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ENVIRONMENTAL & SOCIAL IMPACT ASSESSMENT REPORT FOR THE PROPOSED MERU SEWERAGE PROJECT, MERU COUNTY

SUBMITTED TO: NATIONAL ENVIRONMENT MANAGEMENT AUTHORITY (NEMA), P.O. BOX 67839-00200, NAIROBI.

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CERTIFICATION

This ESIA Report has been prepared in accordance with the Environmental Management and Coordination Act (EMCA) 1999 and the Environmental (Impact Assessment and Audit) Regulations 2003 for submission to the National Environment Management Authority (NEMA).

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Designation: .....

Disclaimer:

This Environmental & Social Impact Assessment Report is confidential to Tana Water Services Board and any use of the materials hereof should be strictly in accordance with the contractual agreement between Ecosite Development Consultants Limited and the proponent. It is, however, subject to conditions spelt out in the Environmental (Impact Assessment and Audit) Regulations, 2003.

EXECUTIVE SUMMARY

1.0 Introduction

In this section, we present general information that summarizes the findings of the Environmental and Social Impact Assessment (ESIA) study for the proposed construction of Meru Sewerage Project. The objective of this ESIA was to evaluate the environmental and social impacts associated with the construction and operation of the proposed project and associated facilities. In this report, we have also proposed measures to mitigate the social and environmental impacts that will emanate from the proposed development to make it more sustainable.

1.1 The Proposed project

The proposed project will lead to the construction of new sewage conveyance facilities and a Waste Water Treatment Plant (WWTP). The proposed works include construction of a sewer network of approximately 56.2 km of trunk sewers and manholes, inlet channel with screens, grit channel and parshall flume, waste stabilization ponds, overflow chamber, sludge drying beds, office block with a laboratory, two double grade 9 staff houses equipped with toilets, wash-up and changing facilities, perimeter fence, access roads and parking.

1.2 ESIA Objectives

Objectives of the ESIA study include the following:

(i) To describe the proposed project in terms of its location, project design, the technology, procedures and processes, materials to be used, project inputs and outputs

(ii) To review existing legal, institutional and policy framework relevant to the proposed project;

(iii) To find out impacts associated with the proposed project with an objective of suggesting mitigation measures for the negative impacts;

(iv) To assess the relative importance of the impacts of alternative plans, design and sites;

(v) To generate baseline data for monitoring and evaluation of how well the proposed mitigation measures are being implemented during the project operation period;

(vi) Develop an Environmental Management Plan (EMP) to guide in decision making and for future auditing;

(vii) Raise stakeholder awareness on the impact of the project on the environment with a view to making them understand the implication of the project in their environment; and

(viii) Develop an ESIA report in conformity with the EMCA 1999, EMCA Amendment Act 2015 and Environmental (Impact Assessment and Audit) Regulations 2003.

1.3 Methods Used to Evaluate and Assess the Impacts

The study methodologies used include: collection and analysis of environmental baseline data, identification and evaluation of impacts, formulation of mitigation measures for significant negative impacts, development and analysis of project alternatives and development of environmental management and monitoring plans. Socio-economic data was collected using a variety of methods including administration of questionnaires, stakeholder workshops and discussions with key informants within the project area. Other relevant data was obtained from records and documents availed to our ESIA team from relevant sources and through consultation.

1.4 Land Ownership

The proposed site for the construction of a WWTP is owned by the Meru County Government on a freehold basis. The size of the site is 40 hectares and there are plans to acquire an additional 10 hectares within the same area. There shall be no displacement of people from their land. Loss of crops or assets along the trunk sewer line routes shall be fully compensated by the proponent before implementation of the project.

1.5 Public Consultation

Public participation was mainly achieved through direct interviews, stakeholder workshop and questionnaire administration. Those contacted during this study have welcomed the project because of the benefits associated with its implementation. A summary of their views and recommendations have been included in the report (Chapter 7). The proponent and the consultant shall endeavor to hold further meetings and consultations with the Project Affected People (PAP) to ensure that any lost assets or land are compensated in a free and fair manner before the commencement of the proposed project.

1.6 Positive Impacts

(i) The proposed project will improve hygiene and reduce water borne diseases associated with improper management of waste water in the region.

(ii) An efficient sewage collection and treatment system will protect the environment, surface and underground water resources thus improving environmental quality.

(iii) The project will reduce the costs incurred by the business community in the construction and management of pit latrines and septic tanks on their properties.

(iv) Employment opportunities will be generated during both construction and operation phases of the project. These opportunities will mainly benefit the local people.

(v) It is expected that the development will attract more investment to the region and this will benefit the people of Meru County

1.7 Potential Negative Environmental Impacts

1.7.1 Construction Impacts

- Impacts of obtaining construction materials
- Impacts on businesses and traffic flow
- Noise / Vibration Pollution
- Air pollution

- Health and safety impacts.
- Impacts of waste generation
- Soil and water contamination
- Visual impacts
- Displacement and loss of property
- Socio-economic impacts
- Damage to existing underground infrastructures
- Impacts on biodiversity

1.7.2 Operation Phase Impacts

- Water and soil pollution from sewage leaks and overflows
- Wastes (solid and liquid)
- Odours from the WWTP
- Exposure to chemical hazards
- Physical hazards
- Treated waste water and sludge use

1.8 Summary of Impacts and Mitigation Measures

The table below provides a summary of the identified negative impacts both for the construction and operation phases of the project and the proposed mitigation measures.

POTENTIAL IMPACT	MITIGATION MEASURES
Impacts of obtaining construction materials	• Strip and stockpile topsoil from borrow pits and quarries for use in site restoration. • Close all borrow pits and quarries in accordance with an approved plan to maximize future use and minimize health and safety hazards • Re-use excavated materials from the works as fill.

POTENTIAL IMPACT	MITIGATION MEASURES
Impacts on businesses and traffic flow	• Avoid transporting materials during periods of peak traffic activity • Trenching and laying of pipes should be completed within the planned timeframes to avoid prolonged disruption to businesses • Provide alternative routes for traffic where total closure of roads is expected during trenching • Erect appropriate road signs to warn road users of the construction activities. • Provide temporary bridges over open trenches to facilitate access
Air pollution (Exhaust emissions from vehicles & Dust)	• Service and maintain machinery according to manufacturer's instructions to improve fuel combustion and reduce exhaust emission to the atmosphere. • Spray water on access roads, stockpiles and cleared areas to minimize dust pollution. • Cover all vehicles ferrying construction materials such as sand or aggregate to avoid dispersal of particles/dust along the roads • Provide personal protective equipment gear such as dusk masks to workers who may exposed to excess dust • Impose vehicle speed limits to 10 km/h in all areas within the site boundaries.
Soil erosion and contamination	• Vegetation should only be removed from clearly marked areas • Excavated materials and stockpiled soils should be covered or kept at appropriate sites • Undertake appropriate soil erosion control measures along the trenches and WWTP sites • Construction vehicles and machines must be maintained properly to ensure that oil spillages are kept at a minimum. • Spill trays must be provided if refuelling of construction vehicles are done on site • Materials, fuels and chemicals must be stored in a specific and secured area to prevent pollution from spillages and leakages. The basic EMCA Regulations on of hazardous waste management must be applied fully. • Train drivers and workers on oil and fuel management

POTENTIAL IMPACT	MITIGATION MEASURES
Noise Pollution	• Schedule road traffic movements to normal working hours (08H00 – 17H00). • Noisy equipment and vehicles on the site should be equipped with noise suppressing measures and kept in proper working conditions. • Provide personal protection equipment such as ear muffs to workers operating in noisy areas • Pumps and generators should be stationed far away from areas that are sensitive to noise such hospitals • Avoid unnecessary hooting and revving of engines
Solid Wastes	• Develop a Waste Management Plan to guide the handling, storage, transport and disposal of solid and hazardous wastes in compliance with Solid Waste Regulations 2006 • Recycle or re-use solid wastes where applicable in line with sound environmental management practices • Dispose of non-recycled wastes to sites designated by Meru Municipal Council as dumpsites • Organic wastes from construction camps can be composted • Solid wastes from sewage inflow and site offices should be collected and dumped at designated dumpsites • Sludge if not suitable for agriculture should be disposed of by land filling
Surface and ground water contamination	• Construct oil-water interceptors or sumps to capture discharge of oils, fuels and other polluting liquids • Provide pit latrines/portable toilets at the camp and construction sites for use by workers • Store all raw materials away from the vicinity of water bodies along the project sites to avoid contamination. • Sensitize workers not to dump waste generated from camps and construction sites into rivers
Damage to existing underground infrastructures	• Obtain maps of existing underground infrastructure from relevant institutions to avoid damaging them. • Locate, mark and exercise caution when excavating trenches to minimize chances of damaging such infrastructure • Notify responsible institutions of any damage to ensure that services are restored within the shortest time possible.
Socio-economic impact	• Give priority to locals when hiring workers for the project • Ensure gender balance in employment as far as possible. • Develop and implement an HIV/AIDS awareness and prevention programme targeting workers and local residents • Constitute a committee to handle social conflicts arising from the project

POTENTIAL IMPACT	MITIGATION MEASURES
Occupational Safety and Health hazards	• The Contractor shall conform to all the requirements of the Occupational Health and Safety Act, 2007. • The contractor shall provide ample warning signs and protection around open excavations, stacks of material, etc. and shall be held liable for all claims as a result of neglect of such precautions and provisions. • Train workers on the use of firefighting equipment and first aid • Ensure that persons handling equipment and materials are suitably trained, and supervised • Ensure that emergency contact numbers of the police, fire brigade and ambulance are available at the construction sites. • Provide sanitary facilities at construction sites and potable drinking water • Report and record health, safety and environmental incidences as required by law
Displacement of people and damage to property	• Undertake a detailed valuation of property likely to be lost or damaged and prepare report on compensation before project commencement. • Compensation for loss of land or property should be done promptly and should be based on market rates • Constitute a grievance redress mechanism comprising of representatives of all stakeholders • Resettlement and compensation should be implemented in accordance to National and International guidelines
Visual Impact	• Vegetation clearance should be restricted and confined to marked workstations • Rehabilitate all disturbed areas by backfilling and planting appropriate trees and grasses • Establish access roads for use to avoid unnecessary trampling of vegetation outside work areas
Contamination of soil and water from sewage leakages and overflows	• Regular monitoring and inspection of sewer lines to identify broken pipes and damaged manholes for repair or maintenance. • Use of high quality materials that can withstand anticipated sewage loads and as recommended by the design engineers to prevent leakages and overflows. • Clear and unclog blocked sewer lines within the shortest time possible to contain sewage spills and overflows • Clean and disinfect contaminated sites
Odours from WWTP	• Maintaining proper operations and maintenance practices such as sewer inspections and management to avoid odours • Provide adequate buffer areas such as trees between WWTP site and

POTENTIAL IMPACT	MITIGATION MEASURES
	potential receptors • Minimize hydraulic detention times in pipes and wet wells • Reduce turbulence by minimizing the use of drop manholes • Cover emission points (e.g., aeration basins, clarifiers, sludge thickeners, tanks, and channels), • Explore the use of modern technology systems such as bio-filters and chemical scrubbers to control odours
Exposure to Chemical Hazards	• Train WWTP operators in safe handling of waste water treatment chemicals and emergency response procedures • Provide appropriate personal protective equipment for use by WWTP workers • Install safety showers and eye wash stations near areas where hazardous chemicals are stored or used
Improperly treated effluent discharge and sludge	• Comply with effluent discharge quality standards as stipulated in EMCA Water Quality Regulations 2006. • Sludge intended for agricultural purposes must be properly tested and certified by accredited research institutions before being put into use • Farmers should be trained on how to safely use treated waste water for irrigation in their farms
Physical hazards and safety	• Erect perimeter fence around waste water treatment facilities to restrict access and prevent physical injuries from people and animals • Post security guards to secure the site. • Provide emergency rescue facilities such rescue buoys and throw bags and train workers on how to use them incase of an emergency • Provide adequate security lighting around the WWTP

1.9 CONCLUSION AND RECOMMENDATIONS

1.9.1 Conclusion

The proposed construction of new sewerage facilities within Meru Town will improve public health and sanitation in the region. Improper disposal of human waste due to inadequate coverage of the current sewage system will be minimized. It is expected that the project will attract more development to the region as it will reduce the economic costs of sewage management through septic tanks. Potential negative environmental and social impacts associated with this project have been identified in this report and

appropriate mitigation measures proposed. The consultant has developed an Environmental Management and Monitoring Plan which should be strictly followed and those with responsibilities in project implementation and operation should perform their functions as indicated.

1.9.2 Recommendations

1) Ensure that worker's occupational health and safety standards are maintained through proper training, provision of protective clothing and managing residential camps to the required health standards. Proper warning and protective controls should also be instituted to prevent accidents and injury to the general public especially along open trenches and manholes
2) In order to obtain the support of the local communities, the proponent and the consultant should engage the PAP in meaningful and honest consultations. The process should be all-inclusive where all stakeholders or their representatives are brought on board and compensation done in a fair and open process.
3) The contractor should strictly adhere to construction work program to ensure works are completed within set time periods to minimize disruption to businesses and traffic flow.
4) Proper training should be given to staff responsible for managing the project during the operation phase. Staff in charge of waste water monitoring and treatment, inspection and repair of damaged sewer facilities among others should be adequately trained. The project should be given adequate budgetary allocations to ensure that its properly run and managed.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF PLATES

ACRONYMS AND ABBREVIATIONS

ADB African Development Bank

AIDS Acquired Immune Deficiency Syndrome

CBD Central Business District

CEC County Executive Committee

EHS Environmental Health and Safety

ESIA Environmental and Social Impact Assessment

EMCA Environmental Management and Coordination Act

EMP Environmental Management Plan

HIV Human Immuno-deficiency Virus

KPLC Kenya Power and Lighting Company

MEWASS Meru Water and Sewage Services

MCA Member of County Assembly

M&E Monitoring and Evaluation

NCA National Construction Authority

NEMA National Environment Management Authority

NEAP National Environmental Action Plan

OHS Occupational Health and Safety

PAP Project Affect Persons

PPEs Personal Protective Equipment

PRSP Poverty Reduction Strategy Paper

RAP Resettlement Action Plan

TOR Terms of Reference

TWSB Tana Water Services Board

UN United Nations

WB World Bank

WHO World Health Organization

WRA Water Resources Authority

WWTP Waste Water Treatment Plant

CHAPTER 1

1. INTRODUCTION

The proposed Meru Sewerage project is being implemented by the Tana Water Services Board (TWSB) in collaboration with the Meru Water and Sewerage Services (MEWASS) and with funding from the African Development Bank (ADB) under the Kenya Multi-Towns Sustainable Water Supply and Sanitation Program. The mandate of TWSB is to increase access to safe, adequate and sustainable water and sewerage services to both the rural and urban populations within the area of its jurisdiction. It is therefore pertinent that an ESIA be undertaken before the implementation of the proposed development to identify potential environmental and socail impacts, propose mitigation measures and provide basis for future monitoring and evaluation in order to safeguard the environment as well as the safety and health of the local communities.

1.1 Project background and Justification

Meru Town is served by an old sewerage system which was constructed by the Ministry of Local Government in the mid-1970s, to serve only a small part of the Central Business District (CBD). The sewage treatment plant located at Gakoromone, was designed to treat 750m^3/d of raw sewage and currently serves about 15% of the town area. Over the years Meru town has witnessed an increase in population and expansion of it is infrastructural facilities. Emerging and important developments at Makutano, Milimani, Kinoru, Mwandantu, Gitimbine, Kaaga, Gikumene and Kirunga areas, among others are not served by the existing sewerage system. It is not uncommon to witness leakages of sewage from overloaded septic tanks and sometimes human waste disposed of improperly in some of these areas.

The existing sewage treatment plant is overloaded and receives inflows of about 6,000m^3/d, which is eight times its original design capacity. The sewer trunk system is aging and in bad condition. This has resulted into outflows of inadequately treated sewage into natural watercourses. It is also important to note that even as the water supply services have been improving over the years, the sewerage improvement services

have remained in limbo. The TWSB is therefore seeking to address these challenges by providing new and adequate sewerage facilities that will cover most of Meru Town and its environs. This is hoped to improve public health and sanitation and promote environmental protection.

Plate 1: Existing sewage treatment plant at Gakoromone area

1.2 Objectives and scope of the project

The overall goal of the project is to design and set up a new sewer conveyance system and Waste Water Treatment Plant (WWTP) within Meru Town in response to the emerging needs of the region. Initial project designs and assessments were undertaken by the client but subsequently, the consultant was tasked to review and update the previous design and layouts.

1.2.1 Objectives of the consultancy

As indicated in the Terms of Reference (TOR), the main objectives of the consultancy services are summarized as follows:

i) Review and confirm the design criteria of the sewerage project.

ii) Review the survey data and confirm it on the ground.
iii) Carry out Geotechnical site investigations including reconnaissance surveys to identify rock outcrops and types of soils, limited trial pitting, and laboratory testing to ascertain soil profiles and establish the depth to rock and/or water table.
iv) Review and Confirm the details of the sewer lines including anchorage and river as well as road crossing
v) Review and confirm design of the proposed sewage treatment works and carry out Layout Design, Hydraulic Design, Invert Levels, Health and Safety as well as Operation and Maintenance aspects.
vi) Review and confirm the details of auxiliary works including but not limited to the fencing, staff houses and access roads.
vii) Undertake a Resettlement Action Plan (RAP) and Environmental Management Plan (EMP).
viii) Supervise construction works.
ix) Training

1.2.2 Scope of the Proposed Project

The proposed works include, but are not limited to the following:

- A sewer network of approximately 56.2 km of Trunk Sewers and manholes.
- Inlet channel with screens, grit channel and parshall flume
- Waste stabilization ponds and overflow chamber
- Sludge drying beds
- Office block with a laboratory.
- 2 double grade 9 staff houses equipped with toilets, wash-up and changing facilities
- Perimeter fence, access roads and parking.

