop an environmental management plan for the construction, operation and maintenance, including mitigation measures as per LVEMPII ESMF guidelines.
- Describe the impacts quantitatively and qualitatively, where possible in terms of environmental costs and benefits.
- Impact analysis should clearly address direct, indirect and cumulative impacts. In the analysis, distinguish between positive and negative impacts, long and short term impacts; reversible and irreversible; and identify linkages among project components and the issues.
- Identify, assess and recommend appropriate and practical mitigation measures to remove or minimize the adverse environmental impacts identified.
- Develop an action plan that ensures the health and safety of the workers and neighbouring communities in the project cycle.
- Identify, assess and recommend impact monitoring programs and compliance auditing programs.
- Fill in and submit the NEMA Project Report Form.
- Prepare and submit a Project Report to NEMA.
- Provide any other information that NEMA may require.

(ii) Analysis of project alternatives

- Describe at least three viable design alternatives that would achieve the same objectives.
- Consider and analyze alternatives in terms of location, design, technology and phases, operating and maintenance procedures.
- Compare alternatives in terms of potential environmental impacts, capital and operating costs, suitability under local conditions, institutional, training and monitoring requirements.
- Describe the extent possible; quantify total/ environmental costs and benefits of each alternative, including no project alternative by incorporating the estimated costs of any associated mitigation measures. Describe the impacts quantitatively and qualitatively, where possible in terms of environmental costs and benefits

(iii) If OP 4.12 is triggered, identify potential impacted community/households, loss of assets, livelihood and services and prepare a Resettlement Action Plan.

(iv) Assist the Client to get Environmental Impact Assessment license

1.6 EIA Methodology

The approach to this exercise was structured such as to cover the requirements under the EMCA, 1999, as well as the EIA regulations as stipulated under the Gazette Notice No. 56 of 13th June 2003. It involved largely an understanding of the project background, the interim designs and the implementation plan as well as project commissioning. In addition, the baseline information was obtained through physical investigation of the site and the surrounding areas, interviews with a

sample of surrounding community, photography and most important discussions with the client and the design team. Basic document and data were also consulted. Below is an outline of the basic assessment steps that were followed during this assessment;

1.6.1 Environmental Scoping

Scoping process involved the identification of significant environmental and social issues associated with the proposed improvement works. Through reviews of the historical documents and available data supported with field evaluations, it was possible to estimate the current status of the intake, implications of additional water into the system, the capacity and integrity of the distribution network and the consumers' locations. Interviews and discussions with stakeholders and project beneficiaries were applied in the determining the aspects such as adequacy of the supply, awareness and ownership, willingness to pay for water and general opinions of the people. Significant issues identified through this process have been applied in drawing up the impacts as well as the management plan under this report.

1.6.2 Impacts Assessments and Mitigation Measures

This evaluation focused on the current wastewater generation from Kisumu City and the intended intervention measures with a view to establishing whether there are any environmental and social impacts associated with the proposed rehabilitation/expansion works. Answers to these issues were obtained through documentary and literature reviews, field observations, interviews with the operators and users as well as LVEMP II officials. Responses to these issues also provided a basis for mitigation measures as presented under this report. The findings there from are discussed through the report.

1.6.3 Field Assessment

The physical evaluation of the project area was carried out with specific focus on the environmental and social issues. The environmental issues assessed include, water sources and water quality, drainage and hydrology, air quality, sanitation and hygiene, biodiversity and sources of environmental pollution. The social issues include; settlement patterns, socio economic activities, land use, presence of traditional/cultural sites in the area. On the social economic front, structured stakeholder consultation meeting were held in some specific areas in addition to rapid interactions with the stakeholders to capture the views of all the parties affected.

1.6.4 Reporting

The reporting will provide a Project Report (this report) for review by NEMA and a final ESIA Report for the necessary NEMA approval process. Appropriate consultations were continuously undertaken among the design engineers and other players.

1.6.5 EIA Outputs

(i) Draft ESIA Project Report for submission to NEMA through the Client,
(ii) Final ESIA Project report for approval by NEMA

1.6.6 EIA Team

The ESIA study involved a multi-disciplinary team comprising of the following;

1. Environmentalist/Lead EIA Expert (Team Leader)

2. Sociologist
3. Civil/Water Engineer
4. Health and Safety
5. Physical Planner

Chapter 2: Project Description

2.1 Location

Kisumu City is the third largest urban area in Kenya with an estimated population of 259,258 people (2009). The City is located in Western Kenya bordered by Lake Victoria to the southwest, the sugar belt and Kano irrigation scheme to the east while to the north and western sides lies the hills and the neighbouring Kakamega and Siaya Counties.

While the sanitation improvement addresses the whole City, Kisat Sewage Treatment Works is main focus of this ESIA Study. The plant is located just outside the City Centre along the Kisumu – Busia Road about 5km from the CBD and about 500m to the east from the highway. Key features around the plant include industrial activities to the east, informal settlements to the north, the Kisumu Airport grounds about 4km to the west and Lake Victoria shores (Kisumu Bay) about 1km to the south. The approximate geographical locations can described as34^{o} 45' 17"E and 0^{o} 05' 04"S. (Nyalenda Sewage Treatment Lagoons are located at approximately 34^{o} 46' 32"E and 0^{o} 07' 09"S). The physical location is shown on the map below;

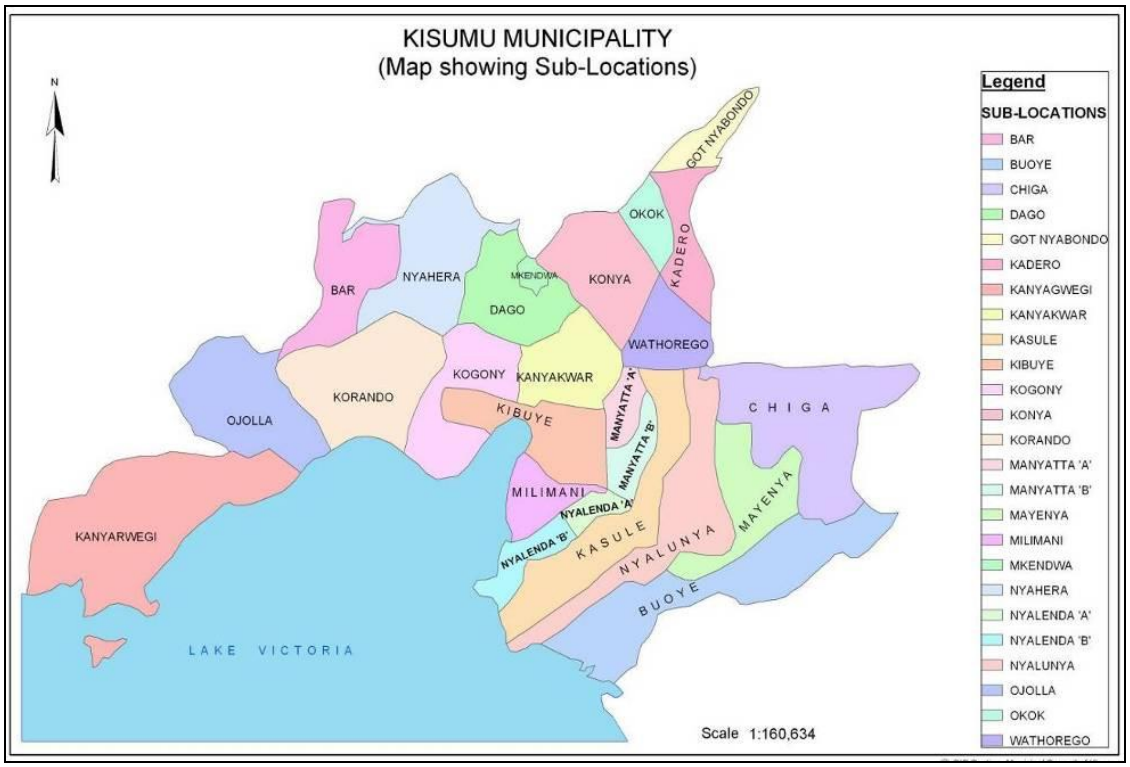
Figure 1: Location of Kisat Treatment Plant

2.2 Administrative Setting

The last two and a half decades has seen Kisumu municipal boundary expand from 50km^2 in 1971 to over 400km^2 to date. The current population growth rate is 2.6% per annum with a density of approximately 975 persons per km^2. Approximately 60% of the Kisumu population lives in informal settlements and the population continue to expand as people from the districts surrounding the Lake Basin move into the city.

About 73% of the total population is aged below 30 years old and a total of 42% of the population is younger than 15. The high population in the town creates a significant amount of pressure on the available educational, health, sanitation and other related amenities. Kisumu benefits from a strategic geographical position as the crossroads of three East African countries (Kenya, Uganda and Tanzania). The town is the hub of communication networks (railway lines, commercial roads, air transportation) that serve most of Western Kenya. This fact has facilitated its dominance as the administrative, industrial, and commercial capital of this region.

Figure 2: Administrative Layout of Kisumu City



Source: Town Planning Department, Municipal Council of Kisumu

2.2.1 Water Supply

Lake Victoria is the main source of water for Kisumu City with the intake and treatment works at Ndunga beach area on the southern end of the city, treated and pumped to a storage tank in Kibuye, whereas water from Kibos River is treated at Kajulu water treatment plant and then flows by gravity to the reservoir. The water is supplied by Kisumu Water and Sewerage Company (KIWASCO) on behalf of Lake Victoria South Water Services Board (LVSWSB) on a Service Provision Agreement.

The current coverage of water supply in Kisumu City is estimated at 44% for domestic consumers, 57% for institutions and about 50% for commercial premises (an average of about 50% overall water supply coverage). The current estimated water demand for the City of Kisumu is estimated at over 50,000m^3/day against a production of approximately 18,700m^3/day (project to be expanded to about 68,000m^3/day) with Dunga water treatment plant producing 17,000m^3/day and Kajulu supplying 1,700m^3/day, leaving Kisumu with a supply deficit of over 30,000m^3/day. However, only just above 10,000m^3/day is supply currently (without even considering transmission losses that could lead to even lower actual supply at points of consumption). This illustrates a serious water supply deficit that continues to grow as the population increases without a matching expansion in the water production capacity.

This implies about 50%, mainly the domestic users, of the city goes without a public water supply such as to rely on other sources among them rivers/streams (23%), springs (2%), shallow wells (9%), boreholes (14%) and roof catchments (7%) while still a significant number draws their water directly from the lake. Water Vending is also big business to satisfy a section of the residents with no access to the piped water. There are still others in the outskirts of the city observed to obtain their water from stagnant pool waters and open drains. Due to this scenario, health challenges associated with water quality are a major concern for the City of Kisumu.

2.2.2 Sewerage Services Coverage

The sewerage system in Kisumu serve an extensive network of sewers lines which were laid in three phases between 1955 – 1965, 1965 – 1975 and 1975 – 1985. The current sewered area is approximately 358Ha but under the Long term Action Plan, it is proposed to increase coverage to 5,140Ha.The sewer reticulation system is served by three pumping stations namely Sunset Hotel pumping station, Mumias Road pumping station and Kendu Lane pumping station. In addition, there are two pumping stations at the Kisat Sewerage treatment works, one of which is a sludge pumping station and the other is a re-circulation pumping station. The two wastewater treatment facilities are described below;

(i) The eastern wastewater treatment district, served by the Nyalenda Waste stabilization ponds collects wastewater from the Southeast of the city. The biological system located at Nyalenda area is a series of stabilization lagoons with a design capacity of 11,000m^3/day. The system serves part of the Central Business District and the Eastern Zones of the City. The Nyalenda Biological Systems comprise the following units;
- Receiving units including screens, grit chambers and channels to the lagoon
- 3No. anaerobic lagoons
- 3No. facultative lagoons
- 3No. tertiary lagoons
- Discharge channels

(ii) The central wastewater treatment district is served by Kisat Conventional Sewage Treatment Works collecting wastewater generated in the central and northwest. The convectional Kisat Wastewater Treatment Plant whose design capacity is 6,800m^3/day comprises of the following units
- Reception section with screening and initial settlement chambers,
- Primary sedimentation/clarifiers (6No.) that separates sludge from the raw liquid phase of the raw sewage. The liquid flows into the trickling filters while the sludge is pumped into the digesters,
- Trickling filters (6No.) that facilitates biological breakdown of organic content in the sewage
- Sludge digesters (4No.) applied for the neutralization of sludge,

- Secondary sedimentation/clarifiers for the effluent discharging from the trickling filters before final discharge,
- Sludge drying beds (38No. on three clusters of 12, 12, 14) where the neutralized sludge is dried into an inert cake
- Discharge channels for the treated sewage into Kisat River and ultimately into Lake Victoria.

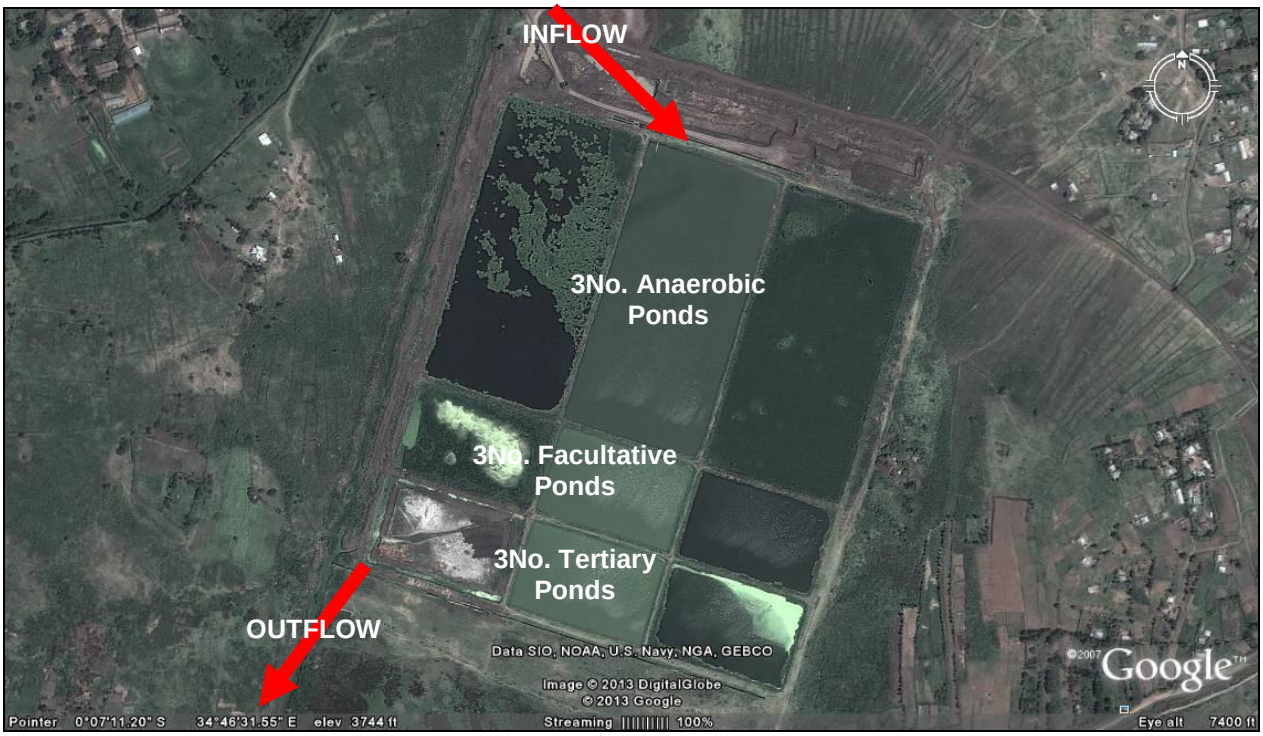
(iii) The Western Wastewater treatment district is currently not served at all. This zones extends from the airport area towards Kisian and upto the area where Kodiaga Prison is located.

The combined design capacity of the sewerage system for Kisumu City is estimated at 17,800m^3 (Nyalenda Lagoons 11,000m^3/day and Kisat Plant 6,800m^3/day) against an estimated sewage generation of 34,000m^3. However, only about 11,000m^3/day of the sewage generated in Kisumu reaches both facilities. Currently, Nyalenda Lagoons are operating at 30% capacity while Kisat plants capacity has been operating at about 32% below its design capacity, mainly due to low feed of raw sewage. The capacity discrepancies may be associated to design, operations and maintenance as well as increasing demand.

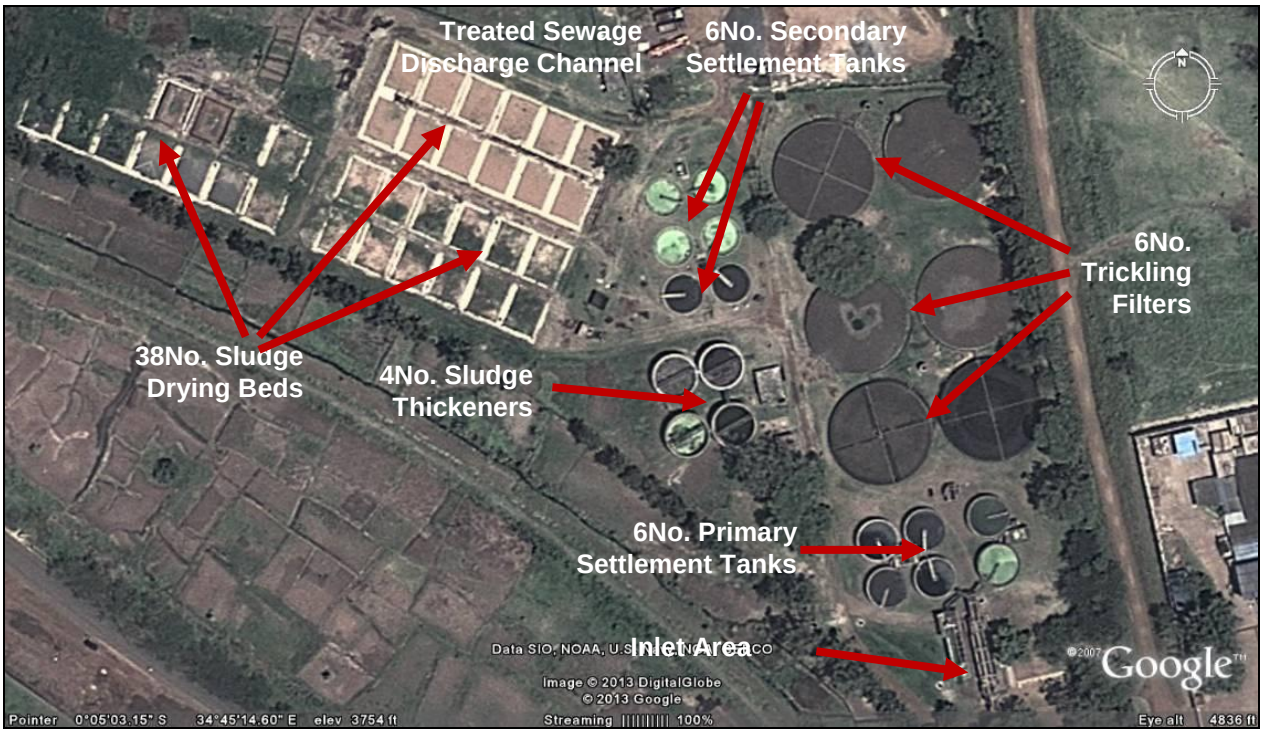
Just about 26% of population connections (with ~10% of the land area coverage) around the city has been achieved and though settlement areas including Kibuye, Manyatta and Nyalenda have reached the flow thresholds for connection, the sewerage systems has not been expanded for higher reach. Other sanitation facilities in Kisumu City, and especially in the low income settlement areas include;

(i) Flush toilets at domestic and institutional levels served by local septic tanks and soak-way pits,
(ii) Pit latrines most of which are shallow and located in small plots and close to each other posing serious health risks to the population. Pit latrines are also found in most public premises including schools, health centers, markets and social centers.
(iii) Public and commercial toilets are also available to the residents for use at a cost
(iv) Open defecation is also common especially in the outer low income suburbs.

Figure 3: Kisumu Sewage Treatment Plants



Nyalenda Sewage Lagoons



Kisat Convectional Treatment Plant

2.3 The Infrastructural General Status

2.3.1 Sewer System

As earlier indicated, the sewerage coverage in Kisumu stands at about 10%. This implies minimal sewer network and where it is present there is low connectivity or poor integrity of the sewer lines. This calls for either rehabilitation of the sewer lines and laying new sewer lines in areas not covered under the existing network. The works had commenced at the time of this assessments.

2.3.2 Nyalenda Sewage Treatment Lagoons

At the time of this assessment, Nyalenda Sewage Lagoons were undergoing rehabilitations. Of the 3No. parallel sets of lagoons, two had been closed for desludging, lining and component improvements). This intervention was overdue as the retention capacity of the lagoons has been reduced significantly down to 30%. Other interventions necessary for the lagoons is the reception systems and the outfall channels.

Figure 4: Status at Nyalenda Ponds

A Section of Nyalenda Ponds undergoing Rehabilitation

Status of the Operational Lagoon at Nyalenda Ponds

2.3.3 Kisat Sewage Treatment Plant

This is a conventional treatment systems whose components status may be described as following;

(i) The sewage reception areas comprising of reception chamber, grit screens, overflow pipe and flow measurements gauges is physically intact. However, the components requires rehabilitation such as to include;
- The collection of the screenings needs a designed hopper and collection tray to enhance hygiene and removal,
- The flow measurements needs to be rehabilitated for effective data collection,
- The overflow pipe need to be channeled into a closed recirculation systems pipeline to avoid internal exposure of raw sewage to the operator community and contamination of open drainage systems

(ii) Primary Settlement/Clarifiers systems are in good shape and fully operational. They are not overloaded

(iii) The 6No. Trickling Filters seems intact. However, at the time of this assessment, only 2No. could be used on rotational basis. The efficiency of the trickling filters is under capacity for firstly leaving the columns dry for some times kills the biofilms and secondly the distribution pipe arms are blocked and cannot provide uniform flows onto the columns and finally almost all trickling filters are leaking on the sides (which is likely due to blockages).