1.3 Significance of the project

The proposed project will improve the level of hygiene and reduce water borne diseases associated with improper management of waste water. An efficient sewage collection and

treatment system will also protect surface and underground water resources and the general environment from contamination thus improving environmental quality. As for the business community, the project will reduce the costs associated with construction and management of pit latrines and septic tanks on their properties. It is expected that the development will attract more investment to the region and this will benefit the people of Meru County.

1.4 ESIA Objectives

Objectives of the ESIA study include the following:

i) To describe the proposed project in terms of its location, project design, the technology, procedures and processes, materials to be used, project inputs and outputs
ii) To review existing legal, institutional and policy framework relevant to the proposed project;
iii) To find out impacts associated with the proposed project with an objective of suggesting mitigation measures for the negative impacts;
iv) To assess the relative importance of the impacts of alternative plans, design and sites;
v) To generate baseline data for monitoring and evaluation of how well the proposed mitigation measures are being implemented during the project operation period;
vi) Develop an Environmental Management Plan (EMP) to guide in decision making and for future auditing;
vii) Raise stakeholder awareness on the impact of the project on the environment with a view to making them understand the implication of the project in their environment;
viii) Develop an ESIA report in conformity with the EMCA 1999, EMCA Amendment Act 2015 and Environmental (Impact Assessment and Audit) Regulations 2003.

1.5 ESIA Approach and Methodology

In undertaking the ESIA, a multi-faceted approach was employed. These involved desktop studies and fieldwork that included direct interviews, questionnaire administration, and stakeholder meetings among others leading to the preparation of this report. Below is a detailed description of activities undertaken during the ESIA study.

1.5.1 Scoping

Preliminary meetings were held with the project consultant and a field visit conducted with the aim of identifying and mapping significant issues to be addressed by the ESIA team. Key issues were identified, deliberated upon and work plan drawn for executing the ESIA.

1.5.2 Literature Review

The assessors conducted a desk study to review the available reports, development plans and maps in order to compile relevant biophysical and socio-economic information about the study area. These pieces of information were obtained from project documents in the custody of the proponent and from other relevant sources. This helped in the identification of the gaps existing in the available information and enabled the ESIA team to arrange to undertake detailed field investigations. Special emphases were placed on the following:

- Climate, hydrology and soils
- National environmental laws and regulations
- Human population and settlements
- Socioeconomic infrastructure
- Project impacts and mitigation measures
- Project processes and alternatives

1.5.3 Field data collection

Field visits were conducted in the study area in order to collect and evaluate site specific information on the biophysical and socio economic environment and compare this with

the secondary data compiled earlier. The following issues, among others were accorded special attention:

(i) The existing physical infrastructures within the project area;

(ii) The existing water supply infrastructure;

(iii) Existing land uses within the project area; and

(iv) Settlement trends.

(v) Vegetation types

1.5.4 Public Consultations

Public consultations with interested and affected parties were conducted through direct interviews, questionnaire administration and stakeholder meetings. Various stakeholders, among them the local members of the provincial administration, County and National government officials and other key contact persons within the project area, as well as the general public.

1.5.5 Ecological Investigations

The ecological assessment team visited the project area to assess the existing ecological conditions by observations and recordings, photography and engaging the local community members in discussions. Representative transects cutting across the proposed project area were done to give an overview of the ecological conditions.

1.5.6 Analysis of environmental impacts and mitigation measures

Potential environmental and socio-economic impacts of the proposed project both at the construction and operation phase were identified and ranked based on their significance and magnitude. Mitigation measures were then proposed and an environmental management plan developed.

CHAPTER 2

2. PROJECT DESCRIPTION

This chapter discusses the project location, population projections, waste water flow projections, design criteria and standards, process and layout of the proposed project.

2.1 Location of the Project

The proposed project area lies within 00° 02’ 40’’N Latitude and 037° 39’ 17’’E Longitude and mainly covers Meru Town and its peri-urban areas (Figure 2.1). It is bordered by Kathita River to the West, Mt Kenya Forest to the North and Kaaga area to the East. The Waste Water Treatment Plant (WWTP) is precisely located at Latitude 00° 04’ 41.4’’ N and Longitude 037° 42’ 59.8’’ E at Kinandi area, Ndiine Sub-location in Rwanyange Location South-East of Meru Town. The WWTP site has been indicated in blue in Figure 2.1.

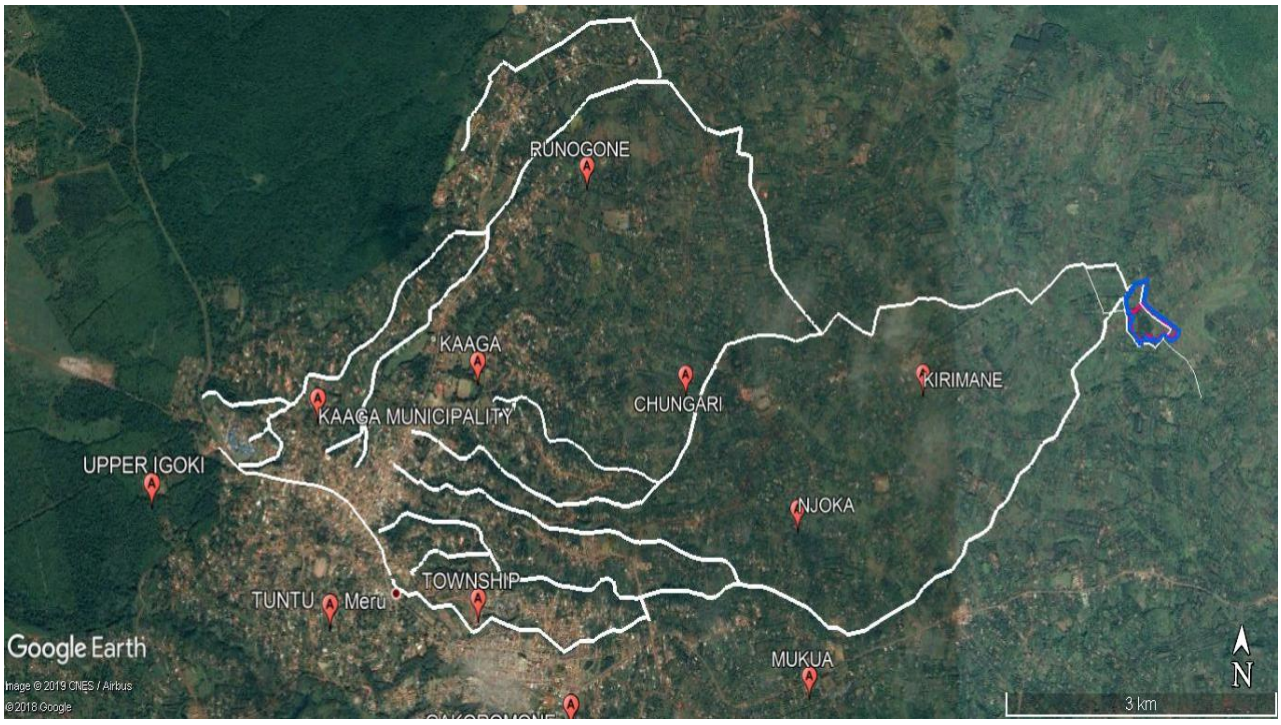

Figure 2.1: Project Layout Map

Administratively, the project drainage area covers Nthimbiri, Kirugua, Nchaure, Muringo Mbugi, Magundu, Gachanka, Mpuri, Upper Igoki, Tuntu, Township, Lower Igoki, Kanyaugo-Kathita, Gakoromone, Mukua, Kiamwitari, Kaaga Municipality, Njoka, Chungari, Kirimane, Kaaga-Mulanthakari, Runogone and Kambiti sub-locations.

2.2 Population, Water Demand and Waste Water Flow Projections

2.2.1 Population Projections.

The project design engineers undertook detailed assessments and projection of the population in the project area based on the 2009 census and adopting an annual growth rate of 2.2%. Population projection is one of the key studies governing the projection of water demand, sewage flow and consequently the capacity of the proposed sewage treatment components. The population data was extracted from the 1999 and 2009 censuses.

A design horizon up to 20 years has been adopted and planning horizons based on initial Design Year: 2017, Future Design Year: 2027 and the Ultimate Design Year: 2037. The Consultant has determined an annual growth rate figure of 2.2%, which was the average value adopted as the annual growth rate for the project area.

General and institutional population projections for the project area were undertaken. Projected institutional population for the project area was categorized into educational, health, administrative, commercial, and industrial as shown in Table 2.1 – 2.6.

Table 2.1: General Population Projections in the project area

SUB-LOCATION	POPULATION				
	1999	2009	2017	2027	2037
Nthimbiri	2893	3451	4107	5106	6347
Kirugua	3170	3781	4500	5594	6954
Nchaure	3119	3714	4420	5495	6831
Muringo Mbugi	1553	2418	2878	3577	4447
Magundu	5708	8707	10363	12882	16014
Gachanka	4041	5562	6620	8229	10230
Mpuri	5355	5761	6857	8523	10596
Upper Igoki	7917	8518	10138	12602	15666
Tuntu	1331	3496	4161	5172	6430
Township	5484	4156	4946	6149	7644
Lower Igoki	2005	1545	1839	2286	2842
Kanyaugo-Kathita	2834	3553	4229	5257	6535
Gakoromone	9140	11458	13637	16952	21073
Mukua	2326	2739	3260	4052	5038
Kiamwitari	5285	6397	7613	9464	11765
Kaaga-Municipality	9657	11689	13912	17294	21498
Njoka	2310	2263	2693	3348	4162
Chungari	4008	4264	5075	6309	7842
Kirimane	2641	3435	4088	5082	6318
Kaaga-Mulanthankari	3562	4633	5514	6855	8521
Runogone	3115	3922	4668	5803	7213
Kambiti	3127	3771	4488	5579	6936
Total	**87454**	**105462**	**125517**	**156031**	**193964**

Table 2.2: Educational Institutions Population Projections

CATEGORY	POPULATION			
	2015	**2017**	**2027**	**2037**
ECDE	3,714	3,879	4,822	5,995
Primary Schools	19,129	19,980	24,837	30,875
Secondary Schools	8,251	8,618	10,713	13,318
Tertiary Institutions	5,770	6,027	7,492	9,313
TOTAL	**36,864**	**38,504**	**47,864**	**59,501**

Table 2.3: Health Institutions Population projections

CATEGORY	POPULATION			
	2015	**2017**	**2027**	**2037**
Hospitals Outpatients	932	973	1210	1504
Hospitals Bed capacity (Inpatients)	458	478	595	739
Dispensary	11	11	14	18
Clinic	29	30	38	47
Health Centers	7	7	9	11
TOTAL	**1437**	**1501**	**1866**	**2319**

Table 2.4: Administrative Institutions Population Projections

CATEGORY	POPULATION			
	2015	**2017**	**2027**	**2037**
Government offices	350	366	454	565
MEWASS	76	79	99	123
Kenya Police	80	84	104	129
Law Courts	58	61	75	94
	564	**589**	**732**	**910**

Table 2.5: Industrial Population Projections

CATEGORY	POPULATION			
	2015	2017	2027	2037
No. of Industries	5	6	8	10

Table 2.6: Commercial Population Projections

CATEGORY		POPULATION			
		2015	**2017**	**2027**	**2037**
Hotels/Butcheries/ Lodgings	Small	106	111	138	171
	Medium	438	457	569	707
	High	20	21	26	32
Shops, Khiosks		976	1019	1267	1575
Petrol Stations		11	11	14	18
Workshops		21	22	27	34
Light Industries		36	38	47	58
Mega stores, supermarkets, storage facilities		58	61	75	94
Banking/Financial services		26	27	34	42
Other professional & Technical services		369	385	479	596
TOTAL		**2061**	**2153**	**2676**	**3327**

2.2.2 Water Demand Projections

The water demand projections were calculated based on the following four main categories namely: Domestic; Institutional; Commercial and Industrial water demand. The tabulated results (Table 2.7) in this section show the summary of the various water demands for the base, future and ultimate design periods.

Table 2.7: Total Water Demand

CATEGORY	WATER DEMAND M^3/DAY			
		2017	**2027**	**2037**
Domestic Demand		11174.8	13891.5	17268.7
Institutional Demand	Educational	1,309	1,628	2,023
	Health	456.3	567.2	705.1
	Administrative	14.4	18.1	22.7
Commercial Demand		335	416	517
Industrial Demand		180	240	300
Total Demand		**13469.5**	**16760.8**	**20836.5**

2.2.3 Projection of Waste Water Flow.

The waste water flows have been projected for the base, future and ultimate design periods respectively. A summary of the waste water flow generation from the various water demands is shown in Table 2.8.

Table 2.8: Total Dry Weather Flows

CATEGORY	TOTAL WASTE WATER PROJECTIONS (M^3/DAY)		
	2017	2027	2037
Domestic	9165	11393	14162
Institutional	1513	1881	2338
Commercial	268	333	414
Industrial	153	204	255
TOTAL	**1109**	**13811**	**17170**

In calculating the total design flows, Infiltration inflow should be considered. Infiltration is the ground water ingress into the sewer system. The Consultant adopted 10% of the flow to account for the infiltration flow as shown in Table 2.9.

Table 2.9: Total Design Flows

	Total Waste Water Projections (m^3/day)		
Total	1,109	13,811	17,170
Add 10%	1,109.87	1,381.07	1,716.97
TOTAL	**12,208.62**	**15,191.82**	**18,886.62**

2.3 Project Design

In planning and designing this project, the project engineers endevaoured to realign the trunk sewers along road reserves and valleys and in such a way as to avoid interfering with existing private properties and developments. The design of sewers aimed at optimising the pipe gradients in order to minimise the earthworks. Project design maps and drawings are presented in Appendix 1 of this report

2.3.1 Sewage Conveyance System design criteria and standards

2.3.1.1 Pipe material

The project proposes to use concrete pipes for its trunk sewers as opposed to uPVC pipes due to their strength and durability. The uPVC pipes shall however be used for the laterals and reticulation sewers.

2.3.1.2 Conveyance system pipe sizes and lengths

A minimum pipe diameter of 300 mm is proposed to be used for the trunk sewers. This size is thought to be adequate in minimizing blockages within the pipes during the operation phase. Pipe connection to individual houses and or up to a maximum of 5 houses shall maintain a diameter of 150mm. A 200mm diameter will be adopted for connections exceeding five houses. The size and length of the trunk sewers within the project area has been designed and Table 2.10 shows the proposed diameter and length of

trunk pipes within the sewage catchment area. The total length of the trunk sewer network is 56.2 kilometers.

Table 2.10: Sewage collection and conveyance system pipe sizes and lengths

Trunk	Pipe Dia (mm)	Length (Km)
Kathita Trunk	300	9.5
	450	3
Karumanthi Trunk	300	4.5
MTTC-Mpuone River Trunk	300	5.4
Kiogo Trunk	300	4.1
	450	4.7
Prisons-Kiogo River Trunk	300	0.9
Bakery-Kiogo River Trunk	300	3.9
Gachoge Trunk	300	3.1
Kaaga Kiogo River Trunk	300	3.2
Kombokie Trunk	375	5.2
	300	4.7
MTTC-Kombokie River Trunk	300	3
Thuura Outfal Sewer	675	1
Total		**56.2**

2.3.1.3 Depth of sewers

The minimum depth of sewers at the starting points will be maintained at 900mm and 400mm at other locations. However, minimum and maximum depths of sewers are dictated by the actual ground conditions on site and economic considerations. The sewers shall be protected by concrete bed and surround or haunch as determined by the depth range, location and structural stability state of pipes.

2.3.1.4 Minimum velocities and pipeline gradients

The minimum gradients for foul sewers shall be such as to produce velocities sufficiently high to ensure that the pipes are self-cleansing. Gradients are largely dictated by practical ground conditions. A velocity of 1.0 m/s, is normally recommended for trunk sewers in tropical climates to avoid the build-up of hydrogen sulphide in sewers, which causes odour and corrosion problems. This velocity shall be maintained in trunk sewers in order to avoid septicity. However, house connections and secondary sewers where flows may

be intermittent and retention times short shall adopt a minimum velocity of 0.75 m/s. A maximum Velocity of 4m/s is recommended to avoid abrasion of the sewer pipes.

2.3.1.5 Manholes

Manholes shall be constructed at every change of alignment, of gradient, at the head of sewers or branches, at every junction of two or more sewers and wherever there is a change in the size of sewers. Precast concrete manholes/slab covers shall be adopted in order to discourage theft or vandalism. In areas with heavy traffic, heavy duty cast iron manhole covers could be used, while medium duty manhole covers and frames or equivalent could be used in areas with limited traffic access. The minimum height from the soffit of the pipe to bottom of the roof slab shall be maintained at 2m in order to provide comfortable space for the maintenance purposes. An area of benching shall be provided in each manhole as to permit a man to stand easily, comfortably and without danger to himself, on such benching while working in the manhole. Table 2.11 shows the recommended manhole spacing to be adopted by the project.

Table 2.11: Recommended Manhole Spacing

Sewer Size		Manhole Spacing	Min. Manhole Dia.	Construction Wayleave	Permanent Wayleave
From	To				
mm	mm	m	mm	m	m
230	375	60	1050	4	3
450	610	80	1200	5	4.5
635	900	100	1500	6	6.0

2.3.2 Sewage Treatment Design Standards and Criteria

The sewage treatment process consists of preliminary treatment and waste water stabilization ponds. The sewage treatment works have been designed for the future year (2027) design flow. The ultimate year design flows land requirement has also been

established by the consultant. Detailed site plans for the WWTP have been attached in Appendix 1 of this report.

2.3.2.1 Preliminary Treatment

The preliminary treatment works consist of screens, grit chambers, parshal flumes, over flow chamber and flow distribution chambers. The works have been designed to have two parallel systems of equal capacity for ease of maintenance.

a) Screens

The purpose of screens at treatment works is to remove from sewage gross which could interfere with its subsequent treatment. Manually raked screens which consist of coarse and fine screens, have been provided in the design. The Screens are located in the inlet chambers with dimensions 5.5 m long and 2.5m wide a design approach velocity of 0.75 m/s.

I. Coarse Screens

These consist of 25mm diameter bars placed at 60° to the vertical at a clear spacing of 50 mm. The vertical inclination gives increased surface area of contact with the sewage and eases the cleaning by the use of a hand held rake.

II. Fine Screens

These consist of 6 mm diameter bars placed at 60° to the vertical at a clear spacing of 25 mm.

b) Grit Removal Channel and Parshal Flume

Two constant velocity rectangular grit channels have been proposed for grit removal. The grit channels are each designed to accommodate the design flow capacity. The Parshal flumes have been provided immediately downstream of the grit removal channel to enable flow measurements and to assist in ensuring constant velocity in the grit chambers.

c) Overflow Chamber.

An overflow chamber has been designed with a weir that connects to a pipe and drain at the sewage treatment works outfall to the river.

d) Flow Distribution Channels.

The flow distribution channels have been designed to distribute the flows to the 2 parallel waste water stabilization ponds systems. Sluice gates have been provided to control the flow and an emergency by-pass to outfall of the sewage treatment works.

2.3.2.2 Anaerobic Ponds

Two Anaerobic ponds in parallel have been proposed. They are designed for a depth of 4.5m, a retention time of 1.42 days with a volumetric flow of 350 g/m3-day. The area covered by each of the anaerobic ponds is 2,407 m^2. Figure 2 shows a schematic flow diagram for the anaerobic, facultative and maturation ponds.

2.3.2.3 Facultative Ponds

Two Facultative ponds have been proposed for the two parallel waste water stabilization ponds systems. They have been designed for a depth of 1.5m, a retention time of 6.42 days and a surface loading of 350 kg/ha-day. The coverage area for each pond is 32,516 m^2.

2.3.2.4 Maturation Ponds

Four maturation ponds have been proposed two for each parallel waste water stabilization ponds system. A depth of 1m has been adopted for the ponds with the minimum retention time of 3 days. In each series the first maturation pond covers 21,815 m^2 and the second maturation pond covers an area of 21,430 m^2.

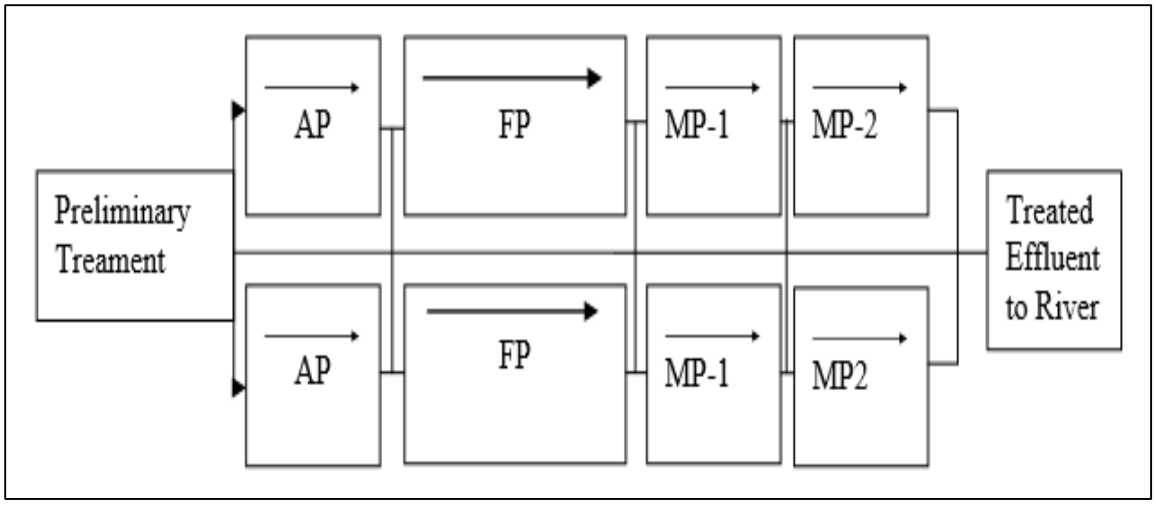

Figure 2.2: Schematic Flow of Sewage Treatment Process

Key to Figure 2

AP – Anaerobic ponds

FP – Facultative Ponds

MP – Maturation Ponds

2.3.2.5 Effluent Outlet Works.

The Consultant has proposed that the effluent be drained into the near Kinyarita River or be used for irrigation purposes downstream.

2.3.2.6 Sludge Drying Beds

Open air sludge drying beds have been proposed. They have an under drainage system with an area of .0.2 ha

2.4 Project Inputs and Construction Activities

2.4.1 Input during construction

- Land is a core component to the establishment of this project. Suitable land has been identified and purchased by the proponent (Tana Water Services Board) for the siting of the WWTP. The size of the land that has been acquired is 40 hectares. Land

purchase agreement is attached in Appendix 3 of this report. The installation of sewerage conveyance facilities also requires land.

- Labour - both skilled and unskilled labour will be required to actualize the project.
- Water for construction activities will be sourced from the Meru Water and Sewerage piped water connection and from private water vendors within the project site.
- Materials such as building sand, gravel, natural stones, and timber among others, will be required during the construction stage. Other materials required include concrete blocks, sand, cement, precast units for drains, iron/stelel bars, concrete pipes and uPVC pipes for sewer reticulation, barbed wires and chain link for security fence.
- Construction tools and equipment including vehicles and earthmoving machinery will also be required at this stage.

2.4.2 Inputs during operation.

During the operation phase, inputs required will be those that are consistent with the running and maintenance of the WWTP and sewage conveyance systems. These include fuel for vehicles, labour, material for repair and maintenance and chemicals for waste water treatment among others.

2.4.3 Project construction activities

An outline of the activities to be carried out during the implementation of the proposed project is given as follows:

2.4.3.1 Pre-construction preparation

A detailed programme of construction activities is necessary before the actual implementation of the project. Such a programme would take into account factors such as topography, hydrology and presence of pre-existing infrastructural facilities within the project area. The proponent and design engineers should employ the services of a contractor with experience in similar works and ensure that a proper programme sequencing project activities is developed. The construction methodology should respect

the laws and regulations that pertains to this project, follow mitigation measures outlined in the project ESIA and agreement statements between the proponent and the land owners. Before construction begins, the contractor should familiarize himself with the surveyed route for sewage conveyance system to minimize damage to private property.

(a) Construction of access roads

Some of the project alignment areas may not be accessed by existing paths or roads. The contractor will therefore be required to construct new access roads for transporting equipment, materials and personnel to the construction sites. Existing roads in poor conditions that may jeopardise the safety of workers and the public will need rehabilitation.

b) Contractor's camps

The contractor will construct temporary camp for his staff, storage yards, and equipment yards among others. The sites chosen should have adequate space for the storage of pipes and materials and be easily accessed. Environmental conditions in the vicinity of the sites should be well guarded by the contractor and his staff.

e) Mobilization activities

Materials and equipment will be transported to the construction sites. Such materials include rock aggregate, sand, cement, steel, pipes, plant and equipment. Workers will also be transported to the sites.

3.4.3.2 Construction procedures

Project construction activities may generally take the following procedures.

a) Marking of sewer pipeline routes and WWTP site

The sewer pipeline route/way-leaves should be clearly marked and boundaries set before the commencement of construction activities. The location and network of existing water and sewage pipelines, underground power cables and internet cables should be identified to avoid damage and disruption of services.

b) Site clearance and preparation

This will involve clearing planted trees, shrubs and grasses at the WWTP site and along the trunk sewer networks. This will be restricted within the project alignment areas so as to ensure minimum disturbance to the environment and property within the vicinity of the project site. The trees felled at the WWTP should be sold and removed from site.

The proposed sewer line routes are located along the valleys whose gradient may be gentle to steep. To attain a desirable gradient for working and installation of pipes, the way-leaves and sites will require removal of top soil layers, leveling and grading. The proposed WWTP site is gently sloped but cutting and filling will be necessary to obtain the necessary levels for the facilities.

c) Trench Excavation

Before commencement of excavation, staking and marking of the trench centerline and locations other underground cables and pipes is necessary. The trenches should be excavated by following the recommended sewer depth. Safe trench crossings will be constructed at locations where the public need access across the trench. Adequate warning signs and barricades will be erected around the trench ensure the safety of the public. Where possible lighting and use of reflective material along the trenches during night hours shall be recommended.

Trenches across main roads shall be excavated by one-half of the road at a time, to allow flow of traffic and alternative roads may be used where possible. Roads with little traffic may be closed to traffic in consultation with the local county officials and businessmen. Appropriate signage should be provided to direct traffic and reduce inconveniences.

d) Construction of the Sewerage Treatment Plant

Already the consulting engineers have conducted geotechnical and physical assessments at the WWTP site to determine the soil and rock characteristics among other issues. The construction process shall then proceed by following a defined programme of construction by the contractor. This will generally start by clearing the site and removal of felled trees and trash, demarcating and fencing of the site, establishment of access

roads. It is the responsibility of the contractor and supervising engineers to draw a detailed programme of work which shall then be followed for the completion of the work.

e) Testing of sewerage system for leakages

An important aspect of the construction process is the testing of the sewage network system for any leakages in accordance to approved procedures and standards. Testing may be done by running water through the system to detect any leakages along the joints or from manholes. If there are any sections that do not pass the test they should be removed and replaced.

f) Site restoration and reinstatement

The contractor shall develop a project-specific restoration and reinstatement plan which shall be followed once the project is complete. The sewer way leaves and other working areas will be filled with stockpiled soils, graded and replanted with appropriate vegetation to protect the ground from the agents of soil erosion.

g) Site clean-up

Prior to demobilization of construction personnel and equipment, clean-up activities will be conducted in accordance with environmental standards and industry best practice. Clean-up activities will consist of the removal and/or disposal of temporary buildings, equipment, tools, and excess material brought onsite or generated during the construction and commissioning programme. All waste shall be removed from site and disposed of at designated dumpsites.

2.5 Waste generation

The proposed project will generate solid, liquid and gaseous wastes during construction, operation and decommissioning phases. Whereas human waste will be disposed of on-site (pit latrines), solid waste will need to be properly managed to avoid attracting scavenging birds and animals. Table 2.12 gives a summary of the wastes and outputs from the project.

Table 2.12: Summary of project wastes/output

Project Phase	Type of waste/output
Construction phase	• Organic wastes including food remains, vegetative matter, wood etc • Papers and workshop wastes e.g. used oil filters etc • Non-biodegradable wastes, plastics, polythene, glass, metal etc • E-waste, batteries, computer components and other electronics • Used oil from vehicles and machines • Waste water from construction activities
	• Gaseous waste such as exhaust emissions from vehicles and machinery • Dust emissions
	• Noise and vibrations
Operation phase	• Solid waste
	• Sludge
	• Odours from waste water treatment plant
Decommissioning phase	• Solid wastes, dust, noise and vibrations etc

2.6 Project construction period

The project has been planned to take 30 months from the time when construction works begin to completion.

2.7 Estimated Project cost

The project is estimated to cost a total of Kenya Shillings Nine Hundred Million (Ksh. 900,000,000.00).

CHAPTER 3

3. ENVIRONMENTAL BASELINE INFORMATION

3.1 Geographical Location

The proposed project area lies within 00° 02’ 40’’N Latitude and 037° 39’ 17’’E Longitude. The site is bordered by Kathita River to the West, Mt Kenya Forest to the North and Kaaga area to the East. The Waste Water Treatment Plant (WWTP) is precisely located at Latitude 00° 04’ 41.4’’ N and Longitude 037° 42’ 59.8’’ E at Kinandi area, Ndiine Sub-location in Rwanyange Location South-East of Meru Town. Meru County has a total area of 6,936.2Km^2 out of which 972.3Km^2 is gazetted forest. The county borders five counties; to the North it borders Isiolo County, to the East Tharaka/Nithi County, to the South West Nyeri County and to the West Laikipia County. Figure 3.1 shows the location of Meru County on the Kenya Map.

3.2 Climatic conditions

The County receives mean annual rainfall averages of between 600mm-1500mm per annum with the short rains being experienced from October to December and the long rains from March to May. The temperatures are generally high, the mean annual temperature averaging between 18°C-28°C. The mean annual potential for evaporation ranges between 1589-1750mm.

3.3 Topography and Geology

The project area is located on the North East of Mt Kenya and lies within the Kathita River drainage area. It is characterized by steep slopes with a mixed parallel and radial drainage pattern in the upper reaches consisting of short spans of ridges and deep gorges that run almost parallel to each other within close proximity but with a general dendritic pattern on the lower reaches. To the North of the Town CBD towards Kaaga area, it is characterized by gentle sloping topography.

Figure 3.1: Location Map of Meru County

3.4 Altitude and Soil characteristics

The Altitude range for the project area is 1763m.a.s.l, on the upper reaches of Kathita River neighboring Mt Kenya Forest whilst the lowest elevation is 1265m.a.s.l at the proposed Sewage Treatment Works site in Thuura location next to Kinyarita River. The soil structure comprises mainly of volcanic soils, which are dark reddish brown, well-

drained, friable and very calcareous and derived from tertiary volcanic rocks. These are suitable for agricultural development. The geology is prevalently basement system rocks consisting of undifferentiated quartzo and is covered by a layer of Kenya Basalt

3.5 Ecological Conditions

The county has varied ecological zones ranging from upper highlands, lower highlands, upper midlands and lower midlands. This has greatly influenced the major economic activities. The upper highlands zones covers majority of the county's area ranging from Imenti South, Imenti Central, Imenti North, Tigania East, Tigania West, Igembe North, Igembe Central and Igembe South constituencies. The lower midland zones are only found in lower parts of Buuri and Tigania which borders Isiolo County

3.6 Biodiversity

Most of the wildlife species are mainly found in the gazetted game parks and forests such as the Meru National Park, Mt. Kenya National Park and Imenti forest. The Lewa conservancy also provides favorable ecosystem that is rich in flora and fauna. A variety of wildlife exists in these protected areas including the big five, that is, the lion, elephant, rhino, leopard and buffalo. Other wildlife includes baboons, giraffe, gazelle, cheetah, gravy zebras and different birds' species. In the northern grazing area some wildlife has coexisted with communities for hundreds of years.

The project site is covered mainly by planted vegetation which includes gravellia, gum trees, guavas, mango trees and crops such as maize, bananas and avocadoes. Natural vegetation consists of acacia trees, lantana camara and napier grasses that are useful for livestock grazing. The site is also home to birds and insects of various types. The seasonal stream adjacent to the site may also be temporary home to some aquatic animals such as frogs and snails.

3.7 Water Resources

There are eleven permanent rivers in the county with the major one being River Kathita which is a tributary to River Tana. The county has several shallow wells, protected springs, water pans, Public and Private Dams and boreholes. These form the major

sources of water for domestic use and irrigation. The quality of waters in the county is good hence recommended for both domestic use and irrigation as it originates from pristine catchment areas within Mount Kenya and Nyambene forests. Despite this, the land use practices and increase in use of agrochemicals in agriculture sector pollute the water as it flows downstream. The WWTP site is situated next to Kinyarita River which is a tributary of River Kathita.

Plate 2: River Kinyarita adjacent to the WWTP site

3.8 INFRASTRUCTURE AND SOCIO-ECONOMIC SET UP

3.8.1 Population size

The projected population of Meru County in 2018 is 1,635,264, consisting of 808,596 males and 826,668 females. The county population is projected to grow to 1,703,945 in 2020 and 1,775,511 in 2022 with an estimated growth rate of 2.1 per cent per annum. The urban population is projected at 68,687 males and 70,007 females as at 2018 with approximately 60 per cent of the total urban population residing in Meru Town.

The rise of urban population is expected to provide an expanding urban market but will also strain the available urban resources. This calls for prior planning of available

resources and expansion of social and economic facilities in the urban areas to accommodate the expanding population.

3.8.2 Land use and Development

The project area is the center of important economic activities in Meru County. It hosts major commercial banks and microfinance institutions, educational as well government institutions, hotels, businesses, industries among others. The housing sector is also expanding within the town as more residential houses are being put up. The dominant land use activity in the vicinity of the WWTP is agriculture and some scattered settlements. However the major land use in the county is mainly for agriculture consisting of crop farming and livestock-keeping. Coffee, Tea and Macadamia are the major crops produced in Imenti Central and Imenti South sub counties respectively. Other crops grown in the county include Bananas, maize, beans, sorghum, millet, green grams, potatoes, cabbages, carrots and kales among others.

The county has a number of tea and coffee factories, milk processing factories, bakery and animal feed processing factories. Other economic activities across the county include fishing, livestock keeping and the growing of crops such as tea, coffee, maize, bananas, avocadoes and miraa (Khat).

3.8.3 Water and sanitation

Meru Water and Sewerage Company (MEWASS) is the only company licensed to supply water and sewerage services in Meru and Maua towns. The water is mainly obtained from rivers originating from Mt. Kenya forest and Nyambene hills. Imetha Water Company supplies water to all other towns and markets around the county. Other small water projects including church owned Diocese of Meru water and Sewerage Company have been started through community initiatives due to high demand for domestic and irrigation especially in arid areas of the county

Only 15% of Meru town is served by an old sewerage system while others areas of the town have no sewer system. Other major towns within the county completely lack functional sewerage systems. The major sanitation facilities are pit latrines which are

used by over 69 per cent of the population in Meru County. Other households using flush toilets and VIP latrines account for 7.9 per cent and 9 per cent respectively.