(iv) The 4No. sludge digesters are under utilized in terms of their design capacity as well as value addition initiatives (methane gas generation),

(v) The secondary settlement/Clarifiers are in good working order within the current flow capacity.

(vi) The drying beds are in good number

(vii) Internal sanitation (staff toilets and bathrooms) are non-existent though buildings are present. They need rehabilitation and maintenance.

Figure 5: Sections of Kisat Convectional Waste Water Treatment Plant

Grit Collection from Raw Sewage at the Reception Area

Open Grit Holding Area

Overflow Raw Sewage Discharge at the Reception

Primary Settlement Tanks

Sludge Digesters

Trickling Filters


Secondary Settlement Tanks


Sludge Drying Beds

Dry Sludge Cake awaiting Disposal

Treated Sewage Discharge Channle

2.3.4 Observations

In view of the above observation, it will be necessary that Kisat Sewage Treatment Plant is rehabilitation to its full operational capacity by addressing the requirements of the existing

components. Only if they are inadequate that additional components are to be considered. It is proposed that an additional 2No. Trickling filters be provided but considering that out of the current 6No. only 2No. are running at one time, it may not be necessary to construct another 2 unless the target catchment demands. It would be recommended that the space be utilized for a constructed wetland, an important component for polishing the final effluent (it is noted that site may have a challenge of land in this respect).

2.4 Proposed Intervention Project

It is noted that with the current water demand for Kisumu City standing at about 50,000m^3/day, a total of 40,000m^3/day of raw sewage would be expected to be generated from the City against the total design capacity of 34,000m^3. With increasing population and hence sewage generation, the capacity of the existing sewerage capacity needs to be expanded. In view of this analysis, there is clear justification for improved performance and enhanced capacity of wastewater management for the City of Kisumu. The ongoing rehabilitation of Nyalenda Sewage Lagoons, the proposed sewer improvement and expansion as well as the intended rehabilitation and improvement of Kisat Sewage treatment plant are overdue. There is also a proposal to construct a new wastewater treatment plant at Otonglo to serve the Western zone of the city extending to Kisian, sections along Busia road, Kodiaga Prison and the surrounding areas.

The proposed long term interventions are described as follows;

(i) Laying trunk sewer running from Mamboleo through Kibos, Migosi and Manyatta areas to discharge into Nyalenda ponds. This will also include connection reticulation for the residents and premises in the eastern zone of the city,
(ii) Laying a trunk sewer from Bandani and Obunga areas to discharge into Kisat wastewater treatment plant,
(iii) Additional sewer sections in the central zone to improve collection into Kisat wastewater treatment plant
(iv) Construct a new sewerage system at Otonglo area to cover the Western Zone of the city such as Kisian, Kodiaga Prison areas and parts of the Kisumu International Airport, Kenya Pipeline areas, Coca-Cola areas and the area around Spectre factory.

The long term interventions may take a considerable duration to realise due to the resources involved, land requirements and associated social and economic linkages. For this reason, it became necessary that Kisat Convectional Treatment Plant be evaluated to determine its operational capacity and what should be done to optimize and ultimately expand its performance for a short term intervention.

Kisat Convectional wastewater treatment plant, designed for 6.800m^3/day can allow expansion to accommodate an additional 3,400m^3/day of sewage. To achieve, it requires 2No. Primary Settlement Tanks, 2No. Secondary Settlement Tanks, 2No. Trickling Filters, 2No. Sludge Thickeners and 1No. Set of sludge drying beds. The additional components would be backed up with increased pumping capacity at Sunset and Busia Road sumps. However, this would only be possible if the performance of the current components are optimized.

A constructed wetland has also been considered for Kisat Waste Water Treatment Plant for the improvement of the biological content of the final sewage effluent. Due to constraints of land at the site, It has been proposed that the section earmarked for the additional sludge drying bed be utilised for a constructed wetland.

2.5 Design Principles

2.5.1 General

The pollution load to Lake Victoria due to urban wastewater and runoff is high. A study by LVEMP indicated that that the pollution load into Lake Victoria from the urban areas was 6,955ton of BOD/year, 3028ton Total Nitrogen/year and 2,686ton Total Phosphorous/year. These figures represent the pollution load from the urban areas close to the lakeshore without consideration of the pollution load originally from towns located far away from the lake shore and which drain into Lake Victoria via streams and rivers. This implies that the cumulative pollution load is much higher. Effluents from about 100,000 people connected to the sewers are emptied untreated into the lake at the shallow Winam Bay. This is as a result of the dilapidated and faulty sewerage treatment facility. Moreover, loads of nutrients from pit latrines and leaking sewers find their way into the lake though untreated storm water.

The purpose of sewage collection and treatment is to ensure that the effluent receiving bodies receive sewage that is not harmful to both the environment and people. Therefore, the sewers are designed to be able to safely transport sewage and the treatment works to ensure safe operations and discharges. Effluent discharges standards are generally considered as follows for the major components:

(i) BoD_5 = 20mg/L
(ii) SS = 30mg/l
(iii) FC = 1000 FC/100ml

Other components of consideration are detailed by NEMA guidelines.

In Kenya, Water Supply and Sanitation is provided in accordance with Ministry of Water and Irrigation Practice Manual of 2005 which is complemented by the British Standards (BSI/EN)and Manual of Practice No.8 (from ASCE)

2.5.2 Sewage Treatment

Wastewater treatment plant is facility for the physical, biological and chemical treatment of wastewater (sewage) inclusive of all facilities for the treatment of solid wastes (screenings, grit, sludge). Confined places are all structures of sewerage and wastewater treatment plants which are in contact with the wastewater, sludge, hazardous chemicals, etc., as far as they are covered or sunken. Wastewater treatment plants are designed in accordance with BS EN 12255 sections as follows:

(i) Part 1: General construction principles,
(ii) Part 3: Preliminary treatment,
(iii) Part 4: Primary settlement,
(iv) Part 5: Lagooning processes,
(v) Part 6: Activated sludge processes,
(vi) Part 7: Biological fixed-film reactors,
(vii) Part 8: Sludge treatment and storage,
(viii) Part 9: Odour control and ventilation,
(ix) Part 10: Safety principles,
(x) Part 11: General data required,
(xi) Part 12: Control and automatization1),
(xii) Part 13: Chemical treatment,

(xiii) Part 14: Disinfection1),
(xiv) Part 15: Measurement of the oxygen transfer in clean water in activated sludge aeration tanks,
(xv) Part 16: Physical (mechanical) filtration1).

For purposes of Kisat conventional treatment plant, only parts 5 and 6 are not relevant but all the outputs are applicable. Other important reference for the systems are:

(i) EN 124, Gully tops and manhole tops for vehicular and pedestrian areas — Design requirements, type testing, marking, quality control.
(ii) EN 476, General requirements for components used in discharge pipes, drains and sewers for gravity systems.
(iii) EN 752-6, Drain and sewer systems outside buildings — Part 6: Pumping installations.
(iv) EN 1085, Wastewater treatment — Vocabulary.

The Kisat Wastewater (Sewage) Treatment Plants design criteria consist of the following:

(a) Preliminary Treatment – Inlet Works designed for 6,800 m³/day raw sewage.

The primary application is for wastewater treatment plants designed for the treatment of domestic and municipal wastewater. Preliminary treatment may include the following:

(i) Screening;
(ii) Grit removal;
(iii) Grease separation;
(iv) Flow balancing and flow separation (overflow storm water)

Screening:

(i) The design velocities through screens shall not exceed 112 m/s at maximum flow. The velocity in the approach channel should not fall below 0.3 m/s at minimum flow.
(ii) With the exception of overflows to a storm water holding tank where screening may not be necessary, wherever inlet overflows are installed screens shall be provided.
(iii) Screenings shall be disposed of in accordance with environmentally acceptable standards to avoid hazards.
(iv) The normal configuration of screening installations is the multiple-channel type, a bypass with a hand-raked coarse screen being required for single-channel installations. Provision shall be made to ensure that each channel can be closed down separately.
(v) The structural design of the screen shall be capable of withstanding 0.5 m hydraulic head.

Grit Removal

(i) Grit removal: Grit removal units shall be designed to remove grit particles with a minimum diameter of 0.3m and velocity of 0.03 m/s.
(ii) Separated grit may be washed and any organic matter removed should be returned to the flow for further treatment.
(iii) Grit chambers should be constructed to operate in multiple channels. In the case of single channel installations, a bypass or alternative facility should be provided. Design features shall ensure that each channel may be taken out of service individually.

Grease And Oil Separation

Because of the deleterious effect of grease it shall be removed rather than being emulsified or solubilized. Where domestic and municipal wastewater includes discharges from hotels, restaurants and food processing operations, a grease and oil removal stage should be included in the design of the plant

(b) Primary Settlement:

Primary settlement serves the purpose of separating settleable solids, which are removed on a regular basis in the form of raw sludge. Grease and other floating materials which can cause malfunction of a wastewater treatment plant can also be separated and removed during this process. Primary settlement tanks are designed to ensure that the sewage entering the trickling filters. Kisat has a circular upflow settlement tank. The design criteria for such is as follows:

(i) The tank should be so designed that the upward flow velocity is restricted to within a typical range of 1.0 $m^3/(m^2 \cdot h)$ to 2.0 $m^3/(m^2 \cdot h)$ surface area at dry weather peak hourly flow.
(ii) The minimum sidewall height between the top of the hopper and top water level shall be from 0.3 m to 1.5 m for individual tanks serving populations greater than 50 people.
(iii) Bottom slab shall be a hopper with a floor slope required to collect sludge and allow it to be scraped to the central hopper for removal. The floor slope should be between 3^o and 30^o measured from the horizontal, depending on the size of tank and the type of scraper to be used.

(c) Trickling filter – Single stage attached growth biological treatment

In trickling filters, wastewater is distributed over and percolates down through a bed of support media, contacting the biological film growing on the surface of elements of the media. The bed shall contain continuous open spaces between elements of support media to promote natural or induced ventilation. Operating conditions on the bed shall support the growth of larger organisms such as protozoa and macro-invertebrates, often termed “grazing organisms”, to control the growth of biological film and reduce surplus sludge. Humus tanks should be used to clarify wastewater discharged from the filter

A trickling filter consists of a bed of highly permeable media on whose surface a mixed population of microorganisms is developed as a slime layer. The word "filter" in this case is not correctly used for there is no straining or filtering action involved. Passage of wastewater through the filter causes the development of a gelatinous coating of bacteria, protozoa and other organisms on the media. With time, the thickness of the slime layer increases preventing oxygen from penetrating the full depth of the slime layer. In the absence of oxygen, anaerobic decomposition becomes active near the surface of the media. The continual increase in the thickness of the slime layer, the production of anaerobic end products next to the media surface, and the maintenance of a hydraulic load to the filter, eventually causes sloughing of the slime layer to start to form. This cycle is continuously repeated throughout the operation of a trickling filter. For economy and to prevent clogging of the distribution nozzles, trickling filters should be preceded by primary sedimentation tanks equipped with scum collecting devices.

For ease of flow distribution these should preferably be circular. Where land space is limited rectangular designs may be considered. Unless otherwise agreed, at all but the smallest sites there should be at least two units to give standby capacity in case of failure. Owing to limitations of distributor design, the diameter of circular filters should not exceed 50m.

The depth of media should be selected depending on the site application and the process requirements, e.g. available hydraulic head. High rate filters designed for partial treatment and nitrifying filters can be between 4.0m and 7.0m deep.

Using the plan area derived from the volume of media and the selected depth and the value for the daily flow rate of wastewater, the designer shall ensure that the surface hydraulic loading is sufficient to ensure that each element is sufficiently wetted to promote biofilm growth throughout the bed. The designer shall select a depth, a suitable rate of recirculation and speed of rotation of a distributor and its design, to achieve a sufficient flushing force for efficient operation of the filter.

Trickling filters flow distribution can be provided by static distributors employing spray nozzles or splash plates, or moving distributors. Rotary distributors are used for circular filters and travelling distributors are used for rectangular filters. Rotary distributors are usually hydraulic reaction driven or electrically driven. The holes in distributor arms shall be a minimum of 20mm diameter. This may be reduced if fine screening is incorporated. Removable end caps shall be included at the ends of distributor arms to facilitate the clearing of blockages

Rotary distributors shall be designed to give a uniform wetting rate to the filter surface. Because a rotating bar covers more surface area on moving away from the centre of rotation, the quantity of irrigation should increase in this direction. This can be arranged by increasing the number of points of discharge per unit length of the distributor arm at greater radii. For efficient operation under intermittent dosing a minimum of one dose per 30min is essential to ensure that none of the biomass dries out.

Oxygen Supply
Trickling filters shall be provided with an under drainage system which allows the unimpeded flow of treated wastewater away from the process. This system shall also provide free access of air to the base of the support media for ventilation. Additional vertical pipes may be incorporated into the bed of media to enhance ventilation.

Clarification And Solid Separation
Trickling filters should be provided with a subsequent clarification stage to remove settleable solids from the effluent. In addition to the type of process planned and the required efficiency of separation, the sizing parameters also depend on the type of clarifier, and notably the minimum settling rate of the sludge. This rate takes into account the specific hydraulic characteristics of upward flow clarifiers, whether or not they are equipped with lamella modules. The clarifier(s) shall be deep enough to retain sludge under maximum flow rates. The upflow velocity of effluent within a clarifier shall be less than the lowest settling velocity of the solids to be settled. The design of clarifier and sludge removal equipment shall be suitable to prevent re-suspension of solids.

(d) Secondary Settlement:

(e) Sludge Handling facilities: Sludge thickening tanks and drying beds

The choice of the sludge treatment process depends on the size of the treatment plant, the type, origin and characteristics of the sludge to be treated and the final method of utilization or disposal. Processes which allow for more than one sludge utilization or disposal option are preferable.

Sludge Thickening:
Sludge thickening is carried out in a continuous or batch mode of operation, using gravity thickeners, mechanical thickening equipment such as filters or centrifuges, or dissolved air flotation. The selection of the thickening method and its design shall take account of the following factors:

(i) The sludge solids concentration required by subsequent processes;
(ii) The solids recovery from the process;
(iii) Resolubilization of phosphorus in gravity thickeners;
(iv) Retention times, which when exceeding one day can result in anaerobic degradation, causing odour emission, foaming, bulking and impaired de-waterability;
(v) Control of the sludge feed and liquor removal rates;
(vi) The storage and controlled return of sludge liquor where nitrification or nitrogen removal is required.

Due to enhanced viscosity, positive displacement pumps should be used for transferring the thickened sludge. A programme of sludge testing and analysis shall be considered where practicable to assist in the design of gravity thickeners. Gravity thickeners should have a depth of at least 3 m, have a bottom slope of at least 50° (conical) or 60° (pyramidal) to the horizontal or be equipped with either an agitator or a rake which includes a bottom scraper (e.g. picket fence).

The flow velocity in liquid sludge and sludge liquor pipelines shall not be continuously less than 1 m/s unless measures for the prevention of sedimentation/encrustation are taken. If the rate of gravity flow is too low then pumping shall be considered. Pump casings with ventilation and dewatering bores should be provided. The leaking water from lubricated glands shall be drained. The circumferential velocity of the rotors of eccentric screw pumps should not exceed 2 m/s during regular operation in order to avoid excessive wear

Sludge Drying Beds

Sludge drying beds, often installed in countries with a drier climate, may consist of a minimum of two cells with porous filter media and drain pipes. The filter beds are usually built of multiple sand and gravel layers where the particle size increases from the top to the bottom. The finest upper layer is gradually removed together with the dried sludge and shall be renewed after several removal cycles. The upper sand layer shall have a depth of 50 mm to 100 mm and the lower gravel layer shall have a depth of 300 mm to 400 mm. The drainage pipes in the gravel layer shall have a minimum DN 80.

Anaerobically digested sludge is applied to the drying beds to a maximum depth of 300 mm and other sludge to a depth of 100 mm. It is recommended to apply digested sludge from the bottom of the digester. Due to the pressure drop, dissolved gas is released and floats the solids to the sludge surface thus enabling the sludge water below to drain rapidly. The removal of the sludge is carried out manually or with mechanical scrapers. Adequate access shall be provided for vehicles to carry out sludge removal. The following section provides guidelines for generic systems of wastewater treatment plants that should be considered when design of the systems take place.

(f) Systems for separating solids from wastewater

(i) Screening and filtration equipment and installations for dewatering the screenings as well as grit chambers and grease traps shall be designed so as to minimize contact by persons with the solids and to ensure safe removal of the solids.
(ii) chambers with spiral flow and water depths exceeding 1,35 m, a suitable holding fixture for self-rescue shall be provided on the downward flow side over the whole length of the chamber.
(iii) Safety ropes or bars shall be installed at the water level around rotating equipment. chambers with horizontal flow, emergency exits should be installed downstream.
(iv) These emergency exits shall not be located in the vicinity of the grit hoppers and shall be within reach of the holding fixture.

(v) Suitable holding fixtures for self rescue can be for example, grippable pipes, stay bars or tightly stretched cables.
(vi) Sunken loading bays for vehicle containers shall be equipped on the approach side with a raised edge to
(vii) prevent the vehicle wheels falling in when reversing. A suitable raised edge would be a barrier a minimum of 0,25 m high painted in yellow/black contrasting colours.

(g) Wastewater pumping stations

(i) In order to avoid hazards from dangerous substances, wet wells shall only have access from outside of the buildings and are not allowed to be connected with other rooms.
(ii) Permanent provision for man entry to wet wells is not required if there is no need for man entry either for cleaning or maintenance purposes.
(iii) Access is not required if e.g. the deposition of solids is prevented by mechanical equipment or if cleaning and maintenance work can be carried out effectively from safe standing places.
(iv) Pumps even when installed in wet wells and electrical equipment shall be so designed, that ignition energy can be released if they are used in locations where explosion hazards may occur. This requirement is adequately satisfied, if e.g. explosion-protected submersible motor-pumps are used, or if the pump motors are completely submerged during the whole pumping cycle.
(v) Pumps shall be designed and installed so that they can be maintained easily and safely. Each pump shall be capable of being hydraulically isolated while other pumps of the station are still operating.
(vi) In the case of screw pumps in addition it shall be taken into account that:
- The screw can be cleaned safely;
- The standing places over the inlet are situated clear of the highest water level.

(h) Ventilation

(i) Confined spaces in wastewater treatment plants, in which dangerous substances, explosive atmosphere or aerosols can accumulate in the breathing air in concentrations harmful to the health or in which an oxygen deficiency can arise, shall have effective ventilation. It shall be possible to measure the efficiency of the ventilation from a safe position.
(ii) Natural ventilation can be effective, if e.g. the design of the opening provides sufficient ventilation without dead zones and the ventilation openings cannot be shut.
(iii) Ventilation openings which are located only at the top or bottom of a door and windows shall not be deemed effective means of ventilation.
(iv) Forced ventilation shall be provided if natural ventilation is not sufficient.

2.5.3 Sewers

All gravity sewers will not be designed to run surcharged.

Design Horizon
Design Horizon – Sewage generation will follow the water demand horizon. The mid horizon is year 2022 while the ultimate is year 2037.

Minimum size of sewers

In order to reduce the risk of blockage and simplify maintenance, it is recommended that all trunk sewers should be at least 225mm in diameter; property sewers should be 100mmm or 150mm in diameter depending upon the flows with which they must deal.

Velocity Calculations for Gravity Sewers

Manning's equation is commonly used in sewer design. It is recommended that manning n value of 0.13 be used for all sewers and therefore should be adopted for Kisumu Sewerage. Manning's Equation (Gravity):

$$V = \frac{1}{n} \times (R_H)^{\frac{2}{3}} \times S^{\frac{1}{2}}$$

Where: V = velocity in metres/second (m/s)
n = coefficient of roughness (Manning), n = 0.013
S =slope of energy grade line, m/m
R_H = hydraulic radius, m
=cross-sectional area of flow (m^2)
wetted perimeter (m)

All gravity sewers shall be designed for:

- Peak flows which it will receive
- Minimum velocity to avoid siltation (self-cleansing), 0.75 m/s.
- Minimum velocity to avoid hydrogen sulphite attack, 1.0 m/s.
- Maximum velocity to avoid pipe material scour by sediments 3.0 m/s. However, this is not mandatory when special protection is provided.

It is recommended that for the sizing of gravity sewers, the Tables for the design of Storm-Drains, sewers and pipe-lines by Hydraulic Research Station (HRS) be used to avoid lengthy computations.

Contingency Factors

The World Health Organization (WHO) Report No. 9 recommends a modification to Crimp and Bruges tables, for small diameter sewers, to allow for changes in sewer grade during construction, unforeseen housing development and forecasting analyses. The proposed sewer reticulation is essentially a separate system. In the final design, specific flow analyses will be made wherever it is proposed to admit storm water into the system and maximum inflow rates will be taken into account. Therefore, we believe that the peak flows received into the system will be significantly less than 5 or 4 ADWF as recommended in WHO.