3.8.4 Solid waste management

Solid waste is collected in trucks and disposed of at the county designated dumpsites. The county has three waste dumpsites and there are plans to construct waste receptacles in major markets. There also plans to formulate Waste Management Strategies for urban and rural areas, buy additional waste collection trucks and procure a waste incinerator.

3.8.5 Health services

Meru County has a total of 498 health facilities comprising of 435 dispensaries, 39 health centres, 23 sub-county/district hospitals and 1 referral hospital. The referral hospital is located within the proposed project area. The county has 144 community health units and 259 Community health volunteers in Level 1. There are 1,872 health care workers distributed evenly across the county.

3.8.6 Energy Resources

The main source of energy for the project shall be electricity that will be sourced from the main KPLC grid. Already the contractor has applied for a 3 phase line connection to the site. Statistics for Meru County (Kenya Population Census 2009) indicate that the main source of energy for cooking by household is wood fuel and charcoal which accounts for 86.1 per cent and 6.6 per cent respectively. The number of household connected to electricity in the county is 13.6 per cent; those using paraffin are 4.5 per cent, gas 2.4 per cent, biogas 0.1 per cent and solar 6.6 per cent.

3.8.7 Education

The fully fledged universities in the County are Meru University of Science and Technology (MUST) and Kenya Methodist University (KEMU). Other universities with campuses in the County are: University of Nairobi (UoN), Co-operative University of Kenya, Africa Nazarene University (ANU), Jomo Kenyatta University of Agriculture and Technology (JKUAT) and Mount Kenya University (MKU). In addition there are two teacher training colleges, namely, Meru and Igoji Teachers Training Colleges. There are

five technical institutes and various private colleges most of them offering training in ICT. There are 647 primary schools and 192 secondary schools.

3.8.8 Transport Infrastructure

Major roads traversing through the project site are Meru- Nairobi, Meru - Maua, Meru-Nkubu and Meru - Mitunguu Roads. The county has 5,968 km of road network. This comprises of 582 km bitumen, 581 km gravel and 4,805 km of earth surface roads. The county is served by the Isiolo International Airport and two airstrips, namely Gaitu, Mitunguu airstrips. There are other private airstrips that also serve the county and include Lewa wild life conservancy, Meru national park, Kisima farm, Oldonyo farm, Embori farm and Maarania farm airstrips. The WWTP site is located about 3 km off Meru – Maua tarmac road.

Plate 3: Road leading to the WWTP site.

CHAPTER 4

4. POLICY LEGAL AND ADMINISTRATIVE FRAMEWORK

4.1 General

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 this, the 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 the key stakeholders being industrialists, business community and local authorities. This culminated into the preparation and passage of Environmental Management and Coordination Act of 1999

4.2 Relevant National Policies

Relevant national policies applicable to the proposed project are highlighted Table 4.1 below.

Table 4.1: Relevant National Policies

POLICY	RELEVANCE TO THE PROPOSED PROJECT
The National Environment Policy, 2013 This policy framework was formulated to ensure sustainable management of the environment and natural resources for sustainable development. Objectives of the policy includes the provision of a framework for integrated approach to planning and sustainable management of Kenya's environment and natural resources; Strengthen the legal and institutional framework for good governance, effective coordination and management of the environment and natural resources; and ensure sustainable management of the environment and natural resources, such as unique terrestrial and aquatic ecosystems, for national economic growth and improved livelihoods.	The project shall be implemented guided by the core principles of the policy of a clean and healthy environment and a duty to safeguard and enhance the environment, the right to development in consideration of sustainability, resource efficiency and economic, social and environmental needs. Environmental resources will be utilized in a manner that does not compromise the quality and value of the resource or decrease the carrying capacity of supporting ecosystems and in support of the stakeholders.
National Land Policy of 2009 The policy recognizes problems associated with rapid urbanization, inadequate land use planning; unsustainable production, poor environmental management, inappropriate ecosystem protection and management are common and require appropriate policy responses. The policy further recognizes that land use planning is essential to the efficient and sustainable utilization and management of land and gives guidelines on development of land in urban and peri-urban areas. The policy also recognizes Environmental Assessment and Audit as Land Management Tools	The process of implementing the proposed project and public participation shall be guided by the planning principles outlined in this policy. Environmental assessment and audits for the project will be carried for sound environmental management.

The National Environmental Action Plan (NEAP) 2009 -2013. The NEAP was a deliberate policy effort to integrate environmental Considerations into the country's economic and social development. The integration process was to be achieved through a multi-sectoral approach to develop a comprehensive framework to ensure that environmental management and conservation of natural resources are an integral part of societal decision making. The NEAP proposes interventions of identifying environmental problems and issues, raising environmental awareness, building national consensus, defining policies, legislation and institutional needs and planning environmental projects.	The proposed project will interact with the various elements and components of the physical, social and economic environments in ways that could lead to negative impacts. Issues of environmental integrity will be addressed through robust environmental assessment processes and public participation.
Vision 2030 Kenya The development blueprint, states that the current population trends in the country, indicate that more than half of the population in Kenya is likely to live in urban areas. There is therefore need to plan decent and high quality urban livelihoods. Preparation and development of metropolitan plans for 11 towns as flagship projects including Meru Town are planned for.	The development and implementation of the sewerage project will support the government's vision for clean and decent urban areas majority are expected to reside by 2030.

4.3 Legal Framework

Applications of national statutes and regulations on environmental management suggest that the project proponent will have a legal duty and social responsibility to ensure that the proposed development is carried out without compromising the status of the natural

resources in the area, public health and safety. The key national laws that have direct relevance to the proposed project are briefly discussed below.

Table 4.2: Relevant Legal Framework

LEGISLATION/REGULATION	RELEVANCE TO THE PROPOSED PROJECT
The Constitution of Kenya (2010) As relates to the environment, article 42 of chapter four, The Bill of Rights, confers to every person the right to a clean and healthy environment, which includes the right to have the environment protected for the benefit of present and future generations through legislative measures, particularly those contemplated in Article 69, and to have obligations relating to the environment fulfilled under Article 70.	The project shall be carried out in adherence to the right of every individual to a clean and healthy environment. The proposed project shall be operated and managed in accordance to the environmental management plans to mitigate possible adverse effects to the environment. Any emerging issues shall be given adequate attention in respect of a clean and health environment.
Environmental Management and Coordination (Amendment) Act, 2015 The Environmental Management and Coordination Act 1999 was amended in 2015 and provides for the establishment of an appropriate legal and institutional framework for the management of the environment and for matters connected therewith and incidental thereto. Section 58(1) of the Act states that "notwithstanding any approval, permit or licence granted under this Act or any other law in force in Kenya, any person being a proponent of a project shall, before carrying out, executing, or	Environmental Management and Coordination Act provide a legal and institutional framework for the management of the environment- related matters. This report has been prepared pursuant to section 58 (1) of this Act. The proponent is expected to comply with Part II on General principles by ensuring that environmental conservation and protection are given the priority throughout project's life span. Other sections that the proponent should comply with include Part VII Section 71 (1) on water quality Standards, Section 78 on air quality standards, Section 86 on standards for waste, and Section 101 on standards for noise. These should be done by avoiding acts of pollution of water, air;

LEGISLATION/REGULATION	RELEVANCE TO THE PROPOSED PROJECT
conducting or causing to be financed, commenced, proceeded with, carried out, executed or conducted by another person any undertaking specified in the second schedule to this Act submit an Environmental Impact Assessment Project report"	ensuring that proper infrastructure for solid waste management is developed and noise levels especially during construction period are within regulatory limits stipulated in the Noise and Excessive Vibrations Pollution (Control) Regulations 2009.
Occupational Safety and Health Act (OSHA), 2007 Cap 514 Laws of Kenya The act requires that all practicable measures be taken to protect persons employed in the factory and other places of work from any injury. The Act provides that adequate measures should be taken to ensure safety, health and welfare of the all stakeholders in the work place. They outline the safety requirements that need to be observed when machinery to prevent accidents and injuries. At the same time construction sites should be registered as a workplace.	Construction activities pose the risk of causing injury to workers as well as to the general public. These may be in the form of accidental falls into open trenches, falls from heights, exposure to energized circuits, excessive noise, and dust pollution among others.
Environmental Impact Assessment and Audit (Amendment) Regulations 2016. These regulations stipulate how an EIA should be done and specify all the requirements. They highlight stages to be followed, information to be made available, role of every stakeholder and rules to observe during the whole EIA process	Regulation 7 of Part II on Project Report requires the proponent to prepare a project report and stipulates in Sub-regulations 1a-k what the contents of the project report are supposed to include. The proponent is also required to pay special attention to the issues specified in the Second Schedule of the regulations. Sub regulation 3 states who is qualified to prepare a project report. The regulations also give in 3rd Schedule general guidelines for carrying out an environmental impact assessment study. All these are relevant to the proposed project.

LEGISLATION/REGULATION	RELEVANCE TO THE PROPOSED PROJECT
The Water Act 2016 The Act declares that every person in Kenya has the right to clean and safe water in adequate quantities and at reasonable standards of sanitation. Pollution of water resources is prohibited in Part VIII, section 143 of the Act. Any rubbish, dirt, refuse, effluent or any other offensive matter shall not be allowed near or in water resources. Section 144 states that a person who pollutes will be required to clean up the pollution caused or remedy any harm caused. The act states that a permit is required for the discharge of a pollutant into any water resource. It is the duty of a licensee receiving trade effluent into its sewerage system to ensure that it has in place measures for the receipt and handling of the effluent without causing pollution of the environment; harm to human health; damage to the sewerage system	Waste water discharge permits shall be required for discharge of treated effluent into River Kinyarita.
Environmental Management and Co-ordination (Water Quality) Regulations, 2006 These Regulations apply to drinking water, water used for industrial purposes, water used for agricultural purposes, water used for recreational purposes, water used for fisheries and wildlife, and water used for any other purposes. The Regulations provide for prevention of water pollution. They require every	The proponent should ensure that discharge of treated waste water from the waste water treatment plant meets the standards set out in the regulations before being released into River Kinyarita.

LEGISLATION/REGULATION	RELEVANCE TO THE PROPOSED PROJECT
person to refrain from any act which directly or indirectly causes, or may cause immediate or subsequent water pollution. The regulations also require that no person shall throw or cause to flow into or near a water resource any liquid, solid or gaseous substance or deposit any such substance in or near it, as to cause pollution.	
The Public Health Act Cap 242 Laws of Kenya The Act stipulates that every local authority has a duty to take all lawful, necessary and reasonably practicable measures to safeguard and promote public health. The act also provides for protection of drinking water supply from pollution sources. Section 129 makes it the duty of the Local authorities to prevent such pollution, to purify a pollution source and to prosecute the polluters. The Cabinet Secretary may make, and require local authorities to enforce rules for preventing polluting activities threatening drinking water supply, and for purifying polluted water.	Public health issues must be strictly addressed both during the construction and operation phases of the project. The contractor and proponent should put in place plans to mitigate all forms of nuisance as stipulated in Part IX Sections 115 and 118 of the Act Solid waste generated from project should handle and disposed of according to the provisions of the act.
The Penal Code Cap 63 Chapter XVII of the Penal Code strictly prohibits the release of foul air into the environment which affects the health of the persons. It states "Any person who voluntarily vitiates the atmosphere in any place so as to make it noxious to the health of persons in general dwelling or carrying on business in the	The provisions of the Code that prohibit the fouling of water (section 191) and fouling of air (Section 192) should be adhered to by the contractor and project proponent to ensure the environment and health of people is safeguarded.

LEGISLATION/REGULATION	RELEVANCE TO THE PROPOSED PROJECT
neighbourhood or passing along a public way is guilty of a misdemeanor".	
Noise and Excessive Vibration Pollution (Control) Regulations, 2009. Under Part II , section 3 on 'general prohibitions', the Regulations provide 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. In determining whether noise is loud, unreasonable, unnecessary or unusual; various factors including time of the day; proximity to residential area; whether the noise is recurrent, intermittent or constant; and the level and intensity of the noise among others may be considered. Any person who contravenes the provisions of this Regulation commits an offence.	Use of heavy machines, equipment and construction vehicles are expected to generate noise and vibration at the project site. The contractor should ensure that noise levels at all construction sites are within regulatory limits stipulated in the First Schedule of these regulations. Appropriate mitigation measures should be put in place to mitigate where the levels are exceeded. Construction workers should be provided with ear protection gears and construction activities should be carried out during daytime.
Environmental Management and Coordination (Waste Management) Regulations 2006 These regulations give guidelines on the management and disposal of solid waste, industrial waste, hazardous waste, pesticides and toxic substances, biomedical wastes and radioactive substances. They require that any person whose generates waste to minimize the waste by adopting cleaner production principles which include among others: improvement	Waste from construction works should be sorted out, segregated and disposed of at designated and licensed dumpsites. Where possible waste shall be re-used or recycled in line with good environmental management practices. Liquid waste such as oils and grease should be managed in accordance to the provisions of the regulations.

LEGISLATION/REGULATION	RELEVANCE TO THE PROPOSED PROJECT
of production process through conservation of raw materials and energy; eliminating the use of toxic raw materials within such time as may be prescribed by the Authority and reducing toxic emissions and wastes, monitoring the product cycle from beginning to end. They regulations also require waste transporters/vehicles and waste disposal facilities to acquire license for their activities.	
Environmental Management and Coordination (Air Quality) Regulations 2014 These regulations provide for ambient air quality tolerance limits and prohibit air pollution in excess of specified limits. Part IV of the regulations provides for the control of emissions from vehicles and internal combustion engines. Part VII prohibits open burning and control of particulate emissions from material handling. The regulations require that of air pollution control equipment be installed where pollutants emitted exceed specified limits. They also provides for the control of fugitive emissions within property boundary.	Machinery and equipment that shall be used at the site will release exhaust emissions into the atmosphere. Where the specified limits are exceeded appropriate mitigation measures shall be undertaken Similarly, transportation and stock piling of soil and sand at the project site may also generate dust/particulate matter.
The Land Act 2012 The act provides for the conversion of private land to public land through compulsory acquisition, transfer, surrender or reversion of leasehold interest to Government.	Installation of the sewerage pipeline network may lead to destruction of private property including trees, crops etc. Any such a loss shall be promptly and justly compensated.

LEGISLATION/REGULATION	RELEVANCE TO THE PROPOSED PROJECT
Under the act the National Land Commission is given mandate for creation of public rights of way (ROW) or way-leaves and that just compensation shall be paid promptly in full to all persons whose interests in the land have been affected.	
Meru County Water & Sanitation Bill, 2014 Part VI Section 66 of the Bill empowers water and sewerage companies to operate and maintain sewer systems and treatment facilities so as to ensure applicable discharge requirements are met. Section 67 gives the sewerage and sanitation companies in Meru county to carry out effluent quality analysis in collaboration with other government lead agencies. This is to ensure compliance with effluent standards. The bill also require that the waste water management companies to ensure treated wastewater and sludge for re-use/disposal meets accepted health standards. Section 69 prescribes punishment for persons that discharge contaminated water or effluent. Section 70 of the Bill also requires regular monitoring and inspection of the sewer system and facilities to ensure facilities are not interfered with unless with permission from the authority in charge.	MEWASS should adhere to the guidelines of the Bill especially during the operation phase of the project.

4.4 International Conventions, Protocols and Guidelines

4.4.1 The Kyoto Protocol

The goal of Kyoto Protocol is to lower overall emissions of greenhouse gases. The protocol initially covered a five-year period from 2008-12 but was extended until 2020 during climate talks in Doha. Much as most of the provisions of this protocol apply to developed countries, emissions of these substances, especially methane would still occur at the sewage treatment plant. This will therefore be properly mitigated. Kenya, as a signatory to the Kyoto protocol, is bound to observe its provisions.

4.4 World Bank Guidelines

4.4.1 OP/BP 4.01 Environmental Assessment (January 1999)

Requires that environmental and social assessments are carried out as part of project design for the bank's financing. Public consultation and views of the project-affected persons/groups and local NGOs are given a lot of eminence. .

4.4.2 OP/BP 4.04 Natural Habitats (June 2001)

This guideline supports the conservation of natural habitats and the maintenance of ecological functions as a basis for sustainable development. They outline measures to rehabilitate degraded natural habitats and discourage the significant conversion or degradation of critical natural habitats. The Bank does not support projects that involve the significant conversion or degradation of critical natural habitats. Therefore during the implementation of this project measures shall be undertaken for the protection of natural habitats

4.4.3 OP 15.50 Disclosures

This Policy details the Banks requirements for making operational information available to the public. The Bank reaffirms its recognition and endorsement of the fundamental importance of transparency and accountability to the development process. In addition,

timely dissemination of information to local groups affected by the projects and programs supported by the Bank, including Non-Governmental Organizations (NGOs), is essential for the effective implementation and sustainability of projects.

CHAPTER 5

5. ENVIRONMENTAL IMPACTS AND MITIGATION MEASURES

5.1 Introduction

This chapter presents the assessment of the issues likely to arise as a result of implementation of the proposed project. For each issue, the analysis is based on its nature, the predicted impact, extent, duration, intensity and probability, and the stakeholders and/or values affected. In accordance with best practice, the analysis includes issues relating to the project's environmental and social sustainability.

For potential negative impacts judged to be significant and require mitigation, the analysis is followed by notes on mitigation options. Impacts and their possible mitigation are combined in this chapter, for easy reference. Although the impacts and analyses are quantified as far as possible, many of the impacts of the proposed project will be indirect. In these cases, and also in terms of 'significance', a qualitative assessment is necessary. These assessments - value judgments - are the study team's professional opinion based on extensive experience of impact assessment and rural development. As in most impact studies, the analyses focus on potential problems and their solutions. Appropriate actions, are included in the EMP (Chapter 8), and recommended immediate next steps are highlighted in Chapter 9.

5.2 Impact identification

5.2.1 Sources of impacts

The impacts associated with the proposed project will emanate from project inputs, activities and outputs. These are highlighted below:

i. Project inputs

The project inputs that shall be potential sources of impacts include:

- Aggregate materials taken from the local sources including crushed rocks, stones gravel, steel and cement.
- Skilled and unskilled workforce exerting indirect demand for energy, water supply, sanitation, health services etc.
- Heavy machinery including excavators, earth moving equipment etc used in the project construction process.

b) Construction/outputs

- Establishment of associated work and support infrastructure including construction camps, accessories etc.
- Obtaining raw materials e.g. water abstraction, quarrying etc
- Transportation of raw materials, machinery and labour to the site
- Health and safety of workers and the public
- Excavation and backfilling
- Refuse and sewerage wastes from construction camps
- Spillage (oil and fuel)
- Resurfacing and replanting disturbed areas.

c) Operation activities/outputs

- Sewage leakages and overflows
- Emission of offensive odours
- Sludge and effluent discharge

5.2.3 Receptors of impacts

The anticipated negative impacts will be received by both the physical and human environments as below:

i) Human environment

- Settlements within the project sites
- Peoples' property and assets

- Local population's exposure to public health and safety hazards
- Residents' exposure to increased noise levels (during construction)

ii) Natural environment

- Terrestrial and aquatic fauna and flora
- Soil structure and susceptibility to erosion
- Surface and ground water resources

5.3 Assessment Methodology

An impact can be defined as any change in the physical-chemical, biological, cultural and/or socio-economic environmental system that can be attributed to human activities related to alternatives under study for meeting a project need. The significance of the aspects/impacts of the process were rated using a matrix with the consequence and the likelihood of the different aspects and associated impacts to determine the significance of the impacts.

5.4 Impact Assessment criteria

The significances of the impacts were determined through a synthesis of the criteria below:

Probability: This describes the likelihood of the impact actually occurring.

Improbable:	The possibility of the impact occurring is very low, due to the circumstances, design or experience.
Probable:	There is a probability that the impact will occur to the extent that provision must be made therefore.
Highly Probable:	It is most likely that the impact will occur at some stage of the development.

Definite: The impact will take place regardless of any prevention plans, and there can only be relied on mitigation actions or contingency plans to contain the effect.

Duration: The lifetime of the impact

Short term: The impact will either disappear with mitigation or will be mitigated through natural processes in a time span shorter than any of the phases.

Medium term: The impact will last up to the end of the phases, where after it will be negated.

Long term: The impact will last for the entire operational phase of the project but will be mitigated by direct human action or by natural processes thereafter.

Permanent: Impact that will be non-transitory. Mitigation either by man or natural processes will not occur in such a way or in such a time span that the impact can be considered transient.

Scale: The physical and spatial size of the impact

Local: The impacted area extends only as far as the activity, e.g. footprint

Site: The impact could affect the whole, or a measurable portion of the above mentioned properties.

Regional: The impact could affect the area including the neighbouring residential areas.

Magnitude/Severity: Does the impact destroy the environment, or alter its function.

Low:	The impact alters the affected environment in such a way that natural processes are not affected.
Medium:	The affected environment is altered, but functions and processes continue in a modified way.
High:	Function or process of the affected environment is disturbed to the extent where it temporarily or permanently ceases.

Significance: This is an indication of the importance of the impact in terms of both physical extent and time scale, and therefore indicates the level of mitigation required.

Negligible:	The impact is non-existent or unsubstantial and is of no or little importance to any stakeholder and can be ignored.
Low:	The impact is limited in extent, has low to medium intensity; whatever its probability of occurrence is, the impact will not have a material effect on the decision and is likely to require management intervention with increased costs.
Moderate:	The impact is of importance to one or more stakeholders, and its intensity will be medium or high; therefore, the impact may materially affect the decision, and management intervention will be required.
High:	The impact could render development options controversial or the project unacceptable if it cannot be reduced to acceptable levels; and/or the cost of management intervention will be a significant factor in mitigation.

The following weights were assigned to each attribute:

Table 5.1: Assessment of significance of environmental impacts

Aspect	Description	Weight
Probability	Improbable	1
	Probable	2
	Highly Probable	4
	Definite	5
Duration	Short term	1
	Medium term	3
	Long term	4
	Permanent	5
Scale	Local	1
	Site	2
	Regional	3
Magnitude/ Severity	Low	2
	Medium	6
	High	8
Significance	Sum (Duration, Scale, magnitude) x Probability	
	Negligible	<20
	Low	<40
	Moderate	<60
	High	>60

The significance of each activity was rated without mitigation measures and with mitigation measures for both construction, operational and decommissioning phases of the proposed.

5.5 Identification of Key Impacts

The key impacts listed in the following section have been determined through the following avenues:

- Professional understanding by the project team on environmental issues;
- Views of interested and affected parties;
- Existing legislation and regulations

5.6 Impact analysis and proposed mitigation measures

The findings of the impact assessment have been consolidated in the sections below. The impacts have been classified as impacts on the biophysical environment and impacts on the socio-economic environment. The impacts are further classified in terms of the phase of the development in which they are likely to occur, namely the construction phase, the operational phase and the decommissioning phase (where applicable). During their analysis, specialists were required to consider the impact significance before and after mitigation measures are implemented. The mitigation measures are also highlighted in this chapter. Even though some impacts are perceived to be of high severity, it must be highlighted that the probability of these impacts occurring might be low and therefore the significance of the impact is reduced.

(i) Biophysical Environment

- Impacts of obtaining construction materials;
- Impact on soil and water resources
- Impacts of waste generation
- Biodiversity impact
- Atmospheric pollution;

(i) Socio-Economic Environment

- Displacement and loss of property
- Noise Impact

- Impact on businesses and traffic flow
- Health and Safety;
- Socio-economic impact
- Visual impact

5.7 Environmental Impacts and mitigation measures

5.7.1 Impacts of obtaining construction materials

i. Impact description

The project will require some amount of materials for construction of project related infrastructure. Staff offices will be built at the site as well as other infrastructures. The project will require quarries to obtain rocks and stones for building works. These need to be sited, accessed, operated and closed to minimize impacts on land users and avoid the creation of safety or health hazards (e.g. steep slopes, malarial ponds). The project will also require sand. Sand mining from rivers is associated with habitat destruction due to changes in channel morphology.

ii. Significance rating

Opening up of quarries to obtain building materials has various impacts which are long term in nature. With mitigation measures, the significance of the impacts will be reduced to low.

Project phase	Impact: Impacts of obtaining construction materials						
	Activity	Probability	Duration	Scale	Magnitude/ Severity	Significance	
						WOM	MM
Construction	Opening up of quarries to obtain aggregates and soil Delivery of materials to the site leading to air pollution. Health and safety issues from the quarries (Mosquitoes and drowning)	Probable (WOM) Probable (WM)	Long term	Local	low	Moderate	Low

WOM = Without mitigation measures. WM = With mitigation measures

ii. Mitigation options

1) Construction phase

- Maximize the re-use of excavated materials in the works, as fill.
- Site quarries and borrow pits carefully so as to minimize impacts on existing land uses.
- Strip all available topsoil from borrow pits and quarries and store it safely for use in site restoration.
- Close all borrow pits and quarries in accordance with an approved plan to maximize their long-term biological productivity (capacity for plant growth) and minimize health and safety hazards.
- Carry out EIA for quarry site if new quarries are to be opened for purposes of this project

5.7.2 Impacts on Businesses and Traffic flow

(i) Impact Description

Excavation of trenches and the presence of construction vehicles on site will have an impact on businesses and the traffic situation along the roads in Meru Town. Open trenches and piling of soil along trench lines will restrict access to some business establishments. Equally, closing of roads for trench works may also lead to heavy traffic jams within the town.

(ii) Significance Rating

The impact can be described as moderate and short term. However with mitigation measures the impact will be low. The impact on traffic during the operational phases of the project is negligible.

Project phase	**Impact: Impact on Businesses and Traffic flows**						
	Activity	**Probability**	**Duration**	**Scale**	**Magnitude/ Severity**	**Significance**	
						WOM	**MM**
Construction	Impact of excavated trenches on businesses	Highly Probable	Short term	Local	Medium	Moderate	Low
	Impact of excavated trenches on traffic	Highly Probable	Short term	Local	Medium	Moderate	Low

WOM = Without mitigation measures. WM = With mitigation measures

6.7.8.1 Mitigation measures

(1) Construction and Operational Phases

(i) Trenching and laying of pipes should be completed within the planned timeframes to avoid prolonged disruption to businesses

(ii) Provide alternative routes for traffic where total closure of roads is expected during trenching

(iii) Avoid complete closure of roads where trenches are excavated across the road. Partial closure is recommended to allow traffic to flow

(iv) Adequate and appropriate road signs should be erected to warn road users of the construction activities.

(v) Sensitize drivers on safe driving and working practices

(vi) Avoid transporting materials during periods of peak traffic activity

(vii) No construction vehicle should be allowed outside the demarcated areas on-site.

5.7.3 Noise Impact

(i) Impact Description

Significant impacts regarding the noise environment will be expected during the construction phase. The noise will be due to construction activities, excavation equipment, concrete mixers and the transportation of equipment, materials and people. Noise and vibration from construction will be minimal and manageable. During the operation phase there are no activities expected to generate noise.

(ii) Significance Rating

Residential areas are not so close to the boundary of the sewage treatment site. The magnitude of the impact at the nearest dwellings is thus rated as being 'low'. The excavation of trenches for trunk sewers lines near residential, institutional and commercial areas may cause disturbance noise. This will be mitigated as appropriate to lower the impacts.

Project phase	Impact: Noise						
	Activity	Probability	Duration	Scale	Magnitude/ Severity	Significance	
						WOM	MM
Construction	Noise Impact associated with construction of the project	Highly Probable (WOM) Probable (WM)	Short term	Local	Medium (WOM) Low (WM)	Moderate	Low
Operation	Noise impact associated with monitoring and inspection of the project:	Probable	Long term	Local	Low	Low	Low

6.7.7.1 Mitigation measures

(1) Construction Phase

(i) Schedule road traffic movements to normal working hours (08H00 –17H00).

(ii) All equipment and vehicles on the site should be equipped with noise suppressing measures and kept in proper working order.

(iii) Provide personal protection equipment such as ear muffs to workers operating in noisy areas

(iv) Pumps and generators should be stationed far away from areas that are sensitive to noise such hospitals

(v) Avoid unnecessary hooting and revving of engines

(2) Operational Phase

The operation phase of the project is not expected to generate any significant noise and the impact is negligible hence no mitigation measures required.

5.7.4 Air Pollution

(i) Impact Description

The expected air pollutants from the proposed Project will include dust, particulate matter and gaseous emissions. Dust will be generated from the excavations, earth moving and materials delivery. Particulate matter will come from dry materials including sand, cement, gravel, murram, etc. Smoke, hydrocarbons and nitrogenous gases will be emitted from machinery exhausts. These will be expected to increase slightly and will be localized hence expected to be experienced within a small radius of less than 100m at the project sites. The dust generated during the construction period is expected to be a temporal nuisance and will not significantly impact the health of the surrounding communities.

During operation phase, the waste water treatment plant may lead to the deterioration of local air quality if not managed according to standard operating procedures. In Gravity Sewers, odours in collection systems result principally from hydrogen sulphide gas and other reduced-sulphur compounds produced by anaerobic sulphate-reducing bacteria in sludge deposits and slime layers. Preventing or limiting the source conditions that allow the bacteria to grow will reduce the odours

(ii) Significance Rating

Dust from construction operations and emissions from operating machinery are unlikely to affect residents/institutions in any significant way. Risks of dust pollution from rock crushing and from open cuts and earthmoving operations will be controlled by dampening down during dry periods as need may arise. The impact of offensive odours from the WWTP will be low if the project design standards and operating procedures are adhered to. Every significant emission could be mitigated to a significance of low to negligible.

Project phase	Impact: Atmospheric pollution						
	Activity	Probability	Duration	Scale	Magnitude/ Severity	Significance	
						WOM	MM
Construction	Dust pollution from earthworks and increased traffic	Highly Probable (WOM) Probable (WM)	Short term	Regional (Local)	Medium	Moderate	Low
Operation	Odours from the release of Hydrogen Sulphide, methane and other gases from WWTP	Probable (WM)	Long term	Local	Low	Moderate	Low

6.7.5.1 Mitigation measures

(1) Construction Phase

(i) Impose speed limits (10 km/h in all areas within the site boundaries).

(ii) Engines for construction vehicles and equipment should be regularly serviced and maintained

(iii) No refuse wastes will be allowed to be burned on the premises or surroundings.

(iv) Spray water on access roads, stockpiles and cleared areas to minimize dust pollution.

(v) Ensure that no refuse wastes are burnt on the premises or surroundings. Refuse wastes should be removed by an official contractor and dumped at an approved site in compliance with local laws regulations.

(vi) Proper rehabilitation of disturbed areas is required in order to minimize bare patches.

(vii) Transported materials must be done in such a manner that they do not fly or fall off the vehicle by covering or wetting friable materials.

(viii) Sprinkle water before undertaking very dusty operations to reduce dust pollution.

(ix) Provide personal protective equipment gear such as dusk masks to workers who may be working in dusty areas.

(2) Mitigation measures: Operational phase

(i) An effective air quality management programme should be compiled for the operations.
(ii) Cover sludge processing facilities and store dewatered sludge at appropriate sites to avoid to reduce the impact of odours
(iii) Odours can be minimized by designing sewers with sufficient slope to maintain flow velocities adequate to prevent solids deposition,
(iv) Hydraulic detention times in pipes and wet wells should be minimized
(v) Reduce turbulence by minimizing the use of drop manholes
(vi) Provide buffer areas around the WWTP planted with trees
(vii) Maintaining proper operations and maintenance practices such as sewer inspections and management to avoid odours.

5.7.5 Health and Safety impacts

(i) Impact Description

Activities associated with construction such as excavating of trenches, movement of construction vehicles, the use of equipment and the congregation of workers and staff on site increase the risk of injury. Construction activities will also result in access of the area by vehicles delivering materials to the site that may result in accidents/incidents. Work at the proposed site may involve hazards such as accidental falls into open trenches, slippery walkways, working at heights, exposure to energized circuits, and heavy equipment. Work at the project site may also involve entry into confined spaces, including manholes and storage tanks among others. Open trenches and excavations may pose risks to the public and lead to injury or death.

During the operation phase of the project workers may be exposed to chemical hazards, physical hazards and nauseating foul smells

(ii) Significance Rating

Most health and safety impacts during construction will be concentrated along the project site and will be short term in nature. The significance of the impacts will be low with implementation of appropriate mitigation measures. Health and safety impacts during the operation phase will also be of low magnitude and significance with appropriate training and mitigation measures.

Project phase	**Impact: Health, Safety and fire hazards**						
	Activity	**Probability**	**Duration**	**Scale**	**Magnitude/ Severity**	**Significance**	
						WOM	**MM**
Construction	Construction activities – increased risk of accidents.	Highly Probable (WOM) Probable (WM)	Medium term	Site	High (WOM) Medium (WM)	Moderate	Low
Operational	Handling and Treatment of sewage (Chemical & physical hazards)	Highly Probable (WOM) Probable (WM)	Long term	Site	High (WOM) Medium (WM)	Moderate	Low
Construction and operation	Fire hazards	Highly Probable (WOM) Probable (WM)	Long Term	site	High	Moderate	Low

6.7.9.1 Mitigation measures

(1) Construction Phase and Operational phase

i) The Contractor shall conform to all the stipulations of the Occupational Health and Safety Act, 2007. The Act requires the designation of a Health and Safety representative when more than 20 employees are deployed.

ii) The contractor shall provide ample warning signs, guard rails, warning tape, etc., around open excavations, stacks of material, debris, etc. and shall be held liable for all claims as a result of neglect of such precautions and provisions.

iii) Proper access control should be enforced to ensure that no unauthorised persons enter the site.

iv) Construction vehicles should be under the control of competent personnel. Ensure that persons handling equipment and materials are suitably trained, supervised and adequately instructed.

v) Ensure that the contact details of the police or Security Company, fire brigade and ambulance services are available on site.

vi) Ensure the welfare of workers is taken care of by providing sanitary facilities at construction sites and potable drinking water

vii) Report and record health, safety and environmental incidences as required by law

viii) Workers who shall be operating at the sewage treatment plant are exposed to the risk of contamination. Proper training on the operations of the treatment plant and use of Personal Protective Equipment is of necessity.

5.7.6 Soil and Water contamination

(i) Impact Description

Fuel spillage from storage and refuelling of construction vehicles and Water pollution from inadequate sanitation facilities at the project site may contaminate soil, surface ans ground water resources. The location of stockpiled or excavated soil material must be done in such a way as to prevent siltation of drainage systems. The magnitude of the impact is rated as medium, because although the affected environment will be altered it will still be able to function in a modified way. The duration will be medium term, but can be mitigated by direct human action. The impact has a high probability of occurrence in the absence of any mitigation measures. The mitigation efficiency will however be effective in reducing the impact significance to low.

Leakages of sewage from cracked pipes and broken manholes may contaminate soil and local water bodies. The use of improperly treated sludge may also contaminate soils and water resources.

(ii) Significance Rating

The above mentioned impacts have a regional extent during the operational phase as well as medium severity. Even though they can be mitigated, probability of occurrence has been rated as low – there still is a probability that it may occur in the absence of appropriate mitigation measures, rendering this impact moderate. Mitigation measures proposed will however reduce the impact to low.