Slope

The slope of the various gravity sewer sizes is limited in scope for Manning's n = 0.013 (see table below):

Table 1: Slope Of Gravity Sewers

Pipe Size mm (in)		Minimum % of Grade (V = 0.75 m/s)	Maximum % of Grade (V = 3.0 m/s)
(mm)	(inches)		
150	6	0.74	11.86
200	8	0.51	8.08

Pipe Size mm (in)		Minimum % of Grade (V = 0.75 m/s)	Maximum % of Grade (V = 3.0 m/s)
(mm)	(inches)		
250	10	0.38	6.00
300	12	0.29	4.71
350	15	0.22	3.50
375	18	0.17	2.74
400	21	0.14	2.23
450	24	0.12	1.87
500	27	0.10	1.60
525	30	0.09	1.39
600	36	0.07	1.09
675	42	0.06	0.89
750	48	0.05	0.74
900	54	0.04	0.63
1050	60	0.03	0.55
1500	66	0.03	0.48
1675	68	0.03	0.47

Slope between Manholes
Sewers shall be laid with uniform slope between manholes.

High Velocity Protection
Where design velocities are projected to be greater than 4.5 m/s, the sewers and manholes shall be protected against displacement by erosion and impact.

Steep Slope Protection
Sewers on 20 percent slopes or greater shall be anchored securely with concrete, or equal, with the anchors spaced as follows:

(i) Not greater than 12m centre to centre on grades 21% to 35%;
(ii) Not greater than 6m centre to centre on grades 35% to 50 %; and
(iii) Not greater than 16m centre to centre on grades 50% and over.

Pump stations and Pumped/Pressure Sewers
All pumped sewers shall be design for the key criteria as shown in the table below.

Table 2: Key Criteria For Sewerage Components

Parameters For Pumped/Pressure Sewers	Value
Production components and pumping systems at PDWD	22 hours
Transmission mains - pipe flow velocity: Min / Max	0.5 / 2 m/s
Transmission mains – maximum pressure	15 bar
Transmission mains – maximum head losses	8 m/km
Life time of civil and building works	50 years
Life time of pipe works	25 years
Life time of electro-mechanical components	8 years

Manholes

(i) Manhole shafts shall have a minimum width of DN/ID 1,000 according to EN 476.
(ii) The clear width of manhole covers in vehicular traffic areas shall be not less than DN/ID 600,
(iii) In non-traffic areas manhole covers should have a minimum clear width of DN/ID 800 according to EN 124.

2.5.4 Hazards in Wastewater Treatment Plants

Hazards from substances in wastewater treatment plants can arise from solid substances, liquids, vapours, gases and bio-aerosols, micro-organisms and dust particles in a dangerous quantity or concentration and through the presence of oxygen-displacing media. Hazards can also arise from substances being introduced from an external source or can be produced in situ by biological processes (e.g. fermentation, putrefaction) or by chemical reactions (e.g. when different wastewaters are mixed). Hazards can arise from the following sources:

(i) Gases or vapours which can cause fires or explosions;
(ii) Oxygen deficiency which can result in suffocation;
(iii) Toxic, corrosive, irritant, flammable or hot substances, which can cause harm to health by contact, absorption through the skin or by ingestion, inhalation, or penetration through puncture wounds;
(iv) Increase of flow or level of water, e.g. Following heavy rain or flooding
(v) Potential occupational health and safety of the workers and visitors including slips and falls, food and water contamination as well as related infections.

2.6 Project Alternative Analysis

2.6.1 "NO Action" Alternative

By doing nothing it may mean that the City of Kisumu remains at the worrying sewer coverage status of below 10% while the large part of the sewage generated flows into Lake Victoria. This shows that doing nothing will not only continue worsening the local sanitation challenges but also regional environmental problems as pollution loading into Lake Victoria increases.

2.6.2 Design Alternatives

The sewer designs have been informed by the distribution of settlements and economic activities. The design for the treatment components will be defined by the status of the current components and the identified need for expansion or additional ones. Regarding the plant, the design interventions should be confined within the existing premises to avoid demand for additional land or external impacts. In this connection the following should be considered;

(i) The sewage reception should be redesigned such as to allow the following;
- Safe collection of screenings without compromising the health of the plant workers and the surrounding communities,
- Appropriate measurements of the incoming sewage flows and hence volumetric feeds complete with data collection arrangements,
- Consider arrangements for sludge recycling feed into the raw sewage for effective and enhanced seeding of microbes

(ii) Redesign the existing Sludge Thickeners into complete sludge digesters for efficiency and enhanced stabilization of the sludge and interception of methane gas for local use,

(iii) Review the design and operations of the existing trickling filters with the aim of optimizing their efficiency before providing the additional units,
(iv) Revive the sludge drying beds
(v) A constructed wetland system may be given priority over the additional trickling filters considering the limited land availability at Kisat Treatment Plant.

2.6.3 Management Alternatives

For efficiency enhancement at the plant, a review of the operational procedures may be necessary in view of the proposed intervention measures. This may involve a collaboration of the Site Engineer, the operators and the rehabilitation design engineers as well as the Lake Victoria South Water Services Board Technical Services. The collaboration should come out with a revised Standard Operation procedure for the plant. In addition, a continuous maintenance of the various plant components will be necessary for a sustained performance efficiency.

2.7 Anticipated Challenges

The following are challenges that may be encountered during the operations of the plant;

(i) Excessive entry of surface runoff during the rains into the sewer system could overwhelm the plant,
(ii) Being a largely mechanical plant high operational costs is still a challenge following occasional breakdown of parts,
(iii) Land space limitation is also a challenge to the desired long term expansion of the plant
(iv) Disposal of the sludge cake is still a challenge until the users (local communities) changes the attitude that it is wrong to use human waste as manure.

2.8 Intervention Thoughts

In view of the proposed interventions and the analysis under this study, the following considered opinions have been considered;

(i) Intervention into Kisumu City Wastewater treatment is long overdue. However, it should be viewed from a point of inadequate service coverage as well as inadequate maintenance of the existing infrastructure for optimum efficiency. In this regard, therefore, accurate land use and population distribution for the entire Kisumu City would require to be studied with a view to determining threshold levels for service provision,
(ii) The improvement of Kisat Convectional Sewage Treatment Plant need to be guided by clear appreciation of its design and operational challenges. Consider the following thoughts;
    - Would it improve the efficiency of the plant if thickened sludge instead of clear primary clarifier effluent is re-circulated into the raw sewage? The answer is YES
    - Would it still be necessary to have an additional 2No. Trickling Filter beds if the efficiency of the existing 6No. is optimized (at the moment only two are used at a go due to inadequate sewage flow. Note also that a filter bed should constantly receive flowing sewage to sustain the biofilm membranes)? The answer is NO
    - Would the plant have an economic value addition if the existing sludge thickeners are converted into full sludge digesters such as to generate methane gas for local use? The answer is YES
(iii) The entire internal health and safety setting and provisions of Kisat Plants (and other locations of the sewerage system) needs a total overhaul.

2.9 Project Implementation Plan

It is estimated that the proposed intervention projects will be implemented within a period of 24 months from the date of commencement.

2.10 Project Cost Estimates

The cost for the intervention project for Kisat Convectional Sewage Treatment Plant is estimated at **KShs. 564,355,984.00 (KENYA SHILLINGS FIVE HUNDRED SIXTY FOUR MILLION, THREE HUNDRED FIFTY FIVE THOUSAND, NINE HUNDRED EIGHTY FOUR)** only such as to cover the following items;

(i) Preliminary and General Items
(ii) Construction works
(iii) Installation of equipment
(iv) Contingencies

Chapter 3: Policy, Legal Issues And Institutional Framework

3.1 An Overview

Environmental Impact Assessment is a tool for ensuring new projects and programmes incorporate appropriate measures to mitigate adverse impacts to the environment and peoples' health and safety as well as enhancing sustainable operations with respect to environmental resources and co-existence with other socio-economic activities in their neighbourhood. Recent GOK efforts aimed at formulating a clear policy strategy has culminated in the enactment of a new legislation on water management. The Water Act 2002 is aimed at harmonizing and streamlining the management of water resources, water supply and sanitation services. Necessary policies and legislation that ensures annual environmental audits (EA) are carried out on every running project, activity or programme and a report submitted to National Environmental Management Authority (NEMA) for approval and issuance of relevant certificates.

According to the Kenya National Environment Action Plan (NEAP, 1994) the Government recognized the negative impacts on ecosystems emanating from industrial, economic and social development programmes that disregarded environmental sustainability. Following on this, establishment of appropriate policies and legal guidelines as well as harmonization of the existing ones have been accomplished and/or are in the process of development. The NEAP process introduced environmental assessments in the country with among the key stakeholders being industrialists, business community and local authorities. This culminated into the development of the Policy on Environment and Development under the Sessional Paper No. 6 of 1999.

3.2 Policy Provisions

3.2.1 National Environment Action Plan (NEAP)

According to the Kenya National Environment Action Plan (NEAP, 1994) the Government recognized the negative impacts on ecosystems emanating from economic and social development programmes that disregarded environmental sustainability. In this regard, establishment of appropriate policies and legal guidelines as well as harmonization of the existing ones have been accomplished and/or are in the process of development. Under the NEAP process, EIA was introduced and among the key participants identified were the District Development Committees.

3.2.2 National Policy on Water Resources Management and Development

The National Policy on Water Resources Management and Development (Sessional Paper No. 1 of 1999) was established with an objective to preserve, conserve and protect available water resources and allocate it in a sustainable rational and economic way. It also desires to supply water of good quality and in sufficient quantities to meet the various water needs while ensuring safe disposal of wastewater and environmental protection. The policy focuses on streamlining provision of water for domestic use, agriculture, livestock development and industrial utilization with a view to realizing the goals of the Millennium Development Goals (MDGs) as well as Vision 2030. To achieve these goals, water supply (through increased household connections and developing other sources) and improved sanitation is required in addition to interventions in capacity building and institutional reforms

While the National Policy on Water Resources Management and Development (1999) enhances a systematic development of water facilities in all sectors for promotion of the country's socio-economic progress, it also recognizes the by-products of this process as wastewater. It, therefore,

calls for development of appropriate sanitation systems to protect people's health and water resources from institutional pollution. Development projects, therefore, should be accompanied by corresponding waste management systems to handle the wastewater and other waste emanating there from. The same policy requires that such projects should also undergo comprehensive EIAs that will provide suitable measures to be taken to ensure environmental resources and people's health in the immediate neighbourhood and further downstream are not negatively impacted by the emissions.

In addition, the policy provides for charging levies on waste water on quantity and quality (similar to polluter-pays-principle) in which case those contaminating water are required to meet the appropriate cost on remediation, though the necessary mechanisms for the implementation of this principle have not been fully established under the relevant Acts. However, the policy provides for establishment of standards to protect the water bodies receiving wastewater, a process that is ongoing.

3.2.3 Sessional Paper No. 6 of 1999 on Environment and Sustainable Development

Among the key objectives of the Sessional Paper No. 6 of 1999 on Environment and Sustainable Development (1993) include ensuring that development policies, programmes and projects take environmental considerations into account, ensuring that an independent environmental impact assessment (EIA) report is prepared for any development before implementation and to ensure that effluent treatment standards that conform to acceptable health standards.

This paper provided the basis for the environmental Policy framework that is in the process of formulation. Under this paper, broad categories of development issues have been covered that require sustainable approach. These issues include the waste management and human settlement sectors. The paper recommends the need for enhanced re-use/recycling of residues including wastewater and increased public awareness raising and appreciation of clean environment as well as the participation of stakeholders in the management of wastes within their localities. Regarding human settlement, the paper encourages better planning in both rural and urban areas and provision of basic needs such as water, drainage and waste disposal facilities among others for decent housing of every family.

3.3 Legal Framework

Applications of national statutes and regulations on environmental conservation suggest that the proposed project management institutions will have a legal duty and social responsibilities to ensure the proposed headquarter development is carried out without compromising the status of the natural resources in the area, public privacy, health and safety. This position enhances the importance of this environmental impact assessment for the proposed site to provide a benchmark for its sustainable operation. The key national laws that govern the management of environmental resources in the country have been briefly discussed below. It is noteworthy that wherever any of the laws contradict each other, the Environmental Management and Co-ordination Act 1999 prevails.

3.3.1 The Environment Management and Co-ordination Act, 1999

Part II of the Environment Management & Coordination Act, 1999 states that every person in Kenya is entitled to a clean and healthy environment and has the duty to safeguard and enhance the environment. In order to partly ensure this is achieved, Part VI of the Act directs that any new programme, activity or operation should undergo environmental impact assessment and a report prepared for submission to the National Environmental Management Authority (NEMA), who in turn

may issue a license as appropriate. The second schedule of the same Act lists water programmes and sewage disposal works among the key activities that must undergo environmental assessments.

Part VIII section 72 of the Act prohibits discharging or applying poisonous, toxic, noxious or obstructing matter, radioactive or any other pollutants into aquatic environment. Section 73 require that operators of projects which discharges effluent or other pollutants to submit to NEMA accurate information about the quantity and quality of the effluent. Section 74 demands that all effluent generated from point sources be discharged only into the existing sewerage system upon issuance of prescribed permit from the local authorities or from the licensee. Finally, section 75 requires that parties operating a sewerage system obtain a discharge license from NEMA to discharge any effluent or pollutant into the environment.

Section 87 sub-section 1 states that no person shall discharge or dispose of any wastes, whether generated within or outside Kenya, in such a manner as to cause pollution to the environment or ill health to any person, while section 88 provides for acquiring of a license for generation, transporting or operating waste disposal facility. According to section 89, any person who, at the commencement of this Act, owns or operates a waste disposal site or plant or generate hazardous waste, shall apply to the NEMA for a license. Sections 90 through 100 outline more regulations on management of hazardous and toxic substances including oils, chemicals and pesticides.

Finally, the environmental impact assessment guidelines require that study be conducted in accordance with the issues and general guidelines spelt out in the second and third schedules of the regulations. These include coverage of the issues on schedule 2 (ecological, social, landscape, land use and water considerations) and general guidelines on schedule 3 (impacts and their sources, project details, national legislation, mitigation measures, a management plan and environmental auditing schedules and procedures. This applies in all aspects of the intervention project including among others;

(i) Social disruption control
(ii) Waste management
(iii) Effluent discharge practices
(iv) Aerial emissions,
(v) Excessive noise and vibrations
(vi) Excavations and soil loss
(vii) Adverse interference with natural resources including wetlands and water resources.

The project cycle should ensure compliance with this statutes all the time

3.3.2 Environmental Management Regulations

Water Quality Management Regulations, 2006 (Legal Notice No. 120)
These regulations were drawn under section 147 of the Environmental Management and Coordination Act 1999. In accordance with the regulations, every person shall rephrain from acts that could directly or indirectly cause immediate or subsequent water pollution and no one should throw or cause to flow into water resources any materials such as to contaminate the water. The regulation also provides for protection of springs, streams and other water sources from pollution. This applies anytime there is a discharge of effluent into the environment without meeting the established standards. This requires an all time compliance through the project cycle.
Waste Management Regulations, 2006 (Legal Notice No. 121)
The regulations are formed under sections 92 and 147 of the Environmental Management and Coordination Act, 1999. Under the regulations, a waste generator is defined as any person whose

activities produces waste while waste management is the administration or operation used in handling, packaging, treatment, conditioning, storage and disposal of waste. The regulations requires a waste generator to collect, segregate and dispose each category of waste in such manners and facilities as provided by relevant authorities. Regarding transportation, licensed persons shall operate transportation vehicles approved by NEMA and will collect waste from designated areas and deliver to designated disposal sites. This will apply on disposal of solid wastes into the environmental without complying with the established standards and procedures. Requires an all time compliance.

Noise and Excessive Vibration Pollution Control Regulations, 2009

Part II section 3(I) of these Regulations states that: no person shall make or cause to be made any loud, unreasonable, unnecessary or unusual noise which annoys, disturbs, injures or endangers the comfort, repose, health or safety of others and the environment and section 3(2) states that in determining whether noise is loud, unreasonable, unnecessary or unusual. Part II Section 4 also states that: except as otherwise provided in these Regulations, no person shall (a) make or cause to be made excessive vibrations which annoy, disturb, injure or endanger the comfort, repose, health or safety of others and the environment; or (b) cause to be made excessive vibrations which exceed 0.5 centimeters per second beyond any source property boundary or 30 metres from any moving source.

Part III, Section 11(1) states that any person wishing to (a) operate or repair any machinery, motor vehicle, construction equipment or other equipment, pump, fan, air-conditioning apparatus or similar mechanical device; or (b) engage in any commercial or industrial activity, which is likely to emit noise or excessive vibrations shall carry out the activity or activities within the relevant levels prescribed in the First Schedule to these Regulations. Any person who contravenes this Regulation commits an offence. Section 13(1) states that no person shall operate construction equipment (including but not limited to any pile driver, steam shovel, pneumatic hammer, derrick or steam or electric hoist) or perform any outside construction or repair work so as to emit noise in excess of the permissible levels as set out in the Second Schedule to these Regulations. These purposes include emergencies, those of a domestic nature and /or public utility construction.

Section 14 relates to noise, excessive vibrations from construction, demolition, mining or quarrying sites, and states that: where defined work of construction, demolition, mining or quarrying is to be carried out in an area, the Authority may impose requirements on how the work is to be carried out including but not limited to requirements regarding (a) machinery that may be used, and (b) the permitted levels of noise as stipulated in the Second and Third Schedules to these Regulations. It further states that the relevant lead agency shall ensure that mines and quarries where explosives and machinery used are located in designated areas and not less than two kilometers away from human settlements and any person carrying out construction, demolition, mining or quarrying work shall ensure that the vibration levels do not exceed 0.5 centimeters per second beyond any source property boundary or 30 metres from any moving source

Air Quality Regulations

Under the general prohibitions (Part II), section 5 states that no person shall act in a way that directly or indirectly causes immediate or subsequent air pollution. Among the prohibitions are priority air pollutants (as listed under schedule 2 of the regulations) that include general pollutants, mobile sources and green house gases. Odours are also prohibited under section 9 of the regulations (offensive emissions). Emissions into controlled areas such as schools, hospitals, residential areas and populated urban centers are also prohibited.

Part VII on occupational air quality limits in section 29 states that an occupier of premises shall ensure that exposure of indoor air pollutants does not exceed the limits stipulated under the

Factories and Other Places of Work rules or under any other law. Other sources are recognized at sections 32 and 33 are those arising from construction equipments and materials as well as particulate matter from demolitions of structures and buildings as well as stockpiled dry materials.

Biodiversity Regulations

Part II of Regulations, section 4 states that no person shall engage in any activity that may have adverse impacts on ecosystems, lead to introduction of exotic species or lead to unsustainable use of natural resources without an EIA license. The regulation puts in place measures to control and regulate access and utilization of biological diversity that include among others banning and restricting access to threatened species for regeneration purposes. It also provides for protection of land, sea. Lake or river declared to be a protected natural environmental system in accordance to section 54 of EMCA, 1999.

3.3.3 The Water Act 2002

Part II section 18 provides for national monitoring and information systems on water resources. Following on this, sub-section 3 allows the Water Resources Management Authority to demand from any person, specified information, documents, samples or materials on water resources. Under these rules, specific records may be required to be kept and the information thereof furnished to the authority on demand.

Section 25 of the Act requires a permit to be obtained for among others any use of water from a water resources, discharge of a pollutant into any water resource. According to section 29 of the same Act, application for such a permit shall be subject to public consultation as well as an environmental impact assessment as per the Environmental Management and Coordination Act, 1999. The conditions of the permit may also be varied if the authority feels that the water so used is causing deterioration of water quality or causing shortage of water for other purposes that the authority may consider has priority. This is provided for under section 35 of the Act.

Section 73 of the Act allows a person with a license to supply water (licensee) to make regulations for purposes of protecting against degradation of sources of water which he is authorized to take. Under the Act, the licensee could be a local authority, a private Trust or an individual and the law will apply accordingly under the supervision of the Regulatory Board. Section 75 and sub-section 1 allows a licensee for water supply to construct and maintain drains, sewers and other works for intercepting, treating or disposing of any foul water arising or flowing upon land for preventing water belonging to the licensee or which he is authorized to take for supply from being polluted. However, if the proposed works will affect or is likely to affect any body of water in the catchment, the licensee shall obtain consent from the Water Resources Management Authority.

Section 76 states that no person shall discharge any trade effluent from any trade premises into sewers of a licensee without the consent of the licensee upon application indicating the nature and composition of the effluent, maximum quantity anticipated, flow rate of the effluent and any other information deemed necessary. The consent shall be issued on conditions including the payment rates for the discharge as may be provided under section 77 of the same Act. The statute established to coordinate sustainable utilization of water resources including protection of the same from pollution and degradation (abstraction, use and disposal of wastewater thereof)

3.3.4 Water Rules

One of the outcomes of the water sector reforms has been improved regulatory framework for water resource management and use. In addition to the Water Act 2002, the main document outlining the regulations is the Water Resource Management Rules 2007. The rules set out the procedures for obtaining water use permits and the conditions placed on permit holders. Sections 54 to 69 of the

Water Resources Management Rules 2007 impose certain statutory requirements on dam owners and users in regard.

Other sections within the rules imply that WRMA can impose water quality sampling requirements from the water sources and impacts to the hydrology, water chemistry and river morphology downstream basin. Section 16 of the Water Rules requires approval from the Water Resources Management Authority (WRMA) for a variety of activities that affect the water resources, including the storage of water in dams and pans. Approval by WRMA is conferred through a Water Permit. A permit is valid for five years and must be renewed..

Section 104 of the Water Resource Management Rules requires certain water permit holders to pay water use charges. The intention of the water use charges was to raise revenue for water resource management, raise revenue for catchment conservation activities, improve efficiency of water resource abstraction and provide a system of data collection on water resource usage.

The rules sets the standard procedures and rules to be followed in the utilization of water resources including abstraction controls, modes of use and responsibilities in protection of the resources including effluent treatment standards.