Project phase	**Impact: Soil and water quality**						
	Activity	**Probability**	**Duration**	**Scale**	**Magnitude/ Severity**	**Significance**	
						WOM	**MM**
Construction	Sedimentation of drainage systems	Highly Probable (WOM) Probable (WM)	Medium term	Regional	Medium	Moderate	Low
	Fuel spillage from storage and refuelling of construction vehicles	Highly probable (WOM) Improbable (WM)	Medium term	Local	Medium	Moderate	Low
Operational	Leakages and overflows of sewage may contaminate water resources and soils	Highly Probable (WOM) Probable (WM)	Short term	Local	Medium	Moderate	Low
	Use of improperly treated sludge cake as manure	Highly Probable (WOM) Probable (WM)	Short term	Local	Medium	Moderate	Low

WOM = Without mitigation measures. WM = With mitigation measures

6.7.2.1 Mitigation measures

(1) Construction Phase

The following surface water mitigation measures apply:

i) Bins containing organic solvents such as paint and thinners shall not be cleaned on site, unless containers for liquid waste disposal are placed for this purpose on site.

ii) Construction vehicles and machines must be maintained properly to ensure that oil spillages are kept at a minimum. Oil residue shall be treated with oil absorbent and removed to an approved waste site. Spill kits must be easy accessible and workers must undergo training in the use thereof.

iii) Conduct an environmental education program to reinforce sound environmental principles with regard to littering and water pollution for construction workers

iv) All such materials, fuels and chemicals must be stored in a specific and secured area to prevent pollution from spillages and leakages. The basic NEMA regulations of hazardous waste management must be applied fully.

v) Spill trays must be provided if refuelling of construction vehicles are done on site.

(2) Operation phase

i) Regular monitoring and inspection of the sewer pipeline network to detect any leakages and overflows

ii) Impropt repair of any cracked pipes and damaged manholes

iii) Incase of sewage overflows, the proponent should clean the site and disinfect the affected areas

iv) The sludge cake should be thoroughly tested and certified by credible institutions before use by farmers

v) Ensure sufficient hydraulic capacity to accommodate peak flows and adequate slope in gravity mains to prevent buildup of solids and hydrogen sulphide

vi) Use high quality materials and follow standard and approved procedures in constructing sewerage facilities such as manholes and pipes.

vii) Clean grit chambers and sewer lines regularly to remove grease, grit, and other debris that may block flows

5.7.7 Impacts of Waste generation

i. Impact description

Construction will result in the creation of various solid wastes, principally surplus earth and rock, metal scraps, plastics (wrappings and containers), cardboard, paper, wood, office wastes including e.g. used toner cartridges, kitchen wastes, workshop wastes including e.g. used oil filters, and waste concrete; various liquid wastes including used oils and solvents and runoff from camp. The project will also involve the use of stationary and mobile plant and equipment requiring refueling, mainly with diesel, and the construction of permanent and temporary fuel storage. During the operation phase solid wastes will be generated from site offices and from suspended solid wastes trapped at the primary screening stage.

ii. Significance rating

Solid wastes from excavation and trenching works, construction camp and oil spills from construction vehicles and machinery will lead to short term impacts whose significance can be reduced to low with implementation of appropriate mitigation measures. It is also expected that solid wastes suspended in raw sewage will be transported to the site and collected at the inlet. The significance of this impact has been rated as low with mitigation measures.

Project phase	Impact: Waste generation						
	Activity	Probability	Duration	Scale	Magnitude/ Severity	Significance	
						WOM	MM
Construction	Solid waste from site offices Soil from excavation and trenching works Oil spills from construction vehicles	Highly Probable Highly Probable Probable	Short term	Local	Moderate	Low	Low
Operation	Solid wastes in raw sewage	Probable (WOM) Probable (WM)	Long term	Local	Low	Low	Low

ii. Mitigation options

1) Construction and Operation phase

i) Design and implement formal Site Waste Management Plan.
ii) Collect and dispose solid wastes appropriately at designated dumpsites
iii) Organic wastes from construction camps can be composted
iv) Trees felled at the WWTP site should be solid to local tea processing factories as firewood.
v) Provide pit latrines at the camp or portable toilets at construction sites for use by workers
vi) Apply best practice and Standard Operating Procedures (SOPs) to minimize risk of spills and leakages (including secondary containment of fuel stores, vehicle maintenance on concrete pads with oil and grease traps, avoidance of refuelling within 25 m of watercourses, etc.).
vii) Ensure spill kits and containment systems are available at site and in vehicles.
viii) Train staff in use of spill kits in emergency procedures

5.7.8 Biodiversity Impact

(i) Impact Description

The sewerage pipeline network mainly passes along the valleys and road reserves. These areas are mainly covered with grass, planted trees and agricultural crops. Wild animals do not exist in these areas except various species of avifauna and livestock kept by farmers. The sewage treatment site is also covered by crops and planted trees with the natural vegetation being grasses and shrubs. The impact on fauna and flora is therefore low since domestic animals are confined into farms and homesteads while birds' and insects are free ranging and can move to other areas. Sewage overflows from damaged pipes and manholes may impact negatively on both terrestrial and aquatic life.

(ii) Significance Rating

The construction phase has a definite probability on a site extent, leading to a moderate impact. The probability of occurrence has been rated as definite and the severity is moderate as the area is only covered by planted trees, grass and short vegetation. Mitigation measures would lower the significance of the activity to such an extent that it can be classified as low significance. The impact of sewage overflows on fauna and flora can be described as moderate but with mitigation measures it can be turned into low.

Project phase	**Biodiversity Impact**						
	Activity	**Probability**	**Duration**	**Scale**	**Magnitude/ Severity**	**Significance**	
						WOM	**MM**
Construction	Clearance and excavation of site.	Definite (WOM) Definite (WM)	Permanent	Site	Moderate	Moderate	Low
Operation	Sewage overflows	Probable	Short term	Local	Moderate	Moderate	Low

6.7.4.1 Mitigation measures

(1) Construction and Operation phase

(i) Felling of trees and grass shall be restricted to the project alignment area.

(ii) Construction teams and machinery should not be allowed outside the project alignment areas.

(iii) Clean and disinfect sites contaminated with raw sewage

5.7.9 Visual Impact

(i) Impact Description

The assessment of the various landscape impacts has indicated that the most significant impacts will occur during the construction phase of the development. Major and minor earthworks will take place to ensure site preparation; which will entail the removal of the existing vegetation and soil cover. Trenching, excavations at the WWTP site, material stockpiles, site offices, construction camps and construction equipment will be present on site, which could give the sites a disordered feel. Visual intrusion will be high within Meru Town with the excavation of trenches and piling of soils along the streets.

(i) Significance Rating

The visual impact created during the construction phase will be high to moderate. The visual impact can be reduced to moderate or low if the construction works are completed in time to allow for cleaning and restoration of disturbed areas. Construction of waste water stabilization ponds at the treatment plant will have a permanent visual impact but this could be moderated through landscaping and re-vegetating of exposed areas.

Project phase	Visual Impacts						
	Activity	Probability	Duration	Scale	Magnitude / Severity	Significance	
						WOM	MM
Construction	Removal of vegetation along trunk sewer lines	Highly Probable	Medium	Site	Low	Medium	Low
	Trenching	Highly Probable	Short term	Site	Low	Medium	Low
	Removal of vegetation & excavation / removal of soil at WWTP site	Definite	Permanent	site	Medium	Medium	Low

6.7.6.1 Mitigation measures

(1) Construction Phase

- If practically possible, construction camps should be located in already disturbed areas or where it isn't necessary to remove established vegetation (e.g. naturally bare areas).
- Keep the construction sites and camps neat, clean and organised in order to portray a tidy appearance.
- Rehabilitate or vegetate disturbed areas as soon as practically possible after construction. This should be done to restrict long stages of exposed soil and possible erosion that will result in indirect landscape and visual impacts
- All project facilities, fences and sign boards should be painted with a muted earth toned colour that will blend with the background colour of the vegetation.
- Be sensitive towards the use of glass or material with a high reflectivity in building designs which may cause glare in order to avoid visual discomfort for residents.

(2) Operational Phase

- Maintain the landscape to a high aesthetic standard to retain a high visual quality for visitors and observers.

5.7.10 Displacement of people and loss of property

(i) Impact Description

Land for constructing the WWTP has already been acquired by the proponent and there shall be no displacements at the site. However, it is expected that the construction of sewerage pipeline network will lead to loss of crops, trees and other assets. It is the responsibility of the proponent and the consultant to map and undertake a detailed valuation of property or assets likely to be affected before commencement of the project. The consultant shall appoint a team comprising of a qualified valuer, a sociologist and local administration to conduct the valuation. Project affected persons must be engaged in meaningful negotiations by the client to arrive at agreeable terms of compensation.

(ii) Significance Rating

The significance of this impact may be described as high without mitigation measures. But with adequate mitigation measures the impact will be turned to moderate or low. The impact will be confined to the project catchment areas.

Project phase	**Impact: Displacement and damage to property**						
	Activity	**Probability**	**Duration**	**Scale**	**Magnitude/ Severity**	**Significance**	
						WOM	**MM**
Construction Phase	Loss of land	Highly probable	Long Term	Local	Medium (WOM) Low (WM)	High	Moderate
	Damage to property	Definite	Short Term	Local	Medium (WOM) Low (WM)	High	Moderate

WOM = Without mitigation measures. WM = With mitigation measures

5.7.10.1 Mitigation Measures

- The consultant shall map and undertake a detailed valuation of property that is likely to be lost or damaged to serve as basis for compensation.

- Prepare a detailed report on compensation which shall be made public to avoid corruption and unfairness. Such a report shall contain the list of the PAP, property affected, terms and rates of compensation among other details.
- Constitute a grievance redress mechanism comprising of the client (TWSB), community representatives, officials from the ministry of lands, local administration among others
- Compensation for loss of land or property should be done promptly and should be based on market rates.
- Resettlement and compensation should be implemented in accordance to National and International guidelines

5.7.11 Socio-Economic Impact

(i) Impact Description

Both positive and negative social impacts were assessed. Categories investigated included:

- Health and social well-being
- Gender impacts

The proposed project has the potential to have a significant positive social impact in the region, but to realize this potential it should be managed carefully. This positive social impact must be balanced with the other potential significant impacts to ensure that the development is sustainable and done in a responsible way. A project of this magnitude will have both positive and negative impacts on the socio-economic character of the project area.

(ii) Significance Rating

This positive social impact must be balanced with the other potential significant impacts to ensure that the development is sustainable and done in a responsible way. There will be some negative localised social impacts which can be mitigated with different degrees of success.

Project phase	Impact: Socio-Economic						
	Activity	Probability	Duration	Scale	Magnitude/ Severity	Significance	
						WOM	MM
Construction	Impacts of project on employment creation	Definite	Long Term	Local	High	High +	High +
	Impacts of project on gender equity and relations	Highly probable	Long term	Local	Medium	Moderate	Moderate
	Increase HIV/AIDS prevalence	Definite	Long term	Local	Medium (WOM) Low (WM)	High	Moderate

5.7.11.1 Mitigation measures

1) Construction and Operational Phases

a. Employment

(i) Facilitate effective communication to affected communities to ensure that the expectations for job creation do not outweigh actual job availability.

(ii) Set up labour policies and recruitment procedures and make these known publicly.

(iii) Set up a labour office for job seekers to register and their details to be placed on a database.

(iv) Contractors should be expected to provide on-the-job training to local labour in order to up-grade existing skills.

b. Gender impacts

(i) Employment agencies and employers should give attention to gender distribution in employment and ensure that women get an equitable share of the opportunities.

(ii) The project implementers should ensure an equitable share of work for women and that their employment rights are upheld within the workplace.

c. HIV/AIDS impacts

i) Establish and implement an HIV/AIDS prevention programme specifically related to the project's construction phase. The programme should include, at a minimum, the identification of specific risk groups (e.g. bar workers, truck drivers).

CHAPTER 6

6. PROJECT ALTERNATIVES

This chapter presents the consideration of the various project alternatives detailing the background information which led to the selection of the preferred and best project option. The proposed alternatives are based on the proposed project location, construction materials, socio-economic considerations, proposed technologies and assessment of National and International factors influencing the siting of similar facilities.

6.1 Alternatives to site

Several studies have been undertaken by the proponent to explore best alternative location to site the WWTP. These include

6.1.1 Rehabilitation Alternative

The proponent conducted detailed studies on the possibility of setting up an additional anaerobic pond within the existing treatment works to increase its capacity from 750m^3/day to 2,063m^3/day. This was in cognizant of other rehabilitation works to be undertaken on the subsequent treatment elements of the treatment works. Under this alternative, the sewer network would be expanded to drain other areas not covered by the existing sewer network.

The implementation of the proposed expansion was to be undertaken in two phases seven years apart; that is, the immediate phase comprising of approximately 24 Km long sewer lines of various sizes aimed at replacing the small sized diameter pipes and extension of the service to Makutano area. The second phase referred to as the future phase, comprised of construction of approximately 30 km sewer lines to extend to other areas neighboring the Town. However, this option was abandoned based on the poor state and location of the existing WWTP to the CBD. Furthermore, its capacity could not be expanded further to merge with the increasing population of the area.

6.1.2 Decentralized System Alternative

This option mainly focused on the need for an urgent provision of sewerage infrastructure for part of the Meru Municipality, that is, within the upcoming town of Makutano located along the Meru Maua Road. It was proposed that a 4.5 km long sewer line be constructed to serve approximately 25% of the Makutano population. The collection system was designed to drain into the existing waste water stabilization ponds at the Meru Teachers Training College. Designs evaluation was done to ascertain the adequacy of the facilities and considered the following

i) Capacity for the existing ponds: - 275m3/day.
ii) Population for Meru teachers Training College; - 1,000 people.
iii) Computed Waste Water Discharge for the college population:- 80m^3/day.
iv) Total Population for the Makutano Area; - 9,750 people.
v) Expected Population for the Makutano Area to be served; - 2,438 people.
vi) Computed Waste Water Discharge for the served Makutano population: - 195m^3/day

It was then concluded that the existing waste water treatment infrastructure was adequate for the additional inflow. Rehabilitation works for the treatment works were also proposed. The project was financed by the Ministry of Lands, Housing and Urban Development through the County Government of Meru and implemented by MEWASS. Construction works commenced on July 2015. However, there has been a noticeable objection of the project by the residents on the perceived adverse environmental impacts of the proposed effluent discharge into Gaceuni River.

6.1.3 The Selected Project Site

Relocation of the current WWTP to an alternative location outside the CBD was selected as the best option for the proposed project. This was arrived at after the proponent and consulting team carried out detailed studies at the new site taking into consideration land availability, settlement patterns, topography and accessibility. Under this option most of

the Urban and Peri-Urban areas of the Meru Town CBD and Makutano towns will be covered by the sewer system.

This alternative site offered adequate land acreage for the construction of WWTP and associated facilities from a willing seller. Furthermore there will be no displacement of people from the acquired site. In terms of topography, the site is gently sloped and will allow sewage to flow by gravity from the sewage catchment areas. Settlements patterns around the proposed WWTP site also position this site as the best option. Houses around the area are few, scattered and far from the site.

If this option is accepted by the licensing authorities, it means that the existing WWTP shall be decommissioned at the inauguration of the new treatment facilities This will improve the quality of life of the residents through improvements in sanitation and quality of environment.

6.2 Sewage Treatment System Alternatives

Currently, the centralized sewage treatment system is the most popular and cost effective way of managing large quantities of municipal waste water. Such a system comprises of preliminary waste water treatment and a series of waste stabilization ponds comprising of anaerobic ponds, facultative ponds and maturation ponds. This system is discussed in the subsections below.

6.2.1 Centralized System Technology Option

Centralized systems treat the sewage through biological, mechanical and chemical processes in order to prepare the wastewater to be legally discharged to a body of water without posing a health threat to the public or creating an environmental problem. This option consists of the following waste treatment processes.

a) Preliminary Treatment

Screening, grinding, and grit removal are the most common preliminary treatment processes in a centralized system. This is meant to remove solids and grit.

b) Primary Treatment

Primary treatment typically consists of a settling or sedimentation stage where wastewater is passed through large circular or rectangular tanks where the wastewater is allowed to flow slowly for up to a few hours. Organic and inorganic solids settle to the bottom or float to the surface for further biological treatment

c) Secondary Treatment

Secondary wastewater treatment is almost always accomplished by using a biological treatment process. Microorganisms in suspension (in the "activated sludge" process), attached to media (in a "trickling filter" or one of its variations), or in ponds or other processes are used to remove biodegradable organic material.

d) Tertiary or Advanced Wastewater Treatment

Tertiary treatment is used in wastewater treatment plants when receiving water conditions or other uses require higher quality effluent than that produced by secondary wastewater treatment. Disinfection for control of pathogenic microorganisms and viruses is the most common type of tertiary treatment.

6.3 Odour Reduction Technologies

Odour management at the WWTP is critical for the acceptance of the proposed project by the local communities. Odour treatment technologies can be classified into physical/chemical and biological methods. Adsorption and chemical scrubbers are among the physical/chemical methods, while biofilters, biotrickling filters, bioscrubbers, and activated sludge diffusion reactors etc. are biological approaches for odour control.

Physical/chemical technologies have been broadly implemented since their discovery, low empty bed residence time and extensive experience in design and operation.

Most of these technologies have not been popular in developing countries mainly due to cost implications of acquiring and running them. The proponent and consultant engineers should explore the possibility and suitability of these methods in the proposed project.

Generally, odours can be controlled through proper project designs and layouts as well as adherence to stringent operational procedures. The proposed project has been designed with this in consideration and emission of offensive odours will greatly be minimized.