3.4 World Bank Safeguards

3.4.1 OP/BP 4.01 (Environmental Assessment)

The World Bank has well-established environmental assessment procedures, which apply to its lending activities and to the projects undertaken by borrowing countries, in order to ensure that development projects are sustainable and environmentally sound. Although its operational policies and requirements vary in certain respects, the World Bank follows a relatively standard procedure for the preparation and approval of an environmental assessment study, which:

(i) Identifies and assesses potential risks and benefits based on proposed activities, relevant site features, consideration of natural/human environment, social and trans-boundary issues
(ii) Compares environmental pros and cons of feasible alternatives
(iii) Recommends measures to eliminate, offset, or reduce adverse environmental impacts to acceptable levels (sitting, design, technology offsets)
(iv) Proposes monitoring indicators to implement mitigation measures
(v) Describes institutional framework for environmental management and proposes relevant capacity building needs.

The environmental assessment evaluates a project's potential environmental risks and impacts in its area of influence; examines project alternatives; identifies ways of improving project selection, siting, planning, design, and implementation by preventing, minimizing, mitigating, or compensating for adverse environmental impacts and enhancing positive impacts; and includes the process of mitigating and managing adverse environmental impacts throughout project implementation. The assessment takes into account: the natural environment (air, water, and land); human health and safety) social aspects (involuntary resettlement, indigenous peoples, and physical cultural resources); and trans-boundary and global environmental aspects. Preventive measures are favoured over mitigation or compensatory measures, whenever feasible. This approach is universally applied in many institutional projects.

The World Bank considers environmental impact assessment (EIA) as one among a range of instruments for environmental assessment. Other instruments used by the World Bank include

regional or sectoral environmental assessment, strategic environmental and social assessment (SESA), environmental audit, hazard or risk assessment, environmental management plan (EMP) and environmental and social management framework (ESMF). The Bank undertakes environmental screening of each proposed project to determine the appropriate extent and type of environmental assessment. Proposed projects are classified into one of three categories, depending on the type, location, sensitivity, and scale of the project and the nature and magnitude of its potential environmental impacts:

- **Category A:** the proposed project is likely to have significant adverse environmental impacts that are sensitive, diverse, or unprecedented. These impacts may affect an area broader than the sites or facilities subject to physical works. For a Category A project, the Proponent is responsible for preparing an EIA report.
- **Category B:** the proposed project has potential adverse environmental impacts on human populations or environmentally important areas such as wetlands, forests, grasslands, and other natural habitats - but these are less adverse than those of Category A projects. These impacts are site-specific; few if any of them are irreversible; and in most cases, mitigation measures can be designed more readily than for Category A projects. Like Category A the environmental assessment examines the project's potential negative and positive environmental impacts and recommends any measures needed to prevent, minimize, mitigate, or compensate for adverse impacts and improve environmental performance.
- **Category C:** the proposed project is likely to have minimal or no adverse environmental impacts. Beyond screening, no further environmental assessment action is required for a Category C project.

Environmental Assessment is used in the World Bank to identify, avoid, and mitigate the potential negative environmental associated with Bank lending operations. The purpose of Environmental Assessment is to improve decision making, to ensure that project options under consideration are sound and sustainable and that potentially affected people have been properly consulted. The magnitude of the proposed rehabilitation works falls under category B and hence only ESIA Project Report would be required.

Table 3: OP/BP 4.01 Environmental Assessment

Objectives	Operational Principles
To help ensure the environmental and social soundness and sustainability of investment projects. Also referred to as scoping.	Apply the screening process for each proposed project, as early as possible, to determine the appropriate extent and type of environmental assessment (EA) so that appropriate studies are undertaken proportional to potential risks and to direct, and, as relevant, indirect, cumulative, and associated impacts. Use sectoral or regional environmental assessment when appropriate.
To support integration of environmental and social aspects of projects into the decision making process.	Assess potential impacts of the proposed project on physical, biological, socio-economic and physical cultural resources, including trans-boundary and global concerns, and potential impacts on human health and safety.
	Assess the adequacy of the applicable legal and institutional framework, including applicable international environmental agreements, and confirm that they provide that the cooperating government does not finance project activities that would contravene such international obligations.
	Provide for assessment of feasible investment, technical, and siting alternatives, including the "no action" alternative, potential impacts, feasibility of mitigating these impacts, their capital and recurrent costs, their suitability under local conditions, and their institutional, training and monitoring requirements

Objectives	Operational Principles
	associated with them.
	Where applicable to the type of project being supported, normally apply the Pollution Prevention and Abatement Handbook. Justify deviations when alternatives to measures set forth in the handbook are selected.
	Prevent, minimize, or compensate for adverse project impacts and enhance positive impacts through environmental management and planning that includes the proposed mitigation measures, monitoring, institutional capacity development and training measures, an implementation schedule, and cost estimates.
	Involve stakeholders, including project-affected groups and local non-governmental organizations, as early as possible, in the preparation process and ensure that their views and concerns are made known to decision makers and taken into account. Continue consultations throughout project implementation as necessary to address EA-related issues that affect them.
	Use independent expertise in the preparation of EA where appropriate. Use independent advisory panels during preparation and implementation of projects that are highly risky or contentious or that involve serious and multi-dimensional environmental and/or social concerns.
	Provide measures to link the environmental assessment process and findings with studies of economic, financial, institutional, social and technical analyses of a proposed project.
	Provide for application of the principles in this Table to subprojects under investment and financial intermediary activities.
	Disclose draft EA in a timely manner, before appraisal formally begins, in an accessible place and in a form and language understandable to key stakeholders.

3.4.2 OP/BP 4.04 (Natural Habitats)

The policy is designed to promote environmentally sustainable development by supporting the protection, conservation, maintenance and rehabilitation of natural habitats and their functions. The policy seeks to ensure that World Bank-supported infrastructure and other development projects take into account the conservation of biodiversity, as well as the numerous environmental services and products which natural habitats provide to human society. The policy strictly limits the circumstances under which any Bank-supported project can damage natural habitats (land and water area where most of the native plant and animal species are still present). This project interacts with among other features Lake Victoria at Kisumu Bay with potentail discharge of partially treated effluents. However, the project will not have any direct interaction with the Lakes ecosystem or displace any of these ecosystems though appropriate management measures will need to be integrated to minimize conflicts.

3.4.3 OP/BP 4.11 (Physical Cultural Resources)

This policy is meant to assist in preserving physical cultural resources including the movable or immovable (above or below ground, or under water) objects, sites, structures, groups of structures, and natural features and landscapes that have archaeological, paleontological, historical, architectural, religious, aesthetic, or other cultural significance including sites and unique natural values. Physical cultural resources are important as sources of valuable scientific and historical information, as assets for economic and social development, and as integral parts of a people's cultural identity and practices. The objective of this policy is to avoid or mitigate adverse impacts on physical cultural resources from development projects. As

observed from the baseline conditions, there are no sensitive cultural areas in the areas neighbouring the sewage treatment or sewer lines and hence would not be triggered.

3.4.4 OP/BP 4.12 (Involuntary Resettlement)

The policy states that "Where large-scale of population displacement is unavoidable, a detailed resettlement plan, timetable, and budget are required. Resettlement plans should be built around a development strategy and package aimed at improving or at least restoring the economic base for those relocated. Experience indicates that cash compensation alone is normally inadequate. Voluntary settlement may form part of a resettlement plan, provided measures to address the special circumstances of involuntary resettlers are included. Preference should be given to land-based resettlement strategies for people dislocated from agricultural settings. If suitable land is unavailable, non land-based strategies built around opportunities for employment or self-employment may be used".

Involuntary resettlement is triggered in situations involving involuntary taking of land and involuntary restrictions of access to legally designated parks and protected areas. The objective of this policy is to avoid or minimize involuntary resettlement, though participation in resettlement planning and implementation and, where this is not feasible, to assist displaced persons in improving or at least restoring their livelihoods and standards of living in real terms relative to pre-displacement levels or to levels prevailing prior to the beginning of project implementation, whichever is higher. The policy prescribes compensation and other resettlement measures to achieve its objectives and requires that borrowers prepare adequate resettlement planning instruments prior to Bank appraisal of proposed projects. There are no anticipated displacements by this project and hence no need to resettlement action plan (RAP) required therefore it is not triggered.

3.4.5 OP/BP 4.36 (Forests)

The policy on forest safeguards seeks to realize the potential of forests to reduce poverty in sustainable manner, integrate forests effectively into sustainable economic development and protect the vital local and global environmental services and values of forests. Among the principles is to screen as early as possible for potential impacts on forest health and quality and on the rights and welfare of the people who depend on them. There are no forests anywhere within the vicinity of the project areas and so aspect not triggered.

3.4.6 OP/BP 4.10 (Indigenous Peoples)

This policy contributes to the Bank's mission of poverty and sustainable development by ensuring that the development process fully respects the dignity, human rights, economies and cultures of indigenous peoples. For all projects that are proposed for Bank financing and affect indigenous peoples, the Bank requires the borrower to engage in a process of free, prior, and informed consultation. The broad support of the project by the affected Indigenous Peoples such as Bank-financed projects includes;

(i) Preventive measures to adverse effects to the indigenous cultures and practices,
(ii) Avoid potential adverse effects on the Indigenous Peoples' communities;
(iii) When avoidance is not feasible, minimize, mitigate, or compensate for such effects.

Bank-financed projects are also designed to ensure that the Indigenous peoples receive social and economic benefits that are culturally appropriate and gender and inter-generationally inclusive. The objective of this policy is to design and implement projects in a way that fosters full respect for Indigenous Peoples' dignity human rights and cultural uniqueness and so that they receive

culturally compatible social and economic benefits and do not suffer adverse effects during the development process. Space intensive sub-projects such as solid waste dumping sites, wastewater disposal areas and commuter rail stations has a potential for disruption of indigenous people. Improved Social and economic systems across the metropolitan leads to potential intrusion to existing cultures. This safeguard is not triggered in this project.

3.4.7 OP/BP 4.09 (Pests Control Management)

The policy is meant to minimize and manage the environmental and health risks associated with pesticides use and promote and support safe, effective and environmentally sound pest management. The safeguard is not triggered under this project.

3.4.8 Activities Triggering World Bank Safeguards

The schedule below justifies the extent to which the World Bank safeguards apply to the implementation of the proposed project implementation. This implies, further investigations may be necessary to ensure compliance with the World Bank requirements.

Table 4: Safeguards Triggering Criteria

Policy	Criteria in the Project	Discussions
Environmental Assessment (OP 4.01, BP4.01, GP 4.01)	Yes	The project components will trigger EA safeguards and is Category B due to the interaction with the physical, biological and social setting within the immediate surroundings Lake Victoria ecosystems and neighbouring communities
Forestry (OP4.36, GP 4.36)	N0	No forests in the vicinity
OP/BP 4.04 (Natural Habitats)	Yes	Limited linkages to Lake Victoria ecosystem.
Involuntary Resettlement (OP4.12, BP 4.12)	No	No displacements of people are anticipated
Physical Cultural Resources (OP/BP 4.11)	No	No cultural features
Indigenous Peoples Policy OP/BP 4.10	No	No indigenous peoples
OP/BP 4.09 (Pests Control Management)	No	No linkage to agricultural activities

This report is prepared in compliance to NEMA guideline and WB safeguard policies

3.5 Institutional Structure of the Water Sector

The National Policy on Water Resources Management and Development and the Water Act 2002, presently guides water resources management. The overall goal of the national water development policy is to facilitate the provision of water in sufficient quantity and quality and within a reasonable distance to meet all competing uses in a sustainable, rational and economical way. This policy separates policy formulation, regulation and services provision and defines clear roles for sector

actors within a decentralized institutional framework and includes private sector participation and increased community development.

Under the policy, the Ministry in-charge of Water is responsible for policy development, sector co-ordination, monitoring and supervision to ensure effective Water and Sewerage Services in the Country, sustainability of Water Resources and development of Water resources for irrigation, commercial, industrial, power generation and other uses. The Ministry executes its mandate through the following sector institutions:

3.5.1 Water Services Regulatory Board (WASREB)

The regulatory Board is responsible for the regulation of the water and sewerage services in partnership with the people of Kenya. The mandate of the regulator covers the following key areas;

(i) Regulating the provision of water and sewerage services including licensing, quality assurance, and issuance of guidelines for tariffs, prices and disputes resolution.
(ii) Overseeing the implementation of policies and strategies relating to provision of water services licensing of Water Services Boards and approving their appointed Water Services Providers,
(iii) Monitoring the performance of the Water Services Boards and Water Services Providers,
(iv) Establish the procedure of customer complaints,
(v) Inform the public on the sector performance,
(vi) Gives advice to the Minister in charge of water affairs.

3.5.2 Water Resources Management Authority (WRMA)

The authority is responsible for sustainable management of the Nations Water Resources;

(i) Implementation of policies and strategies relating to management of water resources,
(ii) Develop principles, guidelines and procedures for the allocation of water,
(iii) Development of Catchments level management strategies including appointment of catchments area advisory committees,
(iv) Regulate and protect water resources quality from adverse impacts,
(v) Classify, monitor and allocate water resources.

3.5.3 Water Services Trust Fund (WSTF)

This body assists in the financing of the provision of Water Services to areas of Kenya that are without adequate water services. This shall include providing financing support to improved water services towards;

(i) Capital investment to community water schemes in underserved areas
(ii) Capacity building activities and initiative among communities
(iii) Water services activities outlined in the Water Services Strategic Plan as prioritized by the Government
(iv) Awareness creation and information dissemination regarding community management of water services
(v) Active community participation in the management of water services

3.5.4 Water Services Boards (WSBs)

The WSBs are responsible for the efficient and economical provision of water and sewerage services in their areas of jurisdiction. Lake Victoria South Water Service Board (LVSWSB) is among the seven catchment Boards established with the mandate to;

(i) Develop and rehabilitate water and sanitation infrastructure
(ii) Maintain water and sanitation assets for the Government
(iii) Monitor service provision
(iv) Sourcing of water and sewerage funding
(v) Assurance of water quality
(vi) Handle complaints and complements from clients and customers
(vii) Appointing and contracting Water Service Provider

3.5.5 Water Services Providers

Water Service Providers are the utilities or water companies. They are state owned but have been commercialized to improve performance and run like business within a context of efficiency, operational and financial autonomy, accountability and strategic, but minor investment. Kisumu Water and Sewerage Company (KIWASCO) has been contracted to provide these services in Kisumu City and its environs and has the following responsibilities;

Water Services:
(i) Bulk water sales
(ii) Water treatment
(iii) Water sampling for quality guarantee
(iv) Laboratory water quality
(v) Daily surveillance of water pressure to ensure reliable supply to consumer
(vi) Maintenance of water service lines
(vii) Connections of grid water and opening accounts for new customers
(viii) Notifications of water interruptions

Benefits
- Affordable water prices to all consumers
- Clean high quality water
- Professional services
- Quick response to customer needs and complaints
- Convenient and reliable water supply

Sewerage Services
(i) Sewage treatment and disposal
(ii) Unblocking sewer lines
(iii) Repair burst sewer lines

Benefits
- Effective disposal of sewage into environment in a friendly way
- Quick response to unblocking sewer lines
- Maintenance of sewer lines

3.6 NEMA Compliance

The government established the National Environmental Management Authority (NEMA) as the supreme regulatory and advisory bodies on environmental management in Kenya under EMCA 1999. NEMA is charged with the responsibility of coordinating and supervising the various environmental management activities being undertaken by other statutory organs. NEMA also ensures that environmental management is integrated into development policies, programmes, plans and projects.

3.7 Sectoral Integration

This integration encourages provision of sustainable development and a healthy environment to all Kenyans. The key functions of NEMA through the NEC include policy direction, setting national goals and objectives and determining policies and priorities for the protection of the environment, promotion of cooperation among public departments, local authorities, private sector, non-governmental organizations and such other organizations engaged in environmental protection programmes and performing such other functions as contained in the act.

Other stakeholder authorities include the Ministry in-charge of Water Resources, Ministry in-charge of Environment and Natural Resources, Ministry in-charge of Health and Sanitation, Ministry in-charge of Local Authorities, Ministry in-charge of Lands and Settlement, Ministry in-charge of Social and Cultural Services as well as the Provincial Administration. Others are the Kisumu County Government, Kisumu City Management and KIWASCO as well as key groups working with the beneficiary communities in the respective areas.

3.8 Project Management Institutional Structure

An ideal project management structure is proposed for the organization in this project has the following components;

3.8.1 Contractor

The contractor will be required to establish an environmental office to continuously advise on environmental components of the project implementation. Elements in the environmental and social management plan are expected to be integrated in the project with appropriate consultations with the key Stakeholders involved through the supervising environmental expert. The environmental officer of the contractor is also expected to fully understand the engineering and management aspects of the project for effective coordination of relevant issues.

3.8.2 Supervisor

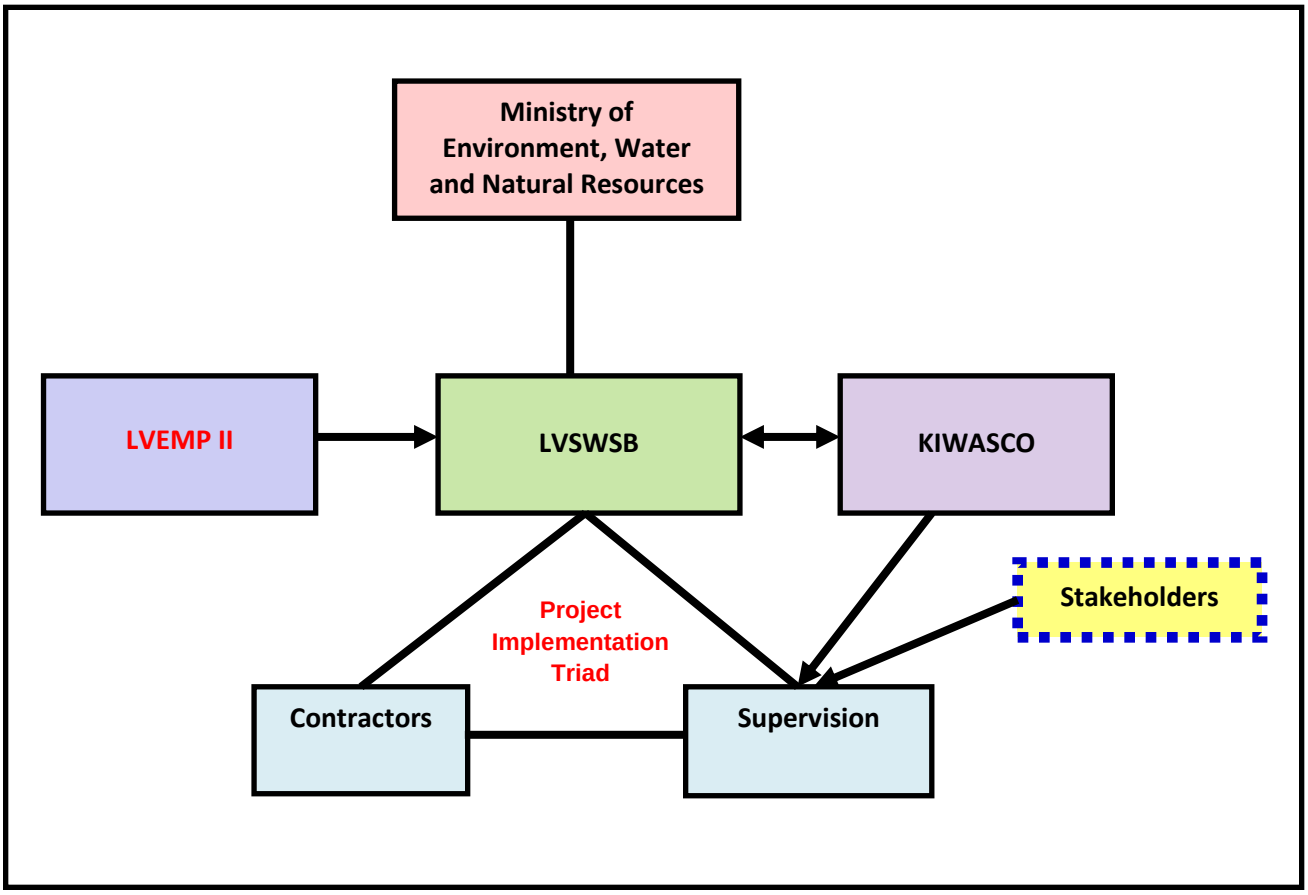
The supervisor will be engaged to ensure effective implementation of the environmental management plan. It is expected that supervisor engages the services of an environmental expert who should in return understand the details of the recommendations on environment management and especially the proposed action plans, timeframes and expected targets of the management plan. The environmental supervisor expert should also be the liaison person between the contractor and the Client on the implementation of environmental concerns as well as issues of social nature associated with the project.

3.8.3 Environmental Management Section

This Section established within the Client framework to facilitate compliance of water projects with appropriate environmental regulations. The office is expected to advise the projects on environmental compliance and is also provide a direct liaison with NEMA. Reports on the project implementation should reach this office directly from the contractor and stakeholders or through the supervisor while on the other, NEMA and other environmental stakeholder are expected to raise environmental issues related to the project through the same office. The office, therefore, is expected to be well informed of all project related issues at all times during the implementation and operations.

3.9 Project Implementation Structure

Figure 6: Project Implementation Responsibility Linkages



Chapter 4: Environmental Setting

4.1 Overview

The physical and biological conditions of Kisumu City and its environs are influenced by a combination of factors. The highlands to the north (Nyakach escarpments and Kajulu hills as well as the Nandi Hills far to the northeast) gives Kisumu the much desired shelter from strong winds. The flat low lying areas of Kano Plains (Ahero and Chemilil areas) though flood prone buffers the city from otherwise strong surface runoff from the hills. Finally the presence of Lake Victoria on the southern edge of Kisumu City give its ecological importance as well as climatic moderation. The city stands on a hump rising above the low lying surroundings taking advantage of potential flooding risks while still providing suitable and safe shoreline where various social and economic features stands. The following sections briefly describes the physical features identified with Kisumu city and its surroundings.

4.2 Topography

The topography of the project site are influenced by the steep hills to the north and the lake Victoria to the immediate southwest of the site location. The area rises from a low of 1,144ma.s.l. at the Lake shores to a high of 1,500m.a.s.l on the highlands. This implies a gradual slope towards the lake and the low lying flats to the east. Other the hills to the north, the rest of the areas are generally flat.

4.3 Water Resources

Lake Victoria, a world renown fresh water body is the largest water source in the area. It supplies most of the social, institutional and commercial water requirements in the area as well as being a transport media between towns within the region as well as across the border in Uganda and Tanzania. Other water sources include rivers and streams including Kisat river, Kibos, Nyamasaria, Kisian, Kajulu, Mamboleo, Luanda and Lidango among other season streams. Due the high water table (2.5m – 3m), ground water is also available around the city (shallow well and boreholes) located in various residential and institutional areas.

Water supply, however, has primarily focused on the surface water mainly because ground water is prone to contamination from insufficient provision of drainage systems and surface runoff. In the informal settlements the residents mostly rely on water kiosks, handcart vendors and boreholes for water supply though, the reliance on the shallow wells and boreholes in these neighborhoods is challenging because water from these sources is of poor quality due to possible contamination from the various point sources like the overflowing pit latrines during the rainy seasons as well as significant number of carwash points set up on the shores of the lake for instance at Kichinjio beach which have adversely deteriorated the quality of the water from pollutants such as oils spills and chemicals.

Kisumu is faced with acute water shortages and only 40% of its population has access to piped water. Informal settlements suffer the most from this inequitable water provision with over 60% of slum/residents obtain their water from unsafe sources, resulting in high rates of water and sanitation related disease and morbidity. Many slum dwellers are forced to buy water from kiosks, usually paying higher prices than in middle and high income areas. The existing water resources are highly polluted mostly by fish traders who dump their waste into the streams. Also washing of cars in the streams contributes to the pollution of the resources

Figure 7: Sections of Kisat River

4.4 Hydrology and Drainage

Like the topography, hydrology of the area is also influenced by the highlands to the north and Lake Victoria. All rivers and streams arising from the highlands flows towards the lake shores . However, due to the flat nature of the areas, the flows are moderated to the extent that at high flows, there is potential for flooding conditions. Nyando River rising from Nandi Hills discharges into Lakve Victoria just south of Kisumu City and influences the surface hydrology in that area. Kisat on the other influences the surface hydrology on the western zone of the city.

The drainage and hydrology around the project site is influenced by Lake Victoria. The site grounds are susceptible to flooding due to the gentle topography but the presence of the structures tends to create flood-free zones around the sites blocking natural drainage into the lake. This flooding does not only complicate accessibility to the perimeter safety road, but also a potential risks to the stability of the runway in the long term.

4.5 Waste Management

The City of Kisumu is estimated to generate between 250 – 300 tons of solid wastes daily from a population of about 600,000 people over an area of approximately 400km^2. At the moment only about 35% of this waste is collected for appropriate disposal. The City has a centralized waste disposal site (Kackok dump site) located in Manyatta near the Kisumu Stadium (adjacent to the commercial centre where Nakumatt is). Whereas it would be expected that all solid wastes is brought to this location, the city lack a strategy to provide waste pathway mechanisms and compel waste generators deliver their wastes accordingly. For this reason there are numerous informal solid waste collection points around the city (even with the provision of waste collection skips).

Waste collection is carried out by a number of agents who collect approximately 36.4% of total waste produced per day, the study indicates. The frequency of collection ranges from daily (33%), weekly (38%) and fortnightly (2%). The individual households still undertake most (63.6%) of the collection, which is often disposed off in open spaces i.e. river banks, roadsides, alleys and undeveloped plots. The Council caters for 13.2% of collection, private companies 11.6%, informal

sector i.e. CBOs, youth and women groups and small scale entrepreneurs 9.6% while recycling about 4%.

Between 60 – 65% of the total amount of waste collected in Kisumu is organic, which presents enormous potential for recycling. Many positive small-scale reuse and recycling initiatives are taking place and these should be further encouraged. There is a need for an environmental awareness campaign educating the residents to take more responsibility for their own waste, as well as to develop broad-based partnerships for waste management. There is no established waste management system in the plant especially waste from the screening section, as a result, the waste ends up in heaps in the compound.

Figure 8: Waste Management Status

Current Kisumu waste dumping site at Kachok

Sample Waste Recycling Initiative

Open Air Burning of Wastes at Kisat Treatment Plant

Grit and solid waste holding area at Kisat Treatment Plant

Regarding wastewater disposal, the quality of the effluent discharging into the environment (Lake Victoria) does not meet established levels. Samples taken of the raw effluent, partially treated, final effluent as well upstream and downstream of Kisat River shows deficiency in oxygen (BOD), high organic matter (COD) and solid matter (TSS) are relat9vely high. The quality is as outlined in the table below;

Table 5: Wastewater Quality

Sampling Location	BOD (mg/l)	COD (mg/l)	TSS (mg/l)
Raw sewage	350	1590	400
Trickling filters output	50	131	60
Discharge point into Kisat river	50	102	20
Upstream Kisat River	150	454	100
Downstream Kisat River	40	131	60
Kisat River discharge into Lake Victoria	60	170	133

This illustrates that though the discharging effluent from Kisat has a high pollutant level, the receiving Kisat river seems to have a higher pollution loading from other sources including residential and commercial areas upstream.

4.6 Geology and Soils

The region is characterized with superficial alluvial soil layer with a down-faulted granites and Kavirodian/Nyanzanian Sediments at intermediate depths. The lakeshores and river mouths have notable depositions of silt and sediment materials brought down by the rivers and surface runoff. On the highlands, the geology comprises of Pre-Cambrian silt with Kavirodian and Nyanzanian sediments. The project area is specifically characterized with black cotton sandy soils with high water retention capacity. The soil is influenced by the long term effects of depositions from the erosion in the hills. It is highly fertile going by the vegetation intensity (no fertility testing was undertaken).

Kisumu County stretches from the Nandi escarpment in the East to the Kano Plains in the middle all the way to the hills of the West. The Kano Plain is perhaps its most famous feature, sporting black cotton soil that is very fertile. The county has several inselbergs, mostly in the Kisian Area. Several rock outcrops also exist in the region, the most famous of them being Kit Mikayi in Seme Sub-county. Kit Mikay consists of several rocks piled onto each other with several caves inside.

4.7 Biodiversity

There is no significant presence of wildlife within and around the airport associated to the high human activities (urban, settlements, institutional and commercial activities. There is, however, potential presence of reptiles (snakes, lizards, alligators associated with the Lake ecology) and rodents (rats and moles among others). There is also heavy presence of various types of bids that are associated with the lake and highland ecologies and also attracted by the social behaviour. Birds are perhaps the most visible wildlife around the project area. Among the common birds species identified during the initial environmental audit include the following;

Common Name	**Scientific Name**
Barn owl	*Tyto Alba affinis*
African Fish Eagle	*Hailiaeetus Vocifer*
Hamerkop	*Scopus U. umbretta*

Hadada Ibis	*Bostrychia hagedash brevirostris*
Cattle Egret	*Bubulcus I. Ibis*
Long-tailed cormorant	*Phalacrocorax A. Africamus*
Black Kite	*Mulvus M. Migrans*
Emerald – spotted wood dove	*Turtur chalcospilos*
Africa morning dove	*Streptopelia perspicillata*
Red-eyes dove	*Streptopelia semitorquata*
Ring-necked dove	*Streptopelia Capicola somalica*
Nyanza swift	*Apus niansae*
Speckled mousebird	*Coluis stritus kikuyuensis*
Speckled pigeon	*Columba guinea*
Long-crested eagle	*Lophaetus accipitalis*
Woodland kingfisher	*Halcyon s. senegalensis*
Grey-headed kigfisher	*Halcyon leucocephala*
Malachite kingfisher	*Alcedo cristata galerita*
Pied kingfisher	*Ceryler rudis*
Africa pygmy kingfisher	*Ispidina picta*
Common bulbul	*Pycononotus barbatus*
Africa paradise flycatcher	*Terpsiphone viridis*
Red-bellied paradise flycatcher	*Terpsiphone rifiventer emini*
Blue-cheeked bee-eater	*Merops percucus*
White-browned robin-chat	*Cossypha heuglini*
Red chested sunbird	*Nectaririnia erythrocerca*
Black headed weaver	*Ploceus cucullatus*
Specke's weaver	*Ploceus spekei*
Black headed gonolek	*Laniarius erythrogaster*
Black-headed heron	*Ardea melanoceph*
Grey heron	*Ardea cinerea*
Green-backed heron	*Burorides striatus atricapillus*
Yellow-billed egret	*Mesophoiyx intermedia*
Little egret	*Egetta garzatta*
Long-tailed cormorant	*Phalacrocorax carbo lucidus*

Figure 9: Birds Attracted to the Site

4.8 Climatic Conditions

Kisumu city and its surroundings have its climatic conditions largely influenced by Lake Victoria while slight moderation is noted from the Nandi hills. Rains are convectional due to the effects of the lake and attain an average rainfall of 1,100mm on the low lying areas including the airport location to 1,650mm in the highlands of Maseno and Nandi hills and are uniformly distributed. The temperatures are generally high (with max. 30^{o}C and min. 20^{o}C. Due to the proximity of a large water body, the humidity is also high (average of 60%).

4.9 Air Quality

The mixer of social, institutional and commercial activity defines the air quality in an urban setting. Kisumu City has similar characteristics with the main air quality components influenced by the transport activities (mainly petroleum residuals and byproducts) and industrial activities including vehicle repair garages. Particulate . Key air quality components include carbon dioxide, particulate matter, carbon monoxide, nitrogen oxides, and sulphur oxides. Particulate matter (dust) arises from road surfaces, factory chimneys and vehicular exhausts. Due to the varying sources of air pollutants, the quality also varies and so are the related impacts especially on human beings. The high dispersal from the winds is likely to maintain the effective air pollutant concentrations very low. The proposed sites are not major emitters of air pollutants.

The air quality around the plant varies with the different stages of treatment of the sewage. At the inlet, the smell is pungent as the raw sewage enters the treatment plant. The smell decreases as the treatment advances. At the discharge point, the smell is barely noticeable as all the microorganisms are removed. However, the discharge river; River Kisat, has a pungent smell from the pollution upstream which is assumed to come from the plant. However, there is a lot of burning taking place in the compound, which affects air quality

4.10 Noise and Vibrations

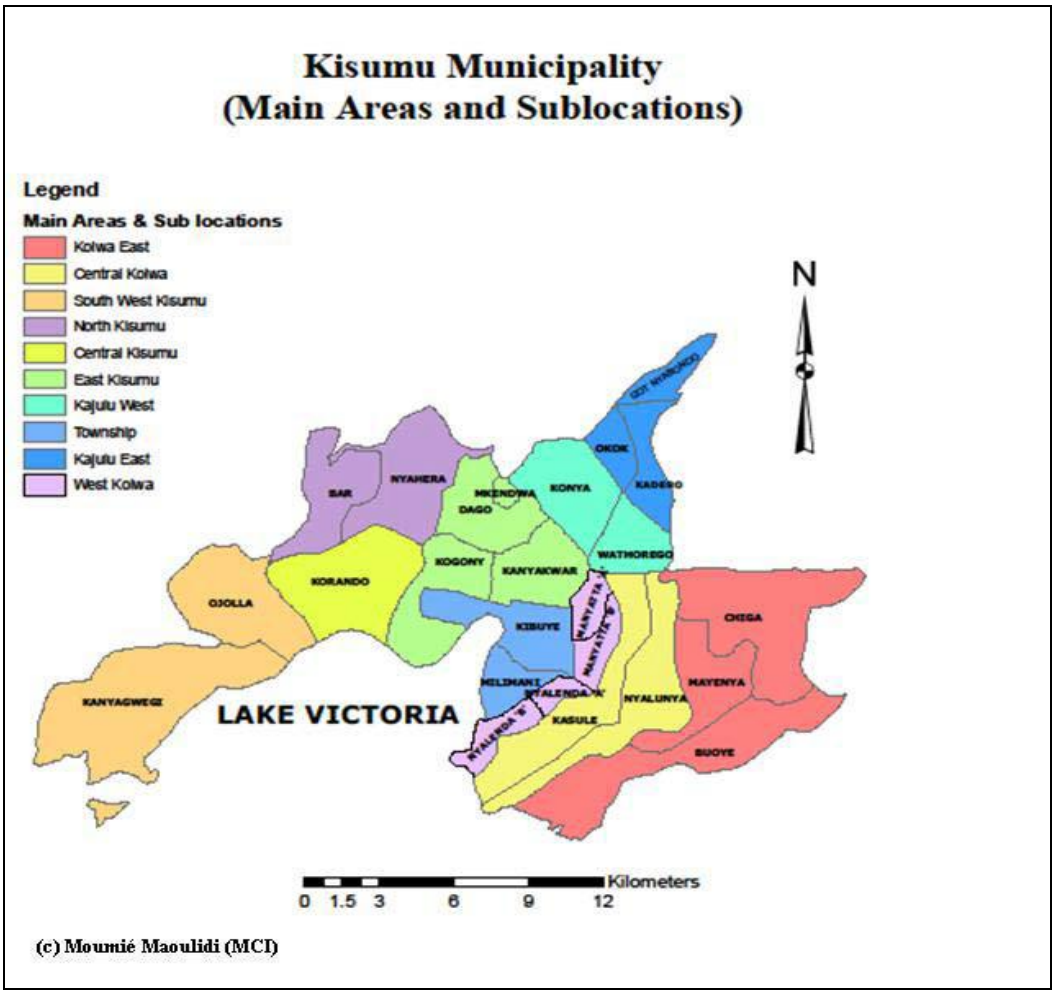
The main noise in Kisumu City arises from the transportation sector, specifically heavy trucks and poorly maintained cars. Barely any noise comes from the plant, as there are not machines that the produce too much noise. Most of the noise and vibrations come from the neighbouring factories and the vehicles using the highway adjacent to the plant

Chapter 5: Social and Economic Setting

5.1 Project Location

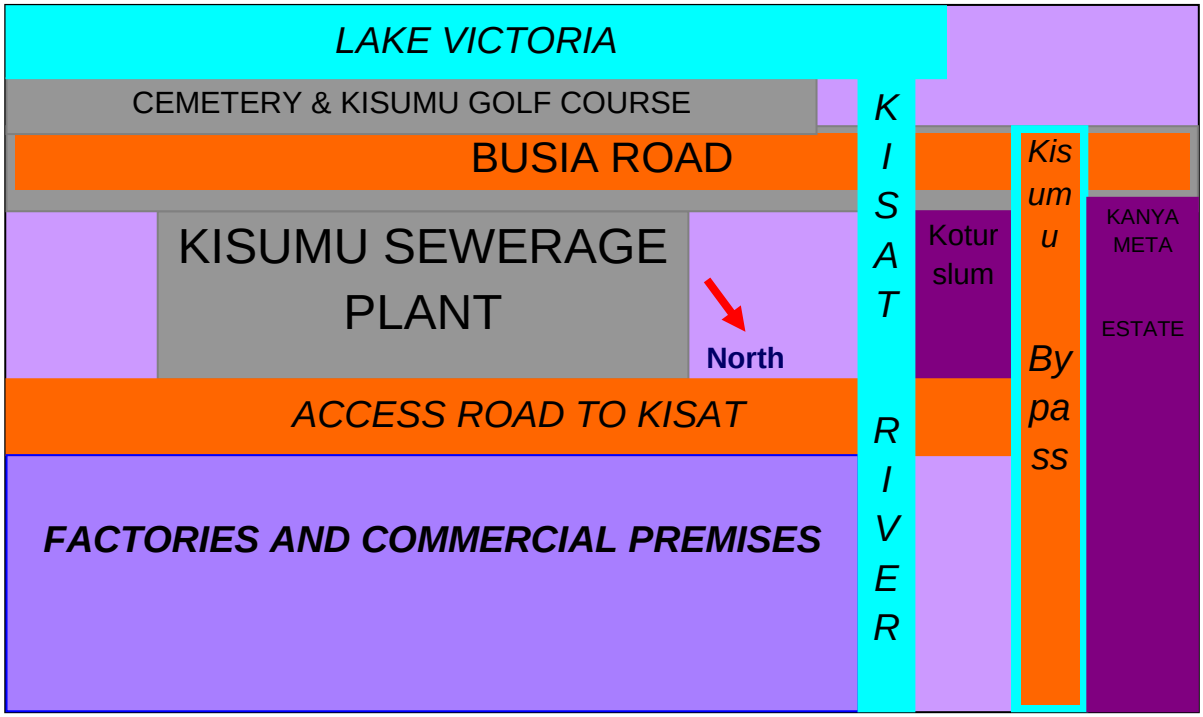
The Kisumu Sewerage Plant is located in Bandari sub-location, Kisumu Town location of Kisumu East sub-county and Kisumu County. Kisumu County is located in Nyanza and constitutes 6 constituencies (Kisumu Town East, Kisumu Town West, kisumu Rural, Nyand, Muhoroni and Nyakach). Kisumu East, Kisumu West and Nyando districts. Politically, the sewerage plant is located in Railways ward of Kisumu central constituency. The railways ward covers Kanyakwar, Bandari and Nyawita Sub–Locations. The administrative map of the project area is as presented in the following figure:

Figure 10: Administrative Units of Kisumu County



To the north, the Kisat treatment plant borders Kisat River and Kotur slums while to the east it neighbours industries and to the south and west, it borders Busia road. Physical and geographic neighbourhood of Kisat treatment plant is presented in the figure below:

Figure 11: Illustration Kisat Sewage Plant Neighbourhoods



5.2 Land and Settlements

5.2.1 Land Ownership and Land Use

In Kisumu County 80% of the land area is predominantly rural in character where those living in rural areas depend entirely on land as the natural resource for subsistence and economic purposes. The mean land holding size in the county is 1.6 acres while the mean agricultural parcel is 1.0 Acres. 78.8% of the land in the County is owned by individuals and is mainly freehold where individual owners have direct influence on pattern of development. 10.7 per cent of it is rented or leased, 4.9 per cent clan/family owned and 0.4 per cent is communally owned. Others are owned by the various local authorities.

With the ever rising population especially in and around the Kisumu City, land use trends is dominated by residential and commercial establishments. For example, areas such as the Kibos which was initially zoned for industrial investment has been taken up by residential users while the Riat hills, initially reserved for conservation, has now become a prime residential investment area. Kisat sewer treatment works stands on government owned land. The land neighbouring Kisat treatment plant is owned by private individuals and companies and has various uses including:

(i) Industrial and commercial establishments to the east;
(ii) Residential slums to the North and;
(iii) Small scale crop growing, tree nuseries and recreation as well as social facilities to the west and south;

The neighbourhood is traversed number of roads, river Kisat and a railway line whose land is government owned. A short distance to the north and northwest is a flight corridor into Kisumu International Airport.

5.2.2 Settlements Patterns and Housing Characteristics

The main wall material for houses in Kisumu county is mud/wood accounting for 49.6 per cent followed by mud/cement 21.2 per cent, bricks/blocks 21.2 per cent and stone houses only account for 3.2 per cent. The main materials for the floor are earth 55.2 per cent; cement 42.4 per cent and tiles 1.5 per cent. Corrugated iron sheet is widely used with over 85 per cent of households using it for roofing. The table below summaries house building materials in the project county:

Table 6: Percentage Of Households By Main Building Materials

House Section	Main Building Materials	Percentage
wall	Stone	4.7
	Brick block	32
	Mud/wood	42.9
	Mud/cement	20.3
	Corrugated iron sheet	0.1
floor	Cement	53.4
	Tiles	1.7
	Wood	1.4
	Earth	43.5
roofing	Corrugated iron sheet	83.1
	Tiles	4.4
	Concrete	0.8
	Asbestos sheets	0.8
	Grass	10.9

Source: *Kisumu County Integrated Development Plan, 2013-2017*

Within the neighbourhood of Kisate sewerage treatment plant, there are owner occupied houses, though largely a majority of the residents pay rent for their shelter. Most of the houses are built with either stone blocks or mud walls, iron sheets and wood roofs. Majority of homes, especially in Kotur slum, have single dwelling house while the rest have two to over four housing units per plot.