6.4 Solid Waste Management Options

WWTP generate a significant amount of solid wastes and it is important that their characteristic are known for proper management and disposal. Effluent discharge characteristics from industrial activities determine whether sludge can be re-used or disposed of (Harrington, W.M., 1978). The primary methods for managing solid wastes from WWTP are landfilling in a designated waste sanitary landfill and incineration with adequate air pollution controls. If sludge characteristics have the potential for re-use, several methods of direct land application can be used.

6.4.1 Sanitary Landfilling

Sludge from wastewater treatment plant can be incorporated into general solid waste sanitary landfills. But this depends on the characteristics of the dewatered sludge. If the sludge produced is designated as hazardous, the incorporation and disposal can only happen in a hazardous waste facility. Highly contaminated sludge should not be allowed for direct mixing, even in a designated hazardous waste sanitary landfill. Such wastes require segregation and/or encapsulation.

Monitoring of sanitary landfills is required to ensure that surface and subsurface waters are protected from contaminants. A contingency plan for correction must be developed during the design phase in order to avoid the degradation of the surrounding area if an upset occurs.

6.4.2 Incineration

Sludges designated as too hazardous for beneficial reuse will require reduction by incineration in areas where designated hazardous waste sanitary landfills are too far and uneconomical for use. The ash residue from the hazardous sludge combustion process will require disposal in a designated hazardous waste landfill or by encapsulation at a land disposal site. Air pollution control from the combustion of sludge is critical in the selection of the incineration process. Additional gas scrubbing may be required to remove gaseous products from the exhaust gas stream. Although incineration is an alternative for the disposal of dewatered sludge treatment, there are no industries that are expected to generate highly hazardous wastes within the sewage catchment area. Furthermore, MEWASS has the responsibility to ensure that effluent discharge from various establishments should be treated before release to the sewer system.

6.4.2 Beneficial Re-use

Sludge from wastewater treatment plants can be processed in a variety of ways to convert it into a readily marketable product safe for consumer use. The processes of conversion range from open composting to heat treatment. These include mechanical composting, flash drying, and fortification with additional nutrients. Once the quality of sludge has been tested and its safety and quality confirmed by lead agencies, it can be used by famers as manure. There is potential for use of sludge manure in agricultural farms surrounding the project site.

6.5 Alternatives to Energy use

Energy for the proposed project will be sourced from the national electricity grid. Electric power cannot be fully relied upon in the long term because of the frequent power shortages experienced in the country. Other sources of energy should be considered to provide power at the WWTP site. Solar power should be considered for lighting at the WWTP site and offices. The possibility of tapping biogas from the waste treatment processes should also be explored.

6.6 No project alternative

The no project alternative assumes that the proposed project will not be undertaken and status quo remains. The current wastewater treatment plant located at Gakoromone area was constructed in the early 70's with design capacity to treat 750m^3/day of raw sewage. However, due to the expansion of the town and the increase in population, the treatment plant receives inflows of about 6,000m^3/day, which exceeds the plant's design capacity by eight times. This notwithstanding, Meru town has continued to grow with other parts such as Makutano, Milimani, Kinoru, Mwandantu, Gitimbine, Kaaga, Gikumene and Kirunga areas lacking sewerage connection services. The present wastewater treatment plant is associated with pollution of the environment. The no development alternative would mean that the proposed improvements will not be implemented and the poor state of sewage management in the town will continue thus jeopardize the health and well-being of the residents. Already the TWSB and other implementing partners have committed significant financial resources in the design and planning of the project. Huge financial loses would also be incurred if this option prevails.

CHAPTER 7

7. PUBLIC CONSULTATION

7.1 Introduction

Public participation and involvement is an important aspect in the design, planning and implementation of any development project. Public participation tries to inform and consult the public to ensure that due consideration is given to public values, concerns and preferences when decisions are made. It encompasses the public actively sharing in the decisions that government and other agencies make in their search for solutions to issues of public interest. Effective public participation requires the availability of adequate information in public inputs.

7.2 Public participation in the proposed Project

Public consultations with interested and affected parties in this project were done with the following aims:

(i) To inform the local people, leaders and the beneficiary/project affected communities about the proposed project and its objectives

(ii) To seek views, concerns and opinions of people in the project area concerning the proposed project

(iii)To establish if the local people foresee any positive or negative environmental impact which may arise as a result of implementation of the proposed project and if so, how they would wish these perceived impacts to be addressed.

7.3 Stakeholder Analysis

Stakeholder analysis was used to identify stakeholders that would be involved in the ESIA process. The basis of inclusion was informed by the fact that whether they were directly or indirectly affected by the proposed project. The stakeholders have been categorized into two groups for purposes of this study. The first group consisted of institutional stakeholders and the second consisted of community stakeholders. The

institutional stakeholders were drawn from line government ministries and departments, county government as well as various agencies with roles relevant to the proposed project. Community stakeholders on the other hand comprise mainly the Project Affected Persons (PAPs) and their representatives.

7.4 Methodology

Public participation was mainly achieved through direct interviews, stakeholder workshop and questionnaire administration. The following is a detailed discussion of public consultation methodology used by the EIA team

7.4.1 Direct Interviews

This involved interviewing key stakeholders in order to gather information on the design and layout of the project, baseline information on the project area and also to assist in analysis of existing and anticipated impacts of project activities to the community and institutions within the project catchment area. These interviews were conducted to augment and confirm data and information obtained from other sources. Among those consulted through this method include the chiefs and sub-chiefs in the affected areas, Technical Officer of Meru Water and Sewerage Services (MEWASS), Project Design Engineers (Ecosite Development Consultant) and a representative of the Tana Water Services Board.

Plate 4: Interview with MEWASS technical staff

7.4.2 Questionnaire administration

Questionnaires were prepared and administered mainly to the members of the public along the sewer pipeline network and at the proposed site for waste water treatment plant. The aim was to inform them and seek their views on the proposed construction of new sewerage within the catchment area. Sixty questionnaires were administered and duly filled (see attached sample questionnaires in Appendix 2).

7.4.3 Stakeholder workshops

A stakeholder workshop is a meeting of multiple stakeholders that deliberates to improve a particular situation that affects them. It forms a useful social interaction that enables different individuals and groups, who are affected by an issue or initiative, to enter into dialogue, negotiate, learn, and make decisions for collective action. A stakeholder workshop brings together government staff, policy makers, community representatives, scientists, business people and non-governmental representatives to think and work better together. It is in line with this perspective that the consultant organized and held a stakeholder workshop at the Three Steers Hotel. The workshop had the following three main objectives:

(i) Present to the participants the progress report on the project design;

(ii) Get feedback from project stakeholders in form of questions / comments / issues on the presentation by the Client and Consultant Teams on the report and on the progress of the design;

(iii) To respond to questions, discuss and agree on various issues/concerns raised by the participants/beneficiaries, as much as possible.

Among those that attended the workshop were representatives from the Provincial Administration, County Government of Meru, Educational Institutions, Health Institutions, Religious Organizations, Tana Water Services Board, Meru Water and Sewerage Services and Ecosite Development Consultants.

Plate 5: Workshop Participants at Three Steers Hotel

7.4.4 Community consultative meetings

Community consultative meetings offer an opportunity to sensitize stakeholders and enable the ESIA team to gather information on issues relevant to the project. As at the moment, the community has mainly been sensitized through the local leadership comprising of chiefs and sub-chiefs. Nevertheless, the project consultant has constituted a

team that comprise of the local administration, a registered valuer, a surveyor and a sociologist to mobilize project affected persons for further sensitization and consultation especially on compensation issues.

7.5 Stakeholders comments

Stakeholder comments are an important part of an ESIA process. Consideration of these issues is important for the successful implementation of the proposed project and its acceptability by the local community. The ESIA team interviewed and administered questionnaires to the local people neighboring the project site and conducted face to face interviews with the local leaders and county government officials.

7.5.1 Summary of public comments

A summary of the responses received after administering questionnaires to the public seeking their opinions has been compiled and presented in this sub-section. The respondents were sampled from Meru town, Makutano and at the proposed location of the waste water treatment plant. The full details of the responses are attached in Appendix 2 of this report.

Some of the benefits that the respondents gave out included;

- Relocation of the current WWTP from town will create more space for expanding the Gakoromone Market or for putting up business premises that will improve people's livelihoods and earn the county government revenue through taxes.
- The cost incurred in sewage handling and disposal by private handlers especially in areas not covered by the existing sewage network such as Makutano will be reduced. There will be no need for constructing septic tanks in upcoming developments.
- Creation of employment opportunities for the residents during the construction and operational phases of the new project.
- Improvements in hygiene and sanitation in the town hence improving quality of life of the people.

The respondents further cited the following impacts associated with the project. These include;

- Interference with the parking places in business premises hence potential losses.
- Disruption of transport operations along the planned sewer lines resulting to traffic congestion
- Some of the respondents were concerned about damages to property, such as on the pavements and entry ways, loss crops, buildings etc during the installation process.
- Air and noise pollution was also associated with the proposed project.
- Loss of jobs, especially among those private companies that own exhausters, once the project is completed.

Mitigation measures proposed to minimize the impacts identified include:

- The construction work should be done as from late in the evening into the night and not during business hours.
- The work should take less time as possible within the town center so as to minimize the levels of disruptions on both transportation and economical losses.
- The affected individuals should be compensated before and after their property has been destroyed to avoid conflicts.
- Put up measures to contain foul smell from the proposed WWTP site.

7.5.2 Summary of comments from stakeholder workshops

Among other issues addressed in the workshop include the extent of coverage of the proposed project, whether the existing Gakoromone Sewage Treatment Works (STW) will be decommissioned after commissioning of the new plant and actual cost of the proposed project. The participants also wanted to know the measures that will be put in place to ensure that effluent discharged is properly treated. The client and consultant responded and addressed the concerns.

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CHAPTER 8

8. ENVIRONMENTAL MANAGEMENT PLAN (EMP)

8.1 Introduction

An EMP is an instrument that summarizes the potential impacts of a proposed project, mitigation measures, responsibility of the various actors, timeframes and estimated cost of remedial actions. An EMP allows for integration of environmental management strategies in the life cycle of a project, namely, during implementation, operation and decommissioning phases of the project.

8.2 Scope and Objectives of the EMP

The focus of an Environmental Management Plan is to provide a framework of action that will mitigate impacts identified during assessment. It is an instrument that will guide the contractor, the client (TWSB), MEWASS, users of the proposed facility and other key stakeholders to adhere to environmental best practices during the various phases of the project. This plan is meant to establish measures and procedures to control the analyzed impacts and monitor their progress. It will achieve the following in the long run:

(i) It will provide the basis for environmental monitoring, auditing and evaluation of the various activities of the project taking into account the applicable environmental laws and regulations as outlined in Chapter 4
(ii) Points and instructs the proponent, operators, users and other key stakeholders of their mandates and responsibilities in all phases of project.
(iii) Ensures continuous compliance of the client, operators, contractor, users and other key stakeholders with applicable legislation, standards and policies regarding the environment;
(iv) Assure the regulators, interested and affected parties that their demands and needs are being met and action is taken.

8.3 Responsibility of the various stakeholders

Implementation and monitoring of the EMP is the responsibility of various actors chief among them the proponent, the operator and contractor. Regulatory bodies such as NEMA and other government departments also have a role to ensure that the environment is protected, health and safety of workers and the public is safeguarded. The proponent should include in their contractual arrangements with contractors clauses that require them to protect and conserve the environment. This sub-section gives a summary of the roles and responsibilities of the various key stakeholders.

8.3.1 Responsibility of Tana Water Services Board (TWSB)

The proponent (TWSB) will ensure that all project operations are conducted in accordance with their internal environmental policies and in accordance with the EMP. TWSB in partnership with the contractor, the operator (MEWASS) and other key stakeholders will ensure that the EMP and other requirements related to health, safety and environment are implemented in full. TWSB should strive to manage operations in a manner to protect the environment and health and safety of employees, contractors, consumers and the general public. Among other objectives, the proponent should:

(i) Ensure that all authorizations/Approvals/Licenses required for project implementation are obtained;
(ii) Request the contractor operates on the basis of valid Authorizations/approvals/ licenses for the activities to be implemented;
(iii) Ensure that the EMP is an integral part of the contract document with the Contractor and that the contractor will be responsible for its implementation;
(iv) Establish institutional linkages with relevant parties in the project implementation as needed, or designate a representative for that purpose;
(v) Ensure that the various project activities comply with the mitigation measures proposed in the Environmental Management and Monitoring Program (EMMP);
(vi) Make regular inspections to all the different activities with regard to social aspects, health, safety and environment and check for any non-conformity with the EMP attributable to the Contractor and identify the steps taken for its correction;

(vii) Ensure that any corrective activities recommended by the audits or inspections (performed internally or externally) are implemented within the pre-set timeframes.

8.3.2 Responsibility of Meru Water and Sewerage Services (MEWASS)

The responsibility of operating, maintaining and managing the project after completion of the construction phase lies primarily with the Meru Water and Sewerage Services (MEWASS). Sewage collection and treatment is vital for the protection of public health and the environment. MEWASS shall mainly be responsible in implementing mitigation measures proposed in the EMMP especially during the operation phase of the project. It shall;

- Operate and maintain the sewerage system in a manner that will avoid blockages, spills and odours
- Manage any sewer spills and clear and disinfect affected properties or environment
- Carry out effluent quality analysis in collaboration with other government lead agencies
- Ensure treated wastewater and sludge for re-use/disposal meets accepted health standards
- Conduct regular monitoring and inspection to ensure facilities are not interfered with unless
- Ensure that effluent discharged from industries into the sewage system is treated and meets effluent discharge quality standards

8.3.3 Water Resources Authority (WRA)

Water Resources Authority (WRMA) is a state corporation under the Ministry of Environment and Natural Resources which was initially established under the Water Act 2002 as WARMA but has now been changed into the WRA under the Water Act 2016. It is the lead agency in water resources management in Kenya. The Authority will carry out the following mandates under this EMMP:

- Monitor and enforce conditions attached to water permits and water use;
- Regulate and protect water resources quality from adverse impacts;

- Regulate and protect water resources from adverse impacts;
- Regulate water infrastructure, use and effluent discharge;
- Work with the beneficiary communities to manage and protect water catchments;
- Establish water resources monitoring networks

8.3.4 Responsibility of the Contractor

The contractor should identify individuals responsible for overall management of the environment, social management, safety and health management during all operations. The Contractor shall be responsible for relevant training of its staff, which must be able to complete the project activities in an efficient and appropriate manner in accordance with the contractual requirements of the proponent. Among many tasks, the contractor shall:

(i) Prepare its own EMP implementation plan as well as a health and safety plan within 30 days of signing of the contract.
(ii) Operate on the basis of valid Licenses/Approvals/Authorizations for the activities to be implemented;
(iii) Prevent or minimize the occurrence of accidents which might cause damage to the environment and be able to respond positively to an accident if it occurs;
(iv) Ensure compliance to working procedures and environmental requirements and health and safety established in the contract with the Proponent;
(v) Minimize environmental damage, waste control, avoid pollution, prevent loss or damage on natural resources and minimize the effects on the users and occupants of surrounding lands and the public;
(vi) Provide Personal Protective Equipment (PPE) to workers which is appropriate to the tasks to be performed and ensure that it is used;
(vii) Manage the complaints process on the elements that fall within its jurisdiction, or refer complaints to the Proponent, so that they can receive treatment/appropriate response;

(viii) Prepare a Rehabilitation Plan which shall include preliminary designs on the temporary and permanent landscaping plan during both the construction and post-construction and maintenance period (where applicable).

8.3.5 Responsibility of National Environment Management Authority (NEMA)

NEMA is the regulatory body charged with management and coordination of environmental issues. The object and purpose for which the Authority was established is to exercise general supervision and co-ordination over all matters relating to the environment and to be the principal instrument of Government in the implementation of all policies relating to the environment.