Figure 12: Settlements within Kisat Wastewater Treatment Plant

5.3 Population

According to the 2009 Population and Housing Census, Kisumu County had a population of 968,909 persons with 474,687 males and 494,222 females. The County's population is projected to reach 1,098,560 (538,231 males and 560,329 females) by 2015 and 1,145,747 (561,351 males 584,396 femsles) by 2017. According to the 2009 population census, Kisumu East, the project host sub-county had a total population of 474,649. Politically, the Kisumu Central constituency had a population of 168,892 and the railway ward had a population of 34,924. The sewer plant administrative location and sub-location is as presented in the table below:

Table 7: Population Data of the Project Location and Sub-Location (2009)

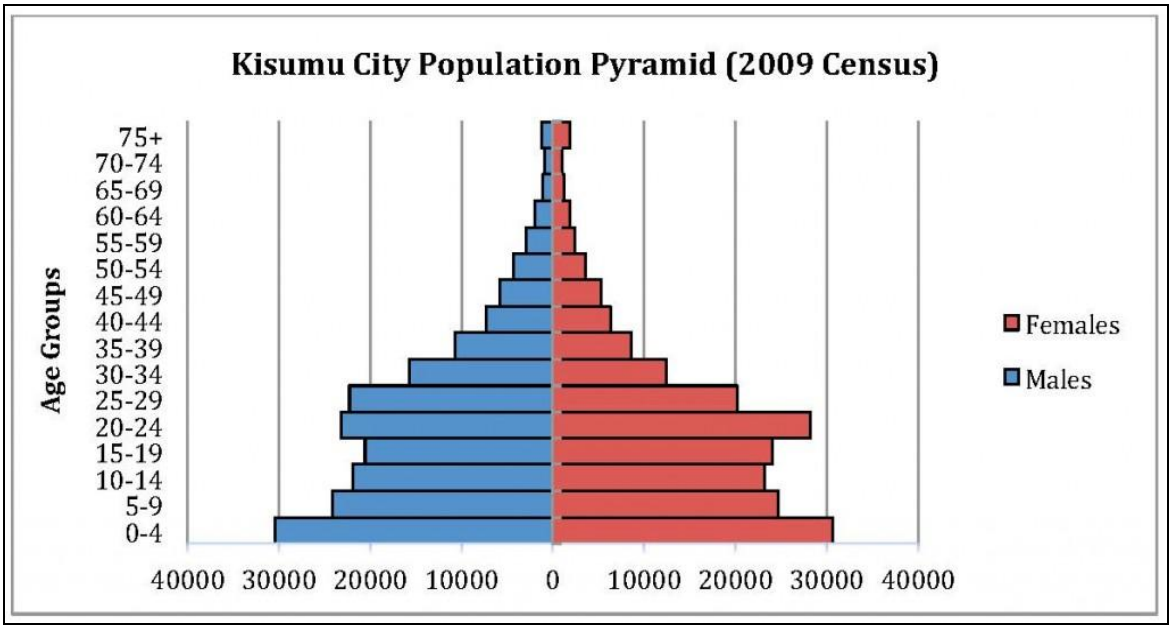
Areas	Male	Female	Total population	Households	Pop. Density
Township Location	20,344	20987	41,331	10,162	2,608
Bandari Sub loc	3,878	3,745	7,523	1,921	1,055

Source: 2009 GOK Population census

Kisumu city experiences a net population immigration flow from the surrounding areas of the Lake Basin namely Nyando, Siaya, Bondo, Suba, Migori, Homa Bay and Rachuonyo. The urban population growth rate for Kisumu is estimated at eight per cent a year. In 2009, Kisumu City had a population of 259,258 in 2009.

A notable characteristic of Kisumu City population is a large number of male and female children under five years old. Residents in the project area are mostly the middle aged, 21 – 70 years with nuclear families being the majority. The proportion of youth between the ages of 10 and 19 is also quite high. The top of the pyramid indicates the impact of mortality on those older than 44 years old.

Figure 13: Population Trends for Kisumu City



It is projected that at an annual population increase of 8%, the city's population will reach 491,893 by 2017. The table 7 below presents the projected population of Kisumu city.

Table 8: Population of Kisumu city

2009			2012			2015			2017		
Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total
131,062	128,196	259,258	166,649	163,005	329,654	211,852	207,220	419,072	248,666	243,228	491,893

Source: Kisumu County Integrated Development Plan 2013 - 2017; September 2013

The high and rapidly increasing population of Kisumu city implies increased sewage generation, which calls for expansion of the sewer plant commensurate with population increase.

5.4 Stakeholders

Stakeholders in Kisumu waste water plant include the public health, KIWASCO, NEMA, Lake Victoria North Water Services Board, Kenya Airports Authority (KAA), Kenya Civil Aviation Authority (KCAA), the private sector and neighbourhood communities including institutions, residents, commercial and industrial operators.

5.5 Economic Activities

A section of Kisat Sewage Treatment Plant premises features a number of staff houses and kitchen gardens growing sugarcane, arrow roots and maize among others utilizing manure from the sewer plant. In addition, manure generated from the sewage treatment is sold to willing farmers at a cost of KShs. 100 per lorry, though consumption is low as a result of cultural and social attitude that this is human waste. The sludge cake is therefore collected and held on a section of the premises and may soon become a challenge for disposal.

The economy of the areas neighbouring the sewage plant is diverse and consists of small scale farming, rental and business buildings, industries and warehouses (Jayfish, East African sea Foods and Delight among others), small scale enterprises, recreation, cemetery and informal enterprises along roads and slums. The economic neighbourhoods are as illustrated in the figure below:

5.5.1 Agriculture

62.10% of all households in Kisumu County depend on crop farming as a source of income undertaken on small parcels of land. Urban and peri-urban farming practices in Kisumu city and within the project area largely include small-scale rain-fed mixed farming, small-scale river irrigation, wetland farming, fish farming and free range livestock keeping. The most intensive agriculture is practised along the lake shore in the lower-lying flood plains of Nyalenda and Dunga, and in the wetlands to the South of the city. Larger plots under agriculture are found along the foothills to the east bordering the peri-urban fringe.

Crop growing is minimal within the project area as much of the land has been taken up by buildings. However, residents practice kitchen gardening while sizeable farming is undertaken along road reserves and river Kisat. Workers in the waste water plant also undertake kitchen gardening, mainly using the manure generated by the plant. The main food crops produced are maize, Sorghum, beans and cassava. Others are bananas, arrow roots, sweet potatoes, Sugarcane and Green vegetables (kale and indigenous greens).

Numerous tree nurseries have also been established along the Busia road to the west of the project site. The nursery operators produce diverse range of tree for a diverse range of clientele. Facilitated by ICRAF, these operators have been trained in better nursery practices, marketing and entrepreneurial skills and are well equipped to cope with challenges faced in conducting their businesses in the Kisumu urban setting.

5.5.2 Livestock and Fishing

Livestock keeping within Kisumu city is prohibited and any livestock found straying into the town is arrested and owners charged. There are however poultry kept in the project neighbouhood. Other animals kept include dogs and cats.

Fishing is one of the key economic activities in Kisumu County most of the fish harvesting taking place in Lake Victoria. With the advent of fish ponds, households are investing in the Ponds. Fishing is the main alternative activity that provides an exit option for local communities when they cannot access employment opportunities and/or when local farming activities are depressed. Men dominate in the physical removal of the fish and women basically does the sales. The common fish species catch being Oreochromus Osculentus (Ngege), Catfish (mumi), Nile perch, Omena, and Protopterus acthiopus (kamongo).

5.5.3 Trade and Finance

Kisumu City is the headquarters and the main commercial base of Kisumu County. The County has 31Trading centres. The main trades in Kisumu city include manufacturing; wholesale and retails (Hypermarkets and Supermarkets) as well as kosks (light or temporary construction); Hotel and lodgings; hawking and; transport (e.g boda bodas) and other services.

The main financial institutions in Kisumu city include Kenya Commercial Bank, National Bank of Kenya, Standard Bank, Barclays Bank, Equity Bank, Diamond Trust Bank, Family Bank, and Cooperative Bank among others. In addition, there are Savings and Credit Cooperatives (SACCOs) as well as a number of microfinance institutions namely: Faulu Kenya, Kenya Women Finance Trust among others. Within the project area, the dominant trade is hawking and retailing. These small scale enterprises get supplies from Kisumu town with minimal dependence on the neighbouring communities. They serve workers from factories/industries, pedestrians as well as the sewer plant workers. The main commercials include M-pesa and KCB mtaani agents among others.

5.5.4 Tourism

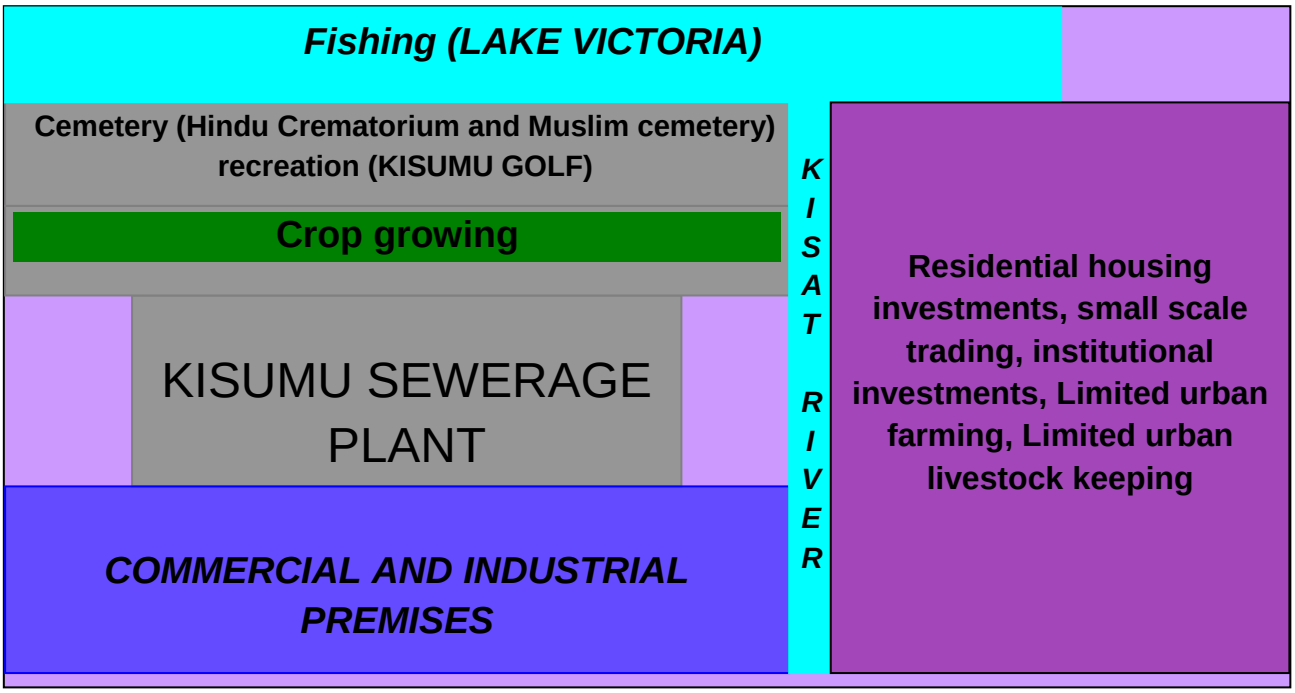
Kisumu City lies in the Western Kenya tourism circuit where the major tourist attractions sites are around the lake. The city is well served by national and international trunk roads as well as Kisumu International Airport. The city also has high-class hotels and lodges including Kisumu Hotel, Sunset Hotel, Imperial hotel, Jumuia Guest House, Great Lakes Hotel and Lasavana Hotel among others. The main tourist attractions in the city include Lake Victoria scenery and aquatic life, the Kisumu Impala Sanctuary, Kisumu Museum, Rich folk tales and songs, an easily assimilative culture and friendliness of the people. In addition, there are also diversity of landscapes, wildlife, culture and the many beaches along Lake Victoria; camping sites, water sports and tourist resorts among others.

Figure 14: Hippos in Lake Victoria at Kiboko Bay

Source: Kisumu County Integrated Development Plan, 2013-2017 27

The main tourism facilities in the neighbourhood of the sewer plant include hotels and lodges, recreation sites notably the Kisumu golf club and lake Victoria (for scenery as well as boat riding and fishing) as well as the scenic hills to the north of the project site.

Figure 15: Illustration of Economic Activities Around the Plant



These small scale enterprises get supplies from Kisumu town with minimal dependence on the neighbouring communities. They serve workers from factories/industries, pedestrians as well as the sewer plant workers.

Figure 16: Sample Economic Features

Industrial Premises Neighbouring Kisat Wastewater Treatment Plant

5.6 Welfare Indicators

Kisumu city hosts the Millennium City Initiative (MCI) Programme and is expected to capitalize on new opportunities by designing social and economic development strategies and attracting the foreign direct investment necessary to create jobs, stimulate domestic enterprise through value addition on rural agricultural production and increase prosperity.

5.6.1 Poverty and Income Levels

Over 60 per cent of the population in Kisumu County are poor compared with the national average of 46 per cent as at 2006. Poverty levels are higher in the urban areas (70 per cent) compared with rural (63 per cent). Kisumu East Constituency contributes 0.9% to the National poverty and 62% of its population live below the poverty line.

Poverty in Kisumu city is characterized by the high percentage of households in the informal settlements, inaccessibility to affordable healthcare, the high rates of unemployment, low agricultural production, high rate of school drop outs and high prevalence rate of HIV/AIDs, malaria, and other diseases e.g. cholera. The main causes of high poverty within the project area include HIV and AIDS pandemic, unemployment, low agricultural and fish production, poor water and sanitation systems as well as diseases.

5.6.2 Education

Education is an essential facet in the development of the human capital which in turn translates to increased productivity of labour per capita. Kisumu County has 997 ECD centres, 655 primary schools, 158 secondary schools, 3 universities, 1 national polytechnic and one medical training in addition to a number of private institutions. The literacy levels in the county are fairly high with 83.1% being able to read and write. The school drop out rate in Kisumu city stands at 4.3%

Majority of the institutions of higher learning are concentrated in Kisumu City and include Maseno University, Great Lakes University (private) and various accredited colleges including Kenya Institute of Management (KIM), Kenya Medical Training Centre (KMTC), Kisumu Polytechnic, Kisumu, Ramogi Institute of Science & Technology and Tom Mboya Labour College.

5.6.3 Health

Several institutions that are either private or government funded provide health services in Kisumu County. The Infant Mortality Rates for Kisumu County is medium, at 95/1000. The under five mortality rates for the county are 149/1,000. Life expectancy in Kisumu is 49 years with Females having a higher life expectancy (50 years) than males (47 years) where Death rate stands at 29 per 1,000.

The location of Kisumu County puts it in major breeding ground for mosquitos, and malaria has been a perennial problem since time immemorial. Another health problem that majorly affects the county is the relatively high rates of HIV infection. But the rate has stabilised recently. Prominent health facilities in the county are Jaramogi Oginga Odinga Teaching and Referral Hospital (popularly known as Russia since it was built by the Soviets), the Kisumu District Hospital and the Aga Khan Hospital Kisumu. There are cases of typhoid due to lack of clean drinking water and poor waste treatment methods.

5.6.4 Sanitation and Hygiene

Sanitation in Kisumu is not well organized – the refuse collection efficiency is a mere 20%. High Income neighborhoods have their refuse collected whereas slums are largely neglected. Kisumu also has only 10% sewerage coverage. The majority of slum dwellers are forced to rely on pit latrines that are overused and not adequately maintained. The County Council of Kisumu struggles with a lack of refuse collection facilities and low operational efficiency. Many dumpsites are next to residential houses, causing health problems and intolerable living conditions.

Figure 17: Status of Sanitation and Hygiene at Kisat

PPE Provision

State of Toilets and Bathrooms at Kisat Site

5.7 Public Services Infrastructure

Public infrastructure in the area include tarmac as well as earth roads and communication. Among the features include the following;

(i) Roads including access roads. The main roads (Busia road and city road network) are mainly bitumen surface) while access roads are gravel and earth surfaced across the City of Kisumu, Other transportation infrastructure include the railway line running a short distance from Kisat Plant as well the Kisumu International Airport located about 5km west of Kisat Plant.
(ii) Water supply network with distribution pipelines from the Dunga Water Treatment Plant and reservoirs,
(iii) Sewer network linking the served areas of the city to either Nyalenda sewage ponds or into Kisat Treatment Plant,
(iv) Communication network including overhead telephone lines, underground fiber optic cables, etc.
(v) Power distribution network (overhead and underground cables)
(vi) Surface runoff drainage systems for the city (through not well defined in most areas)

Figure 18: Sample Infrastructure

Sample Access Roads

Water Pipelines and polluted Kisat River

Ongoing Bypass Road Construction

5.8 Cross Cutting Issues

5.8.1 Gender

Gender issues are important aspects in sustainable development and poverty reduction. Gender disparity in Kisumu East District is characterized by a situation where women bear disproportionately large share of both domestic and agricultural work. The main decision makers at the household level are male. In some cases, the female, in female headed households as well as both partners may make decisions. The main areas of gender disparities in Kisumu are:

(i) Women are faced with inhibitive cultural norms such as traditional divisions of labour, lack of access to land and property, wife inheritance, exclusion of women in decision-making and restriction on family inheritance.
(ii) Women and the youth have less access to resources and limited enjoyment of socially valued goods, opportunities and rewards right from childhood.
(iii) The HIV/AIDS prevalence rate among women is higher than the male prevalence rate owing to their socio-economic and biological reasons.
(iv) The literacy rate among men stands at 85% against the female rate of 81.4%.

(v) Employment levels are skewed against female. The employment levels for the males are 89.4 per cent while for the female is 85 per cent relative to their labour force. This is due to lack of relevant skills and knowledge required by the employer.

(vi) The female are not as energetic as their male counterparts thus the employers preference of the male to the female especially in the construction, jua-kali and transport industries. Culture also tends to favour the male against the female.

5.8.2 Social and Cultural Setting

The area is dominated by the Luo tribe consisting of various sub-tribes. However, there are a number of people from other ethnic groups notably the Luhyia and Kisii who mainly reside here and commute to work. The Social audit revealed that community participation in activities of the sewer plant is low as they considered the plant unhygienic. The neighbourhood community's right and opportunity to participate in the management of the sewage plant ensures ownership of the efforts and will enhance sustainability of the facility.

5.8.3 HIV/AIDS and Other Communicable Diseases

According to the National HIV Surveillance Report 2010, the national prevalence rate stands at 6.3% while in Kisumu County, it stands almost double at 11.2%. However, in Kisumu city, the HIV/AIDS prevalence is quite high at 15% compared to the rural areas where it stands at 8%.

Women are infected at relatively younger ages than men and tend to have much higher HIV prevalence rates than men (KDHS, 2008). The causes for women having higher HIV infection rates is that they tend to have older partners. Men may have lower HIV prevalence rates because male circumcision significantly reduces the risk of HIV acquisition in young men (Bailey et al., 2007).

The impact of high HIV/AIDS prevalence have included high drop out of school to either care for the sick or their young siblings. The key stakeholders in HIV/AIDS include the National AIDS Control Council (NACC), the Ministry of Health, Social Services Department, and NGOs such as AMREF Maanisha Programme, Plan International, APHIA II Nyanza, World Vision, Christian Children Fund, ADRA and others, and the private sector e.g Marie-Stoppes Kenya (Jiokoe Project).

Chapter 6: Stakeholder and Public Consultations

6.1 Overview

It is recognized that public consultations is an important process in ESIA studies as it ensures stakeholder involvement and creates a sense of responsibility and commitment towards a project. Under this ESIA for Kisat sewer treatment plant, public consultations are aimed at ensuring that all stakeholders are consulted and effectively involved with the project proponents. In addition, the consultations aim at ensuring that all relevant and accurate information is provided and disclosed by the proponent to those who may be affected during and after project implementation. These objectives were achieved through rapid interviews and consultative public discussions. These activities created awareness of the project and its implications on the community members thereby preparing them for eventual results.

6.2 Participation of Consultative Public

Stakeholder consultations for the proposed rehabilitation project were conducted in order to capture the major concerns associated with the project from all stakeholders. The consultations was carried out in two phases, i.e. rapid interviews followed by public participation during a detailed stakeholder consultative meeting. Interactions during the first phase was used to identify key stakeholders and to mobilize for the detailed consultation forum. The Stakeholders consultations were held on the 14th January 2014 at the Kisat Sewerage Treatment Plant. The meeting was attended by representatives drawn from the local community, public organizations and community groups among others. Among the specific organizations included (Full list of invited participants is in annex);

(i) Lake Victoria Environment Management Project 2 (LVEMP II),
(ii) Kisumu Water and Sewerage Company (KIWASCO),
(iii) Lake Victoria Commission (for East African Commission),
(iv) National Environment Management Authority (NEMA),
(v) Kenya Airport Authority (KAA),
(vi) Lake Basin Development Authority (LBDA),
(vii) Local groups and organizations (Water Resources Users Association WRUA)),
(viii) Government Agencies and the
(ix) County Administration.

The stakeholder consultative meeting provided views, opinions and suggestions on the most appropriate considerations on the construction and use of the proposed project. The outcome of deliberations during this meeting is presented under the following topics.

6.3 General Views

The stakeholder discussions, it revealed that many were not aware of the activities of Kisat treatment plant nor of proposed project. Rather, the plant was viewed to be a nuisance always producing foul air while the proposed expansion was seen to require extra land and therefore lead to displacement of some persons.

6.4 Emerging Issues

(i) There have been numerous rumours making rounds that the rehabilitation project will displace people around Kisat Sewage Treatment Plant. Through the stakeholder

meeting however, these romours were dispelled and efforts will be made to ensure the correct status is known by all the residents through awareness creation.

(ii) The rehabilitation project is expected to enhance the wellbeing of the people through improved sanitation and hygiene (especially if connectivity is increased) as well as possible interventions at the micro-sanitation level,

(iii) Sewage treatment at Kisat Sewage Treatment Plant provides manure from human waste to willing farmers at low prices. This will be enhanced alongside health considerations as well as education and sensitizing the users;

(iv) Some residents dispose human waste into river Kisat or nearby bushes due to lack of sewer reticulation, cultural as well as poor housing conditions.

(v) There were feelings the cost of sewer connections might be prohibitive hence compromising on the desired benefits to the low income areas,

(vi) In addition, house owners exhaust and discharge raw sewage from their septic tanks into open drains and subsequently into Kisat river and Lake Victoria risking the health of the residents especially young children. The affected areas include Bandari slums.

(vii) It was appreciated that the water from the treatment works is cleaner than that along river Kisat owing to disposal of industrial waste, traditional beer brewers along the river and indiscriminate human waste disposal. The Kisat WRUA therefore undertook upon itself to enhance cleaning of the river Kisat. It is appreciated that the project will enhance environmental cleanliness especially foul air

6.5 Suggestions and Recommendations

During the consultative stakeholder meeting, participants raised the following suggestions and recommendations:

(i) The residents, who have been passive on the activities of Kisat should henceforth actively participate. This should be enhanced through mobilization and awareness creation on the roles of the sewer plant vis-à-vis the service users and resident population, further solid waste value addition potential proposals should be included for community empowerment

(ii) There should be no land acquisition and displacement to provide for the project expansion. The proposed wetland should be located far away from the residential quarters and fenced to prevent intruders from interfering with it;

(iii) There is need to construct more sewage management facilities to cater for the ever increasing population of Kisumu city. This will also include provision of sewer service lines and subsidies to households willing to connect.

(iv) In addition, the project should consider supporting the communities by providing ventilated improved pit latrines (VIP) toilets should be constructed along the road, river Kisat and slum areas as part of the proposed project which will enhance the objective of the project;

(v) The youth should be involved in repair of numerous sewer bursts that take long time to be repaired. This should be considered and recommendation by KIWASCO,

(vi) There is need to enhance security through organized community policing during construction when construction workers are on site.

(vii) The Contactor should not destroy the existing infrastructures (roads, water lines and sewer line) but enhance their maintenance during. The Contractor should be asked to repair road sections and related bridges used for materials deliveries during the construction as a social responsibility,

(viii) There is need for KIWASCO in conjunction with NEMA to periodically check and enforce against indiscriminate throwing of toilet waste into open drainages

(ix) Employment of the locals should be considered and the community be actively involved by the Contractor during the construction works to enhance harmony and ownership.

(x) There is need to include a conservation component to support the WRUA in implementing the storm water drainage around the project area and its upper catchment.

Figure 19: Stakeholder Consultations

Chapter 7: Anticipated Impacts and Mitigation Measures

7.1 An Overview

Effects associated with municipal wastewater are varied and dependent on two main factors namely the quality of the wastewater and the receptor environmental and social setting. Raw or partial municipal wastewater may contain organic and chemical pollutants in excess of the established standards for effluent disposal into natural environments and also for drinking water. On the other the receiving environments poses different characteristics ranging from supporting aquatic systems, supplying environmental water and water for social and economic requirements.

Kisat River is the recipient of effluent discharging from Kisat Convectional treatment plant. The river arises from the highland to the north of Kisumu City and runs through a densely populated residential estate before picking the plant's effluent and discharging into Lake Vitoria about 3km west of the plant. At the point of the effluent discharge into the river, the river water seems to he already highly polluted from social and economic activities upstream and has no social value. The river seems to be the main pollutant conveyor into Lake Victoria, some previous reports indicating that it is a major contributor to the Lake's water degradation.

In addition to discharging effluent into Kisat River, the sewage treatment plant has other linkages to the local environment and social factors. Surrounded with residential houses on one side, industrial premises on the other and public amenities on the other, impacts levels from operations of the plant will be varied during construction and post-construction. This chapter describes the various impact types and also identifies appropriate mitigation measures.

7.2 Impacts Criteria

The following are the key impact criteria applied during this study,

(i) Pollution loading into Kisat River and ultimately to Lake Victoria,
(ii) Effects to air quality including undesirable odours into the neighbourhoods
(iii) Attraction of birds into the neighbourhoods,
(iv) Extended local impacts from solid waste disposal
(v) Potential risks to health risks to the workers and immediate residents

In order to establish the impacts, the characteristics of the raw sewage, the efficiency of the sewage treatment system and quality of the treated effluent as well as the sensitivity of the receiving environment were considered.

7.3 General Positive Impacts

The following are the perceived impacts associated with the proposed rehabilitation of Kisat Convectional Sewage Treatment Plant.

(i) The rehabilitation of the plan will provide additional capacity to accommodate the revised sewer catchment area,
(ii) Enhance efficiency, especially with respect to internal hygiene and improved treated effluent quality,
(iii) Reduced pollutant loading into Kisat River and subsequently less contribution of pollutants into Lake Victoria,
(iv) Reduced risks to public health in the surrounding areas.

7.4 General Negative Impacts

The broad negative impacts arising from the construction and post construction of the plant will include the following;

(i) Potential temporary disruption of the operations at the plant including switching over,
(ii) Potential dust emissions during the construction activities (earth moving, materials preparation and mobilization,
(iii) Potential elevated noise levels to the neighbourhoods from the construction activities
(iv) Potential safety risks to the road users from heavy trucks delivering construction materials
(v) Increased volumetric sewage discharge into the lake and effectively higher pollutant loading in the event of operational failure.

7.5 Specific Impacts During Construction

The following sections describes in detail specific impacts and appropriate mitigation measures during the construction phase.

7.5.1 Water Quality

(i) Limited discharge of silt into Kisat river and other local drainage system from earth moving during construction,
(ii) Potential discharge of oil residuals into Kisat River and open rains from the construction equipment,
(iii) Disruption of accumulated solid wastes from work areas and washed down into Kisat river and other drains and ultimately into Lake Victoria.

Mitigation Measures

- Isolate solid wastes disrupted from the works during excavations for safe disposal. The wastes should be collected and disposed in approved sites. This include excavated materials from Kisat sewage treatment plant site
- Earth moving and excavations for the construction be carried out considering safety of the river and surface drainage. Control siltation of Kisat river and other surface drains as well as the lake
- Ensure spilt oil does not discharge into water sources including Kisat river and other water sources including the lake. Provide oil spill containment including concrete platform for servicing of construction equipment and holding of scrap oil drums.

7.5.2 Air Quality

(i) Potential air pollution caused by emissions from construction equipment (carbon, hydrocarbons, particulate matter, etc.) – earth movers and excavators, vehicles and trucks,
(ii) Emission of dust from trucks and vehicles accessing the construction areas and camp sites as well as material piling (sand and aggregate).
(iii) Odor from temporary disruption of accumulated solid waste materials at locations of construction including Kisat Sewage Treatment Site. Such impacts may affect the immediate residential houses and commercial premises. Odor will arise from cchanneling of sewer lines and sewage plant rehabilitation works.

Mitigation Measures

- Maintain construction equipment at high operational conditions such as to control emissions into the air.
- Earth moving be done under dump conditions as much as possible to prevent emission of dust into the air,
- Similarly, piled materials (sand and aggregate) should be maintained dump to prevent dust emissions,
- It will be necessary to notify the immediate neighbourhoods on the potential odors during the excavations. The period should, however, be kept as short as possible (odor generation may not be fully eliminated during the period)

7.5.3 Vegetation

No significant removal of vegetation from the sewer routes or the sewage plant sites is anticipated during the construction phase, save for limited removal of grass cover at Kisat Sewage Treatment Plant. Excavations and earth moving, however, will change the local land surface including interference with surface drainage.

Mitigation Measures

- All excavated locations (sewer lines and Kisat Site) should be rehabilitated to the original land form and clear affected surface drains,
- Undertake appropriate landscaping of the Kisat Site to replace lost grass cover and restore beauty.

7.5.4 Health and Safety

(i) Potential road safety risks from construction vehicles and trucks delivering material to the construction sites (especially the access road section linking Kisumu – Busia Road to Kisat Sewage Plant and crossing points of the new sewer lines),

(ii) Potential safety risks to neighbouring communities accessing the construction areas (open sewer channels and excavated sections of the sewage treatment plant site). Affected members would include children, the elderly, the sick and motorists,

(iii) Occupational safety risks to the construction workers (slips and falls, cuts, heat, falling heavy objects, snake bites, etc.) in all points of work,

(iv) Risks of contaminations (food and water) from solid wastes (settlable matter from raw sewage, raw sludge, raw or partially treated sewage) leading to health challenges to the workers and the immediate communities,

(v) Risks of vector diseases to the workers (malaria, bilharzias, etc.) though this will apply equally to the local communities,

(vi) Potential cases HIV/AIDS arising from interactions among the construction workers and the local community members.

Mitigation Measures

- Provide appropriate signage and information along the sewer channels and around the sewage treatment plant for the safety of the workers and community members. Excavated sites and sewer sections should also be provided with barriers on locations with high population and public movements,
- Construction truck drivers should observe due care at all times for their safety and that of the public during the construction. This caution will apply in all areas since the whole project is within the urbanized areas,
- All workers will be provided with personal safety gear (including gloves, nose masks overall and boots etc) and application enforced at all times while at work. This will be the

responsibility of Contractors and will be an important audit item during the construction period,

- Provide first Aid kit at all work areas and site and maintain it equipped, This will be accessible to the workers at all times as part of the occupational health and safety requirements,
- The Contractors should also provide accessibility by the workers to medical services in the event of sickness or accident,
- Provide clean drinking water to the construction workers at all times and encourage enhanced hygiene behaviors by the construction workers and other support staff including the employees attending the sewerage system,
- Provide sanitation facilities for the workers (mobile toilets where necessary would be recommended). This being an urbanized project it will be very challenging for the construction workers to find appropriate sanitation facilities. Mobile toilets would be required for the sewer line works while the facilities at Kisat site should be rehabilitated for use by the workers,
- Initiate HIV/AIDS awareness, prevention and training for the workers and community immediately upon commencement of the project implementation. The Contractors, in liaison with the Supervision Consultant should provide a HIV/AIDS intervention programme to the Client for discussion and then implementation.

7.5.5 Social Impacts

(i) There are potential conflicts on employment opportunities where the local community may demand enhanced engagement as opposed to construction workers sought from elsewhere. Balancing output capacity, local acceptability and professionalism in the construction would be a major challenge to the Contractors,

(ii) The low levels of sewer connections in most parts of Kisumu City is a challenge to the expected support of the project by the local communities who may perceive the sewerage systems (sewer lines and the treatment works) as of no value to them. This situation has potential impacts to the desired ownership of the sewerage system by the local communities,

(iii) There is potential resentment of the construction works by the local communities if the activities becomes a public nuisance. Among the potential nuisance aspects would include health risks from emissions, waste disposal, disrupted sewage treatment and air pollution,

(iv) Part of the expansion and rehabilitation of the sewerage system may directly or indirectly interfere with neighbouring land use activities (though at the moment no conflict is foreseen).

(v) There is potential disruption of services including existing sewer lines, water supply pipelines, underground power and communication cables that may lead to social inconveniences.

Mitigation Measures

- Contractor(s) will be required to employ to the extent possible local labour (especially to enhance benefits to the local youth) without compromising on the quality of their contractual outputs. This will enhance ownership of the sewer system at the lowest level while providing the necessary awareness on sanitation management in the city,
- It is recommended that the new sewer system setting provide more and easy connections for the users, especially those with houses and buildings in the low income areas. This implies that accessible feeder sewer lines will need to be considered as part of the long term interventions,

- Construction works to ensure minimal disruption of existing sanitation provisions including waste management (solid waste disposal and transfer areas) as well as existing sewer lines. Similarly the existing sewage treatment at Kisat site should also not be significantly disrupted.
- Laying of the new sewer lines should not pose significant conflict with the service lines including damages to water pipelines or underground power cables. In this regard, the system design need to establish the services layout to avoid the conflicts.

7.6 Post Construction Impacts

7.6.1 Impacts to Water Quality

(i) Potential discharge of partially treated effluent from the treatment plants into Kisat River, open drainage system and Lake Victoria. Pollution into water sources may include high organic loading, suspended solids and nutrients among others. This is a particular challenge currently facing the Winam Gulf from Kisumu City and other towns around Lake Victoria,

(ii) There are potential raw sewage overflows from the sewer systems (blocked manholes and broken sewer pipes) into open drains and road surfaces. Potential water contamination from sewage overflows will have both environmental pollution risks and the health of the people,

(iii) Surface runoff from parts of the sewer line corridors and the sewage treatment plant and the surrounding areas (risks of washing down of polluting material from the grounds into the water bodies and Lake Victoria),

(iv) Potential contamination of water bodies from the disposal of sludge cake and settlable matter from the raw sewage, mainly associated with the sewage treatment plant (and specifically Kisat Plant).

Mitigation Measures

- Provide emergency measures for potential sewage overflows from sewer systems, including intervention troughs along the affected main surface drains that are likely to receive overflowing sewage. Similar collection trough could also be provided downstream the treatment plants,
- Draw up a monitoring schedule for the treated sewage quality. This should actually constitute an important component of the sewage treatment disposal (sampling at pre-designated locations of the treatment plants and submitting to the laboratory for analysis. Key water pollutants would include organic matter, settlable solids and nutrient residuals,
- Ensure certification of the sludge cake quality before release for re-use by farmers. The sludge cake suitability as a manure may require approvals from the Health, Agriculture and Water Quality Experts. This would ensure safety of the people, crops, soil and water sources,
- Neutralize all solid and grit extracted from the raw sewage before disposal at the sewage treatment plants (especially Kisat facility) and other locations of the sewerage system.

7.6.2 Impacts to Air Quality

(i) Potential odours to the immediate neighborhoods from un-functional clarifiers, digesters and sludge drying bed at Kisat plant. This is also likely at points of sewage overflow along the sewer systems as well as malfunctioning of the stabilization of the sewage lagoons at Nyalenda,

(ii) Dust emission from the site during dry conditions (sweepings and open burning of wastes) into the air with potential for contamination of air and by extension health of the

people. Contaminated areas along the sewerage systems and the treatment plants such as Kisat are potential culprits in this regard. Residents on the windward side of the potential areas are at higher risk,

(iii) Like dust emission, there is possible generation of contaminated aerosols emanating from the effluent processing (e.g. clarifiers, trickling filters, stabilization lagoons and other overflow locations) leading to air pollution and health risks.

Mitigation Measures

- Initiate tree planting around the sewage treatment plants at Kisat and Nyalenda ponds to provide a buffer to aerial emissions (dust and aerosols) and contamination to the air and mitigate risks to public health. The selection of the trees should, consider, environmentally acceptable species (professional consultation in this regard would be necessary,
- Ground sweepings and solid waste handling in all locations of the sewerage system should be done under dump conditions where possible to control generation of dust into the air,
- Avoid open air burning of solid wastes. Consider provision of a suitable controlled burning chute at Kisat Sewage Treatment Plant to cater for dry hazardous wastes. Other general wastes from all locations of the sewerage systems should be transported to designated public disposal sites.

7.6.3 Impacts to Health And Safety

(i) There are potential risks to health of the communities neighbouring and along the sewerage system caused by contamination arising from partially treated sewage, solid wastes and aerial emissions. etc). the risks are associated to potential water contamination, air pollution and handling of related solid materials,

(ii) Air pollution from aerosols generation arising from sewage treatment processes poses risks to the health of residents, especially those on the windward direction of the sewage facilities,

(iii) There are potential risks to occupational health and safety of the sewerage system employees both in the field maintenance and the sewage treatment plants. This will arise from inadequate sensitization and awareness, malfunctioning equipments and lack of personal protection equipment,

(iv) Potential risks to public safety from open sewer inspection manholes (risks of falling into uncovered holes),

(v) There is risk to public health from food crops grown using raw or partially treated sewage. This has been observed in various locations around the city.

Mitigation Measures

- Educate and create awareness among the neighbouring communities associated with the sewage facilities and co-existence with the same, this will be achieved through public awareness campaigns, perhaps tied to other public participation initiatives,
- Public health aspects be enhanced at the community level especially on hygiene practices (boiling or disinfecting water, hand washing principles, food storage, etc.). The Public Health Department need to guide and lead in this initiative through other public participation initiatives,
- Provide all workers with personal protection gear (overall, gumboots, gloves, nose masks and where necessary head caps) and ensure application at all times while at work,
- Rehabilitate and maintain the staff toilets at Kisat site site (that are currently disused) and also new facilities at Nyalenda ponds for the workers,

- Rehabilitate and maintain the staff bathrooms at the Kisat site (have not been in use for a long time) as well as at Nyalenda ponds for the workers. Taking a shower at the end of every shift should be made a basic rule for all workers at the plants,
- Provide necessary toiletries including disinfectant soaps to the staff.

7.6.4 Impacts to Vegetation Cover

(i) The site and other points with potential sewage overflow will potentially encourage vegetation overgrow including grass and shrubs with potential attraction of birds shakes and other undesirable animals.
(ii) Trees are a necessary air pollution buffer especially around the treatment plants, though at the moment tree population is low.
(iii) There is adequate grass cover at both sewage treatment facilities, an ideal situation to control contaminated dust and surface runoff.

Mitigation Measures

- Maintain low grass cover at the site and other locations with potential sewage overflow to keep away rodents. The maintained grass cover is also ideal for control of contaminated dust emission and surface runoff,
- Tree planting would be ideal around Kisat Treatment Plant and indeed Nyalenda Treatment lagoon to act as a air pollution buffer.

7.6.5 Impacts to Biodiversity

(i) There is a possibility of birds attraction to the sewage treatment plants arising from proliferation of insects and aquatic flora suitable for birds food. Certain species and population of birds at Kisat Sewage treatment plant could become a safety risk to the flight path (a short distance to the north), especially if the constructed wetland is realized. Nyalenda Sewage Lagoons, however are far from the flight corridor,
(ii) Certain animals including crocodiles and hippos may encroach the sewage treatment plants and other areas arising from overgrown vegetations. This will not only be a nuisance to the plants' operations but also pose safety threats to the immediate residents and commercial premises,
(iii) The sewage discharging from the treatment plants (as well as other discharges from sources) are a determinant of the macro and micro flora and fauna in Lake Victoria. Excessive nutrients will lead into increased eutrophication of the lake waters while chemical and organic loading will reduce the capacity for the lake waters to support life (low oxygen levels and toxic conditions).

Mitigation Measures

- LVSWSB and KIWASCO will ensure continuous consultation with the Kenya Civil Aviation Authority (KCAA) and the Kenya Airports Authority (KAA) on any potential risks of birds to the aviation operations for necessary corrective and preventive actions,
- The sewage treatment plants should be protected from wildlife encroachments by providing secure barriers to keep off the animals from interfering with the plant operations and safety. This will also ensure safety of the residents,
- In the event of larger wildlife e.g. hippos and crocodiles, LVSWSB and KIWASCO will ensure appropriate consultations with the Kenya Wildlife Services (KWS) on appropriate management actions,
- The quality of the discharging sewage into Lake Victoria will be an important parameter on the regional control of the lakes eutrophication. Continuous generation and sharing of sewage quality data on pre-scheduled monitoring programmes will be necessary.

7.6.6 Disposal of Solid Wastes and Sludge Cake

(i) There are potential health risks to the workers and farmers using the sludge cake obtained from Kisat sewage treatment plant, if the material is not well neutralized. The same situation applies for other materials disposed off-site from other parts of the sewerage system,

(ii) There are potential risks of soil contamination from application of sludge cake obtained from the Kisat Sewage Treatment Plant if not well neutralized. This also applies to other solid materials disposed off from the sewerage system,

(iii) There are also potential risks to sources of water within and around areas of application of sludge cake on farmlands. This will include groundwater (shallow wells, springs and boreholes) and surface sources (streams, wetlands and rivers).

(iv) There is potential risk to public health 9internally and externally) from the current solid waste handling at Kisat Plant. Grit materials are currently intercepted from raw sewage and strewn around the plant, a serious risks to health and the environment.

Mitigation Measures

- It will be necessary that the workers and farmers are provided with education and awareness on safe management, handling and application of the sludge cake. This will include appreciation of the materials for soil conditioning to surmount the cultural barrier,
- The quality and safety of the sludge cake should be ensured on a collaborative basis (public health, agriculture, water and soil) before it is released to the users. Part of ensuring this would be ensuring efficiency of the sludge digestion and effective sludge drying,
- There should be an initiative to investigate the target areas of sludge use in respect of environmental features (water sources and soil types) as well as social interactions. The opinion of the large communities in the areas of sludge use should also be known.
- Consider an intervention of solid waste management at Kisat Sewage Treatment Plant including the following;
  - ✓ An appropriate collection hopper at the screening unit of raw sewage for safety and order,
  - ✓ A concrete holding platform for grit and solid wastes from the plant to dry (the leachate from the platform to be channeled back to the raw sewage
  - ✓ Construction and efficient controlled burning chute at the site for selected solid wastes (general wastes may be disposed off into the designated dumping sites),
  - ✓ The proposed arrangement may also serve other parts of the sewerage system as may be necessary

7.6.7 Impacts on Drainage

(i) The construction of the sewer lines could affect the status of the surface drains and/or their catchments as a result of excavations and earth moving leaving flow problems thereafter. Among the effects would include inappropriate compaction after laying the pipes or discharge of soils into the open drains,

(ii) The sewer systems could conflict with the natural drainage in the event of overflow at the inspection manholes and/or damaged sewer line sections. Among the effects would include deposition of organic matter as well as contamination of runoff),

(iii) Some of the surface drainage outfalls in the city may lead into residential, commercial or institutional premises. Interaction of the sewerage system with the drainage systems could have direct and indirect conflicts with the communities with health and nuisance problems.

Mitigation Measure

- All drainage outfalls from wastewater treatment plants be installed with appropriately designed grit traps and oil/fats interceptors. The materials so recovered should be disposed off to designated solid dumping sites or safely burned,
- Consider shielding open drains from possible overflow points and hence safety of the surface runoff and the downstream linkages,
- It will also be necessary to identify all affected open drains and install designed grit traps at their outfalls as a measure to intervene in the event of accidental discharge of raw sewage,
- Where the sewer lines passes under or over open drains (and also roads), it will be necessary to strengthen the sewer pipelines.

7.6.8 Impacts to Lake Victoria

(i) Discharge of nutrients into the lake through sewage overflows from inspection manholes and damaged sewer pipes as well as partially treated sewage from the treatment plants may lead to eutrophication of the lake waters. This is currently a regional challenge with a particular concern on Winam Gulf on the face of inadequate waste management in the urban areas along the basin,

(ii) There is still a large population of Kisumu City yet to be connected to the sewer system and hence discharging sewage directly into the lake (only ~10% is connected). This implies over 80% of raw sewage in Kisumu discharges directly into the lake and so is urban pollution,

(iii) There is potential transportation of sludge and solid materials into the lake shores from the treatment plants and other points of sewage overflows. This will add into the pollution loading of the lake as well as siltation affecting the benthic conditions of the lake, especially the zones along the shoreline,

(iv) The sewer system is susceptible to inflow of surface runoff that would effectively overwhelm the treatment capacity. Part of the associated problems is overflow of the excessive inputs. Likewise, operational problems at the treatment works may lead to overflow of bypassing the sewage. These scenarios may lead to direct discharge into the lake and hence pollution.

Mitigation Measures

- Develop a programme of expanding the sewer connection coverage in area and connection numbers to reduce the level of pollution into Lake Victoria. This may be achieved by sensitization of the population, infrastructural expansion, subsidies on connections and support on sewer re-orientation at generation points,
- Provide emergency measures at the discharge channels from the treatment plants, especially during heavy rains and potential overflows to intercept excessive flows and return for treatment. Such measures would include grit traps and holding pans,
- Provide a monitoring station at the inflow and outflow of the sewage flow streams at the wastewater treatment plants as well as at the entry points into the lake (to monitor the raw treated sewage and lake water for any impacts). The monitoring stations will also be backed up with data documentation that would also be shared with conservation groups and authorities in the region for appropriate application,

7.6.9 Social Impacts

(i) There is potential unfavourable odorous environment into the neighboring settlements arising from the accidental failure of the sewage treatment components (anaerobic conditions, sludge digestion, wet sludge on drying beds and wet grit from raw sewage).

Other causes of odor would be aerosols from the lagoons and trickling filters. Effects would be discomfort of the residents (especially by night and on the windward directions),

(ii) Accidental sewage overflow onto pavements and open drains will pose potential nuisance and health problems. This will affect the road users, immediate neighbourhoods with particular concern to children,

(iii) There is still uncertainty on the efficient sewer connections around the city especially in the low income areas. Among the potential challenges include
- High connection costs,
- Limited access to the infrastructure
- Poor willingness to pay for connection of the premises within reach
- High logistics and costs for re-orientation of plumbing systems in buildings
- Cultural change to ensure maximum utilization of the facility

(iv) The value of land and property within and around the plant or areas with improved sewer system will appreciate (provision of efficient sewer services may have a direct linkage to the property values). This is a positive effect to the land and properly owners, although on the other hand rents and investment opportunities by the low income earners will be relatively low,

(v) There is potential problems on environmental health from off-site waste disposal (solid wastes including sludge cake). This will affect the workers and communities at the disposal sites,

Mitigation Measures

- There will be need for LVSWSB and KIWASCO to initiate a programme for education and creation of awareness among the community members on potential odours from the sewerage operations among other effects. This would provide preparedness on any accidental emission of smells,
- Part of community participation on public health should be sensitization on hygiene and sanitation practices to deal with accidental sewage overflows and associated solid waste materials,
- Improved sewer connections (in area and connection numbers) will need enhanced interventions in the short and long term). The following interventions may be considered;
  - ✓ Consider subsidizing the sewer connection costs to encourage many residents to join, especially the low income areas,
  - ✓ Extend the infrastructure (feeder sewer lines) to draw closer to the potential connections,
  - ✓ Enhance education and sensitization to increase the level of willingness to pay for connection of the premises within reach of the infrastructure
  - ✓ Discuss with property owners (buildings and premises) on the logistics and costs of re-orientation of plumbing systems in buildings to match sewer connections requirements,
  - ✓ Consult on appropriate measures to enhance ownership of the entire Kisumu sewerage system by the residents of the city.
- The Kisumu City Planning should consider and integrate the sewage collection and management system. This will ensure harmonized coverage of the remaining areas, reduced conflicts with other services and matching sewerage coverage with water supply reticulation,
- Consider a solid waste burning chute at Kisat Sewage treatment plant accompanied by a designed drying platform for the grit and other recovered solid materials.

Chapter 8: Environment Management Plan

8.1 Management Plan Principles

This project is geared towards enhancing social and economic benefits to the people living in the informal settlements under the project. The project, however, should also observe environmental protection requirements in accordance to the established laws and regulations to ensure sustainability. To realize this goal, acceptability by a majority of the beneficiaries and minimal effects to the physical environment will require to be integrated in the project through constant consultations, evaluations and review of the design aspects throughout the project coverage.

It is recommended that guiding principles specific to this project and the regulations governing water resources management be developed that will allow integration of environmental management considerations in the construction, maintenance of the facility components and public amenities. Among the factors that need to be considered in this particular project implementation will include;

(i) Ensure prevention of pollutants discharge into the drainage systems and pollution of public water bodies,
(ii) Enhance integration of environmental, social and economic functions in the project implementation,
(iii) Consider preventive measures towards possible social and economic disruptions that may arise from the project implementation in accordance with the laid down guidelines,
(iv) The contractors and other players in the project activities be prevailed upon to implement the EMP through a sustained supervision and continuous consultations,

8.2 Specific Management Issues

8.2.1 Management Responsibilities

In order to implement the management plan, it is recommended that a supervisor is identified to oversee environment and management aspects including the water abstraction sustainability, pollution control, water loss control and equity access, management of sanitation and hygiene measures throughout the project area. The supervisor would also be expected to co-ordinate and monitor environmental management during construction and provide monitoring schedules during operations. Other recommended participants could include the respective Environmental Officers, Water Offices and the Physical Planning Offices among others.

8.2.2 Environmental Management Guidelines

Upon completion and commissioning of the water and sanitation facilities, it will be necessary to establish appropriate operational guidelines on environmental conservation and social linkages to enable the operations' management identify critical environmental and social issues and institute appropriate actions towards minimizing associated conflicts. Basically, the guidelines should cover among other areas environmental management progammes, standard operation procedures, compliance monitoring schedule and environmental audit schedules as required by law. Social harmony of the facilities and associated component will be achieved through collaborations with the stakeholders or community management committees at various water points and ablution blocks.

It is recommended that the communities' in-charge of the water and sanitation intervention facilities must have an accountable structure. While appreciating that there is an existing social framework, it

should be recognized that they lack in organizational capacity to manage water and sanitation facilities at a commercial level. The groups will therefore, need to get re-organized to provide for clear responsibilities, documentation and record keeping as well as resource accounting

8.2.3 Environmental Education and Awareness Raising

The Board field staff and the beneficiaries will need to understand the basic environmental, water use, sanitation and hygiene principles associated with the projects. In this regard, therefore, the following steps will need to be considered;

(i) Creation of liaisons on all matters related to environment, utilization of water, health, safety, sanitation and hygiene issues of the water resource development,
(ii) Encourage contribution of improvement ideas from the beneficiaries on specific issues related to the management of the facilities, water accessibility, water availability, sharing, etc. say through a questionnaires or direct interactions,
(iii) Establish initiatives that would instill a sense of ownership of the facilities and related components to all beneficiaries,

8.2.4 Decommissioning Process

Due to the long-term life of the intervention facilities and related components, a decommissioning audit will be undertaken at least 1 year before the process for any of the components commences, following a notice to decommission. The decommissioning process will be guided by a comprehensive decommissioning plan developed through the decommissioning audit process. However, the following features will need to be decommissioned upon completion of the works;

(i) Contractor's camp and installations that will need to be removed without compromising on the safety and general welfare of the immediate residents. Special care to be given to associated wastes and dust emitted in the process,
(ii) Materials stores that will comprise fresh materials and used items. Each category will be moved safely out of site ensuring minimal or no impacts to the related environment and social setting,
(iii) Wastes and debris holding sites will be cleared with maximum re-use of the debris either on surfacing the passageways or other grounds such as schools and church compounds.

8.3 Environmental and Social Management Actions

Table 9: Construction Phase

Activity	Associated Impacts	Impact Levels	Management Actions	Target Areas and Responsibilities	Timeframes and Cost Estimates
Preparatory Activities	Stakeholder preparation Seeking approvals	Low	▪ Involvement of stakeholders and public ▪ Preparation of management plan ▪ Approvals of ESIA Report by NEMA and other authorities ▪ Acquisition of the project land if necessary	▪ New sewer lines ▪ Kisat Convectional Treatment Plant ▪ Nyalenda Sewage Lagoons <u>Responsibility</u> Contractor(s)	Preparation period ~KShs. 0.5M
	Establishment of construction camp sites	Low	▪ Undertake ESIA studies for the target camp sites and obtain approval from the relevant authorities (including NEMA) ▪ Isolate through fencing the camp sites from access by the public for their safety	Camp sites <u>Responsibility</u> Contractor(s)	Preparation period ~KShs. 1.5M
	Access to campsites	Low	▪ Utilize to the extent possible the existing public roads to avoid social and economic disruption ▪ Ensure road safety measures for the construction vehicles to the extent possible by observing all traffic regulations	Access Roads <u>Responsibility</u> Contractor(s)	
Earth moving and excavations (channeling and site preparations)	▪ Safety risks ▪ Air pollution ▪ Social nuisance	Medium	▪ Provide notices, signage and information to the public for their safety at all locations ▪ Install barriers along walkways, crossings and public places affected by the works for public safety ▪ Where there are potential for nuisance from dust generation, ensure earth moving is under dump conditions (consider watering where necessary) ▪ Inform immediate communities or stakeholders of the activities for	All work areas <u>Responsibility</u> Contractor(s)	Preparatory period ~KShs. 3M

Activity	Associated Impacts	Impact Levels	Management Actions	Target Areas and Responsibilities	Timeframes and Cost Estimates
			harmony ▪ Earth moving to take the shortest period possible ▪ Sewers channels to be cut in phase and small sections		
Sewer Construction Works (Laying sewer pipes, erection of inspection chambers washouts and other components)	▪ Public safety ▪ Occupational safety	Medium	▪ Notify public the intent to cut sections for safety precautions ▪ Provide signage and safety information in all work areas ▪ Ensure compliance by workers with safety safeguards including the OHS, provision of safety gear and enforcement of application	Sewer areas <u>Responsibility</u> Contractor(s) Supervision	No direct cost
	Disruption of amenities (access roads, services lines and driveways)	Medium	▪ Notify other services providers and ▪ Laying of sewer pipes and testing be undertaken within the shortest period to avoid public disruption ▪ Mark the lines to avoid conflicts with other activities	Sewer areas <u>Responsibility</u> Contractor(s) Supervision	No direct costs
Construction of Treatment Plant (Kisat Wastewater Treatment Plant) Rehabilitation of existing components and installation of additional components	Materials sourcing, delivery and storage	Medium	▪ Construction material sources should be environmentally sustainable (approved accordingly) ▪ Delivery routes and modes of transport should be approved ▪ Material storage on site not to be internal or external nuisance ▪ Material residuals to be disposed off in accordance with established regulations,	All construction areas <u>Responsibility</u> Contractor(s) Supervision	No direct costs anticipated
	Wastes removals and disposal	High	▪ Construction wastes (residual earth, debris and scrap materials) to be removed for safe disposal ▪ Encourage recycling where possible (concrete debris for access road surfacing), ▪ Contaminated organic matter in the work areas including sludge and grit matter (sewerage plants) to be isolated for safe disposal	Construction areas <u>Responsibility</u> Contractor(s) Supervision	~KShs. 250,000 on waste removal

Activity	Associated Impacts	Impact Levels	Management Actions	Target Areas and Responsibilities	Timeframes and Cost Estimates
	Health and Safety	High	▪ Provide construction workers with personal protective gear (gloves, gum boots, overalls and helmets), especially at the wastewater treatment plants ▪ Provide temporary toilets and bathrooms for the construction workers at the work sites ▪ Provide onsite first aid kit accessible by the workers on need, ▪ Isolate the site for access by the local communities during the construction for their safety and health	All work areas <u>Responsibility</u> Contractor(s) Supervision	No direct costs (part of Consultants employee management
	Air Quality Control	High	▪ Control dust emissions in all work areas (watering where necessary) ▪ Sludge to be covered on removal and transit ▪ Avoid open burning of solid materials during construction works ▪ Any materials preparation (e.g. crashing) be undertaken in controlled	All work areas <u>Responsibility</u> Contractor(s) Supervision	No direct costs (integrated in the works costs)
	Environmental Pollution Control	High	▪ Ensure effluent discharge during construction remains controlled ▪ Neutralize all solids waste matter (including sludge and grit matter before off-site disposal	All work areas <u>Responsibility</u> Contractor(s) Supervision	~KShs. 500,000 for environmental protection measures and monitoring
	Social interactions	High	▪ Fence up the site to keep off local communities for their safety (especially children) ▪ Provide safe shed for the workers who may be served food by the local communities ▪ Ensure any materials released to the local communities for re-use is disinfected	All work areas <u>Responsibility</u> Contractor(s) Supervision	No direct anticipated
	Sewer connections	Low	Provide easy connection points to the treatment plant for the immediate residents for enhanced sense of ownership	Neighbourhoods Contractor Supervision	

Table 10: Post-Construction Phase

Activity	Associated Impacts	Impacts Levels	Management Actions	Target Areas and Responsibilities	Timeframes and Cost Estimates
Commissioning	Acceptability by the communities	Medium	▪ Involve the local communities on the commissioning process for enhanced ownership ▪ Welcome applications for connectivity ▪ Initiate forum for awareness and sensitization on co-existence	All areas of wastewater infrastructure KIWASCO Environment Manager LVSWSB Technical Department	At commissioning No direct costs
Environmental interactions	Environmental pollution	High	▪ Ensure high performance of the plant for less pollutant loading into the environment, ▪ All inspection manholes are secured and effectively monitored to avoid accidental overflows, ▪ Control any discharges into the open drains from the sewerage system.	Kisat Wastewater treatment plant, Nyalenda Lagoons and sewer lines	Upon commissioning and continuous
		High	▪ Control pollution of Surface water sources pollutions (Kisat River and Lake Victoria) ▪ Intercept solid materials discharging into the drains through grits retention chambers. ▪ Install monitoring points and monitoring plan for the performance of Kisat treatment plant	KIWASCO Environment Manager LVSWSB Technical Department	Operations and maintenance budge
	Waste Management (mainly at Kisat Treatment plant)	High	▪ Ensure all solid wastes are disinfected/neutralized before disposal or released for re-use ▪ Waste materials to be disposed off in designated locations in accordance with the Regulations	Wastewater treatment plants	Continuous
			▪ Establish a waste holding yard, sheltered and with provision for segregation for all wastes arising from the operations including grit materials ▪ Consider a solid waste burning chute at Kisat plant for solid materials recovered from the raw sewage.	KIWASCO Environment Manager LVSWSB Technical Department	Operations and maintenance budge

Activity	Associated Impacts	Impacts Levels	Management Actions	Target Areas and Responsibilities	Timeframes and Cost Estimates
	Hygiene and Sanitation	High	▪ Provide and maintain clean all toilets use by the staff (ladies and gents) ▪ Provide and maintain bathrooms for the workers at the wastewater treatment plants (especially Kisat), ▪ Provide safe eating rooms for the workers to avoid contamination. ▪ Ensure the staff are supplied with disinfectants in the bathrooms	All waste treatment premises and infrastructure KIWASCO Environment Manager LVSWSB Technical Department Public Health Office	Continuous ~KShs. 2M
	Bird attraction (and other wild animals)	Medium	▪ Consult with KAA and KCAA on the management of the flight path (a short distance to the north) with respect to birds strike, ▪ Protect the plant for direct encroachment by wild animals such as hippos. ▪ Control rodents population that may become a nuisance to the immediate neighbourhoods.	Kisat Treatment Plant Operators KIWASCO Environment Manager LVSWSB Technical Department	All time No direct costs
Social Interactions	Low sewer connections	High	▪ Create awareness and information on sewer connections ▪ Consider subsidies on sewer connection fees across the entire city ▪ Provide a clear timeframe on the connection of premises to the expanded sewer system (it may require re-configuration of the buildings plumbing layouts),	All areas KIWASCO Environment Manager LVSWSB Technical Department Public Health Office	Initiate action within 12 months ~KShs. 10M
	Health and Safety	High	▪ Provide and enforce application of personal protective gear by all operators and staff, ▪ Provide disinfectant soaps for all the staff, ▪ Avoid direct entry and/or access of the neighbouring communities into the premises or into manholes at all times.	All waste treatment premises and infrastructure KIWASCO Environment Manager LVSWSB Technical Department Public Health Office	Continuous Operations and maintenance budge
			▪ Sensitize the local communities on coexistence of the sewage plant,	Discharge points (Dunga, Kisat River and Lake	Continuous

Activity	Associated Impacts	Impacts Levels	Management Actions	Target Areas and Responsibilities	Timeframes and Cost Estimates
			especially with respect to their health aspects ▪ Monitoring of the effluent quality and status of receiving environment	Victoria) KIWASCO Technical Officer	~KShs. 100,000 per session
	External use of generated manure	Medium	▪ Ensure sludge cake generated is safe and inert before utilization as manure ▪ Educate local farmers on the safety and usability of the sludge cake as manure ▪ Monitor environmental quality (soil and water) of the use areas	KIWASCO Environment Manager LVSWSB Technical Department Public Health	Continuous ~KShs. 100,000 per session
Operational Aspects	Staff Capacity Aspects	Medium	▪ Evaluate the staff requirements for the sewerage system ▪ Initiate a deliberate initiative on training of the sewerage management staff across the board on technical and operational aspects ▪ Prepare standard operation procedures (SOP) for the entire sewerage system, ▪ Consider working with communities on monitoring the sewerage system across the city	Entire sewerage system KIWASCO Environment Manager Public Health	Continuous ~KShs. 350,000 annually
	Health and safety capacity aspects	Medium	▪ Ensure sewerage system staff are trained on health and safety ▪ Provide and ensure application of personal protection equipment (PPE) to all staff in the sewerage system ▪ Install appropriate safety signage and information on appropriate locations across the sewerage network	Entire sewerage system KIWASCO Environment Manager Public Health	Continuous ~KShs. 200,000 annually
	Equipment and facilities	Medium	▪ Evaluate the operation requirements for the sewerage system of Kisumu city (basic implements, monitoring equipment, laboratory facility, vehicles) ▪ Provide and equip the sewerage operations (field operations, monitoring and laboratory facilities).	Entire sewerage system KIWASCO Environment Manager Public Health	Continuous ~KShs. 250,000 annually

Chapter 9: Conclusions and Recommendations

9.1 Conclusions

(i) The proposed rehabilitation of Kisumu Sewerage system is long overdue considering the physical expansion of the City boundaries for the last 3 – 4 decades, increasing population and rising demand for connectivity.

(ii) It is noted that the existing infrastructure is not only inadequate by also operating far below the design capacity calling not only expansion but also intensive rehabilitation. This is particularly the case with Kisat Convectional Wastewater Treatment Plant.

(iii) While appreciating that sewage generation is associated with water consumption, it is noted that at the moment, the two elements may not be correlated. Reason, water supply coverage from the public supply is short of the demand and hence other sources of unquantifiable water delivery are applied. Similarly, sewage disposal facilities are variant across the city on the face of low coverage.

(iv) Kisat Convectional Sewage Treatment Plant is generally serviceable. However, the plant is operating far below its design capacity as a result of breakdown of key components, some requiring re-orientation.

(v) The proposed constructed wetland for Kisat Wastewater Treatment Plant is highly appreciated, as long as it will be appropriately designed such as to adopt indigenous macrophytes and not to attract undesirable wild animals including birds.

(vi) With low or no connectivity in the neighbourhoods of the sewerage systems, the communities do not seem to effectively identify themselves with the facilities. The low sense of ownership impacts negatively to the operations and maintenance of the system

(vii) The cost of connecting to the sewer might be prohibitive to a majority of the residents, especially in the residential areas (part of which may require reorientation of the public configurations)

(viii) Internal health and safety provisions are either absent or none existent, especially at the treatment plant premises. In this regard critical components seem to have been omitted for inclusion in the proposed intervention measures among them internal sanitation, hygiene and waste management provisions.

9.2 Recommendations

(i) It is recommended that within the availability of the required resources, the rehabilitation and expansion of the sewerage system for Kisumu City should be undertaken within the shortest period possible in order to catch up with the rate of rate of physical growth, increasing population and demand for water and sewer connectivity,

(ii) There should be a deliberate initiative and effort to evaluate the design capacity of the existing sewerage facility (especially Kisat Convectional Treatment Plant) first. This will enable rehabilitation interventions to optimize the efficiency before going into additional (perhaps unnecessary components). This will be economical on resources and land spaces available as well as present less challenges of potential social disruptions.

(iii) It will be necessary for KIWASCO to harmonize and provide data on the total water consumed in Kisumu City including the various sources as a criteria for planning sewage management. At the moment, there is high level assumptions on the criteria for threshold determination and design for sewage management facilities

(iv) It is also recommended that the components recommended for Kisat Convectional Treatment Plant be reviewed upon re-evaluation of the necessary rehabilitation to optimize the current design capacity. This specifically applies to the trickling filter beds and the sludge thickeners,

(v) KIWASCO in collaboration with other relevant Authorities may need to draw a connection plan for the residents, among them being support for the re-orientation of sewer systems that may not be in line with the new reticulation (especially where not existed before) as well as subsidizing the costs of connections,

(vi) As part of the rehabilitation interventions at Kisat Convectional Treatment plant, the following sanitation and hygiene components and initiatives should have be considered as a matter of importance;

- Provision and maintenance of staff toilets (ladies and gents),
- Provisions and maintenance of staff bathrooms (gents and ladies) and appropriate disinfected soaps,
- Provision of eating rooms with fresh clean water for all staff to avoid contamination and infections
- Install a solid waste holding and drying platform for the grit recovered from raw sewage to prevent the risk to the health of the workers
- Consider a designed controlled burning chute for solid materials (including recovered grit) at the site.
- Attempt to discourage vending of food stuffs around the sewage plant for control of potential contamination
- Sensitize and create awareness to the neighbouring communities on the coexistence with the sewage treatment plant with special focus on health and safety aspects.

References

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Annexes