Regulatory function

- Co-ordinate the various environmental management activities being undertaken by the lead agencies and promote the integration of environmental considerations into development policies, plans, programmes and projects.
- Identify projects and programmes or types of projects and programmes, plans and policies for which environmental audit or environmental monitoring must be conducted under this Act;
- Monitor and assess activities, including activities being carried out by relevant lead agencies, in order to ensure that the environment is not degraded by such activities

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8.4 Construction Phase Environmental Management Plan

The EMP for the construction phase mainly focuses on impacts that are likely to affect the environment, the health and safety of the public as well as the workers during the planning and construction process. Mitigation measures are then proposed to minimize the anticipated impacts. Issues covered by the construction EMP include; Occupational safety and health, air pollution, surface and ground water contamination, noise pollution, displacement and damage to property and traffic impact among others. This are presented in Table 8.1

Table 8.1: Construction Phase Environmental Management Plan

POTENTIAL IMPACT	MITIGATION MEASURES	RESPONSIBILITIES	TIME FRAME	ESTIMATED COST (KSHS)
Impacts of obtaining construction materials	• Strip and stockpile topsoil from borrow pits and quarries for use in site restoration. • Close all borrow pits and quarries in accordance with an approved plan to maximize future use and minimize health and safety hazards • Re-use excavated materials from the works as fill.	Contractor	During construction phase	1,000,000
Impacts on businesses and traffic flow	• Sensitize drivers on safe driving and working practices • Avoid transporting materials during periods of peak traffic activity • Trenching and laying of pipes should be completed within the planned timeframes to avoid prolonged disruption to businesses • Provide alternative routes for traffic where total closure of roads is expected during trenching • Erect appropriate road signs to warn road users of the construction activities. • Provide temporary bridges over open trenches to facilitate access to businesses	Contractor	Throughout construction phase	1,000,000

POTENTIAL IMPACT	MITIGATION MEASURES	RESPONSIBILITIES	TIME FRAME	ESTIMATED COST (KSHS)
Air pollution (Exhaust emissions from vehicles & Dust)	• Service and maintain machinery according to manufacturer's instructions to improve fuel combustion and reduce exhaust emission to the atmosphere. • Spray water on access roads, stockpiles and cleared areas to minimize dust pollution. • Cover all vehicles ferrying construction materials such as sand or aggregate to avoid dispersal of particles/dust along the roads • Provide personal protective equipment gear such as dusk masks to workers who may exposed to excess dust • Impose vehicle speed limits to 10 km/h in all areas within the site boundaries. • Avoid open air burning of wastes at the site	Contractor	Throughout the construction phase	800,000

POTENTIAL IMPACT	MITIGATION MEASURES	RESPONSIBILITIES	TIME FRAME	ESTIMATED COST (KSHS)
Soil erosion and contamination	• Vegetation should only be removed from clearly marked areas • Earthworks should be carried out during the dry season to prevent soil from being washed away by rain • Excavated materials and stockpiled soils should be covered or kept at appropriate sites • Undertake appropriate soil erosion control measures along the trenches and WWTP sites • Construction vehicles and machines must be maintained properly to ensure that oil spillages are kept at a minimum. • Spill trays must be provided if refuelling of construction vehicles are done on site • Materials, fuels and chemicals must be stored in a specific and secured area to prevent pollution from spillages and leakages. The basic EMCA Regulations on of hazardous waste management must be applied fully. • Train drivers and workers on oil and fuel management	Contractor and Civil Engineer	Construction	500,000

POTENTIAL IMPACT	MITIGATION MEASURES	RESPONSIBILITIES	TIME FRAME	ESTIMATED COST (KSHS)
Noise Pollution	• Schedule road traffic movements to normal working hours (08H00 –17H00). • Noisy equipment and vehicles on the site should be equipped with noise suppressing measures and kept in proper working conditions. • Provide personal protection equipment such as ear muffs to workers operating in noisy areas • Pumps and generators should be stationed far away from areas that are sensitive to noise such hospitals • Avoid unnecessary hooting and revving of engines • Switch off engines when vehicles or machines are not in use	Contractor	Construction Phase	300,000

POTENTIAL IMPACT	MITIGATION MEASURES	RESPONSIBILITIES	TIME FRAME	ESTIMATED COST (KSHS)
Solid Wastes	• Develop a Waste Management Plan to guide the handling, storage, transport and disposal of solid and hazardous wastes in compliance with Solid Waste Regulations 2006 • Recycle or re-use solid wastes where applicable in line with sound environmental management practices • Dispose of non-recycled wastes to sites designated by Meru Municipal Council as dumpsites • Organic wastes from construction camps can be composted	Contractor	Construction Phase	500,000
Surface and ground water contamination	• Construct oil-water interceptors or sumps to capture discharge of oils, fuels and other polluting liquids • Provide pit latrines/portable toilets at the camp and construction sites for use by workers • Store all raw materials away from the vicinity of water bodies along the project sites to avoid contamination. • Sensitize workers not to dump waste generated from camps and construction sites into rivers	Contractor	Throughout the construction phase	400,000

POTENTIAL IMPACT	MITIGATION MEASURES	RESPONSIBILITIES	TIME FRAME	ESTIMATED COST (KSHS)
Occupational Safety and Health hazards	• The Contractor shall conform to all the requirements of the Occupational Health and Safety Act, 2007. • Recruit a safety and health personnel to develop and implement OSH plan • The contractor shall provide ample warning signs and protection around open excavations, stacks of material, etc. and shall be held liable for all claims as a result of neglect of such precautions and provisions. • Restrict and control unauthorized access into construction sites to prevent accidents and injuries. • Train workers on the use of firefighting equipment and first aid • Ensure that persons handling equipment and materials are suitably trained, and supervised • Ensure that emergency contact numbers of the police, fire brigade and ambulance are available at the construction sites. • Provide sanitary facilities at construction sites and potable drinking water • Report and record health, safety and environmental incidences as required by law	Contractor	Throughout the construction phase	1,500,000

POTENTIAL IMPACT	MITIGATION MEASURES	RESPONSIBILITIES	TIME FRAME	ESTIMATED COST (KSHS)
Damage to existing underground infrastructures	• Obtain maps of existing underground infrastructure from relevant institutions to avoid damaging them. • Locate, mark and exercise caution when excavating trenches to minimize chances of damaging such infrastructure • Notify responsible institutions of any damage to ensure that services are restored within the shortest time possible.	Contractor, Meru Water & Sewerage Services (MEWASS), KPLC and others	Throughout the construction phase	100,000
Displacement of people and damage to property	• Undertake a detailed valuation of property likely to be lost or damaged and prepare report on compensation before project commencement. • Compensation for loss of land or property should be done promptly and should be based on market rates • Constitute a grievance redress mechanism comprising of representatives of all stakeholders • Resettlement and compensation should be implemented in accordance to National and International guidelines	TWSB, MEWASS, consultant, County Government of Meru	Throughout the construction phase	To be determined
Socio-Economic impact	• Give priority to locals when hiring workers for the project • Ensure gender balance in employment as far	Contractor	Construction phase	To be determined by the contractor

POTENTIAL IMPACT	MITIGATION MEASURES	RESPONSIBILITIES	TIME FRAME	ESTIMATED COST (KSHS)
	as possible. • Implement HIV/AIDS and STD awareness and prevention programme for workers and local residents targeting risk groups • Constitute a committee to handle social conflicts related to the project			
Visual Impact	• Vegetation clearance should be restricted and confined to marked workstations • Rehabilitate all disturbed areas by backfilling and planting appropriate trees and grasses • Establish access roads for use to avoid unnecessary trampling of vegetation outside work areas	Contractor	During construction phase	500,000
Total				**6,600,000.00**

8.5 Operation phase Environmental Management Plan

Operation phase EMP proposes measures that should be undertaken to minimize adverse impacts that are likely to result from operation activities of the project. The following issues have been identified and mitigation measures proposed as shown in Table 9.2.

- Water and soil pollution
- Solid waste management
- Odours from the WWTP
- Chemical hazards
- Improperly treated effluent discharge and sludge
- Physical hazards and safety

Table 8.2: Operation Phase Environmental Management & Monitoring Plan

POTENTIAL ENVIRONMENTAL ISSUES	MITIGATION MEASURES	RESPONSIBILITY	TIME FRAME	ESTIMATED COST (KSHS)
Contamination of water and soil from sewage leakages and overflows	• Regular monitoring and inspection of sewer lines to identify broken pipes and damaged manholes for repair or maintenance. • Use of high quality materials that can withstand anticipated sewage loads and as recommended by the design engineers to prevent leakages and overflows. • Clear and unclog blocked sewer lines within the shortest time possible to contain sewage spills and overflows • Clean and disinfect contaminated sites	Contractor, MEWASS	Throughout the operation phase	To be determined by contractor, MEWASS

POTENTIAL ENVIRONMENTAL ISSUES	MITIGATION MEASURES	RESPONSIBILITY	TIME FRAME	ESTIMATED COST (KSHS)
Solid waste management	• Solid wastes from sewage inflow and site offices should be collected and dumped at designated dumpsites • Sludge if not suitable for agriculture should be disposed of by land filling			300,000
Odours from WWTP	• Maintaining proper operations and maintenance practices such as sewer inspections and management to avoid odours • Provide adequate buffer areas such as trees between WWTP site and potential receptors • Minimize hydraulic detention times in pipes and wet wells • Reduce turbulence by minimizing the use of drop manholes • Cover emission points (e.g., aeration basins, clarifiers, sludge thickeners, tanks, and channels), • Explore the use of modern technology systems such as bio-filters and chemical scrubbers to control odours	TWASB, Design consultant, Contractor, MEWASS	Construction & Operation Phase	To be determined

POTENTIAL ENVIRONMENTAL ISSUES	MITIGATION MEASURES	RESPONSIBILITY	TIME FRAME	ESTIMATED COST (KSHS)
Exposure to Chemical Hazards	• Train WWTP operators in safe handling of waste water treatment chemicals and emergency response procedures • Provide appropriate personal protective equipment for use by WWTP workers • Install safety showers and eye wash stations near areas where hazardous chemicals are stored or used • Eating, smoking, and drinking should be prohibited within the WWTP. .	MEWASS	Operation phase	1,000,000
Impact of improperly treated waste water and sludge	• Comply with effluent discharge quality standards as stipulated in EMCA Water Quality Regulations 2006. • Sludge intended for agricultural purposes must be properly tested and certified by accredited research institutions before being put into use • Farmers should be trained on how to safely use treated waste water for irrigation in their farms	MEWASS, County Public Health office, KARI	Operation phase	1,000,000

POTENTIAL ENVIRONMENTAL ISSUES	MITIGATION MEASURES	RESPONSIBILITY	TIME FRAME	ESTIMATED COST (KSHS)
Physical hazards and safety	• Erect perimeter fence around waste water treatment facilities to restrict access and prevent physical injuries from people and animals • Post security guards to secure the site. • Provide emergency rescue facilities such rescue buoys and throw bags and train workers on how to use them in case of an emergency • Use fall protection equipment when working at heights • Provide adequate security lights around the WWTP	MEWASS	Operation Phase (yearly)	500,000
Total				**2,800,000**

8.6 Decommissioning phase Environmental Management Plan

8.6.1 Overview

Decommissioning is the final phase of a project life-cycle. It is the release of valuable assets such as machinery and sites for alternative use, recycling and reuse of materials and the restoration of environmental amenity. The decommissioning of one or all components of the proposed project will have some effect on the environmental status quo of the project site, either in a positive or in a negative way. It is therefore important that an Environmental management plan be drawn before any decommissioning activities are allowed to commence. An EMP for decommissioning protects the public, the environment and workers from the hazards associated with decommissioning activities

This sub section contains various environmental guidelines which will assist decision makers to take environmentally responsible and sustainable decisions during decommissioning. In this way, the positive aspects of decommissioning may be maximized and the negative aspects minimized or even avoided.

8.6.2 General guidelines for decommissioning Planning

Before commencement of decommissioning activities, the proponent should develop a detailed master plan for decommissioning. Normally social issues are likely to arise during this phase and may include job losses and compensation among others. It is important therefore to appoint a committee, where affected parties can present their grievances and decision taken. A decommissioning master plan will guide on the various activities to ensure environmental protection, enhance safety and health of the public as well as their social interests. Such a plan should contain:

i) Details of infrastructure, buildings and structures to be retained; alternative uses and further development proposals for retained infrastructure, and structures; infrastructure and structures to be dismantled, removed, sold for recycling and / or disposed of.

ii) Environmental restoration plan. The dismantling of site facilities and transportation of material may expose the ground, leave open pits and disturb vegetation. Such sites can be restored by backfilling with soil and replanting of grass or trees on disturbed areas.

iii) Waste Management Plan – A formal site waste management plan should be developed to ensure that both solid and liquid waste is managed in accordance to the existing applicable laws on waste handling and disposal.

iv) Health & Safety plan that shall be implemented to safeguard the safety, health and welfare of workers and the public. Establish and operate an emergency evacuation procedure for casualties.

v) Mechanisms for addressing project related social issues

vi) Take note of any existing regional and national development plans that may be of relevance to the area.

8.7 Environmental Monitoring and Auditing

Environmental monitoring and audits are essential in the project's life span as they are conducted to establish if project implementation has complied with set environmental management standards in accordance with applicable legislation and regulations. In this Project, environmental monitoring and audit will be conducted to ensure that identified potential negative impacts are mitigated during the project's implementation, operation and decommissioning periods.

Environmental concerns, that will be monitored and audited during the project's construction and maintenance period include: water quality, air quality, and occupational health and safety issues.

8.7.1 Monitoring of Occupational Health and Safety issues

Project activities during the construction and operation phase involve a lot of risks and exposure to hazards. It is therefore important to regularly check and monitor the activities to find out the extent to which the impacts are mitigated and emerging problems are addressed. Table 8.3 presents a monitoring plan of the key issues key verifiable indicators which will be used to monitor the impacts are presented below.

Table 8.3: Monitoring of Occupational Health and safety issues

Monitoring Parameters	Responsibility	Monitoring Location(s)	Time/Frequency	Indicators
Condition of machinery and equipment	Contractor, MEWASS	At work stations	Weekly	Service, maintenance, repair or replacement records of faulty machines
Accidents, incidents, injuries etc.	Contractor, MEWASS	At work stations	Daily	Mitigation/prevention measures in place, PPEs, Records of incidents or accidents, Medical records, Training , First Aid kits; Fire extinguishers
Dust and exhaust emissions	Contractor, MEWASS	At work stations	Daily	Health safety measures in place
Noise emissions	Contractor	At work stations	Daily	Noise monitoring records
Sanitation and welfare facilities	Contractor, MEWASS	Workers camps, construction sites and site offices	Weekly	Presence of sanitation & welfare facilities
Oil spills and leakages	Contractor	Workers camps and construction sites	Daily	Records of daily inspections
Solid Wastes	Contractor, MEWASS	Workers camps, construction sites and site offices	Daily/weekly	Inspection and waste disposal records

8.7.2 Waste water monitoring

Every local authority or person operating a sewage system or operator of any industrial undertaking is required to monitor discharge into the environment as set out in the Fourth Schedule to Water Quality Regulations 2006. Discharge of improperly treated waste water may lead to pollution of ground and surface water. To avoid such occurrences, effluent from waste water treatment plants (WWTP) should be constantly monitored, along with the water quality in the receiving water bodies. Sampling points should be established at the point of effluent discharge from the WWTP and downstream and upstream of the receiving river. The operator should also monitor the quality of effluent discharged from industries at the point of release to the sewer system. This will ensure that industrial effluent is properly treated before discharge.

Waste water monitoring and discharge to the environment should strictly follow guidelines and standards stipulated in the fourth schedule of the Environmental Management and Co-ordination (Water Quality) Regulations 2006. Water quality monitoring plan is presented in Table 8.4.

Table 8.4: Waste water monitoring plan

Monitoring Parameters	Responsibility	Monitoring Location(s)	Time/Frequency	Indicators
BOD, Temperature, Total Suspended Solids (TSS), COD, ammonia nitrogen (NH3-N), PH and faecal coliform counts	MEWASS	Treated water at discharge point from WWTP Sampling points at River Kinyarita	Daily, weekly as required	Quality of water downstream
Industrial effluent (Temperature, COD, BOD5, oils & grease, suspended solids, N, P, pH, sulphates, chlorates, Fe, Cu, Cr, Zn, Ni).	MEWASS	Industrial effluent discharge points	Quarterly	Conformity to effluent discharge standards

8.7.3 Sludge monitoring

Sampling and analysis of sludge content is essential before sludge is put into agricultural use or disposed of. The operator should therefore draft a sampling and analysis plan and identify acceptable and certified laboratories to conduct the analysis. Sludge should be tested for toxicity in order to demonstrate that the sludge or sludge products are not hazardous and that it is suitable for land based applications. Table 8.5 shows the monitoring parameters for monitoring and analysis.

Table 8.5: Sludge Monitoring and Analysis

Monitoring Parameters	Responsibility	Monitoring Location(s)	Time/Frequency	Indicators
PH, NH4, P2O5, K2O, CaO, MgO, , Fe, Mn, Mo, Cd, Cr, Cu, Hg, Ni,NH4-N, B, Pb, Zn, PCB	MEWASS	At the WWTP	To be determined by the operator	Sludge quality depending on its intended use

8.7.4 Air quality monitoring

Odour emissions from waste water treatment plants are generally of much concern to local communities residing in the vicinity of the project site. Odour development is a process that begins at the point of wastewater discharge from homes and industries. It continues with collection and movement of wastewater in gravity sewers and ends with the actual wastewater treatment, solids handling and disposal at the plant or disposal site.

Careful sampling and analysis of gases to identify and characterize the odors is of necessity towards the control of offensive odours. Odours can be quantified by direct sensory measurement of their concentration and intensity, using the human olfactory sense as the odor detector. Alternatively, chemical analysis of odor constituents could be performed. Portable gas monitoring devices are also available and can be used in

monitoring of odours. The main monitoring parameters are hydrogen sulphide and ammonia (Table 8.6)

Table 8.6: Air quality monitoring

Monitoring Parameters	**Responsibility**	**Monitoring Location(s)**	**Time/Frequency**	**Indicators**
Hydrogen Sulphide, Methane, Sulphur dioxide,	MEWASS	At the WWTP site	Yearly, or as need arises	Ambient air quality around the WWTP

CHAPTER 9

9. CONCLUSION AND RECOMMENDATIONS

9.1 Conclusion

The proposed construction of new sewerage facilities within Meru Town will improve public health and sanitation in the region. Improper disposal of human waste due to inadequate coverage of the current sewage system will be minimized. It is expected that the project will attract more development to the region as it will reduce the economic costs of sewage management through septic tanks. Potential negative environmental and social impacts associated with this project have been identified in this report and appropriate mitigation measures proposed. The consultant has developed an Environmental Management and Monitoring Plan which should be strictly followed and those with responsibilities in project implementation and operation should perform their functions as indicated.

9.2 Recommendations

- Ensure that worker's occupational health and safety standards are maintained through proper training, provision of protective clothing and managing residential camps to the required health standards. Proper warning and protective controls should also be instituted to prevent accidents and injury to the general public especially along open trenches and manholes
- In order to obtain the support of the local communities, the proponent and the consultant should engage the PAP in meaningful and honest consultations. The process should be all-inclusive where all stakeholders or their representatives are brought on board and compensation done in a fair and open process.

- The contractor should strictly adhere to construction work program to ensure works are completed within set time periods to minimize disruption to businesses and traffic flow.
- Proper training should be given to staff that shall be responsible for managing the project during the operation phase. Staff in charge of waste water monitoring and treatment, inspection and repair of damaged sewer facilities among others should be adequately trained. The project should be allocated adequate finances to ensure that its properly run and managed.

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APPENDICES

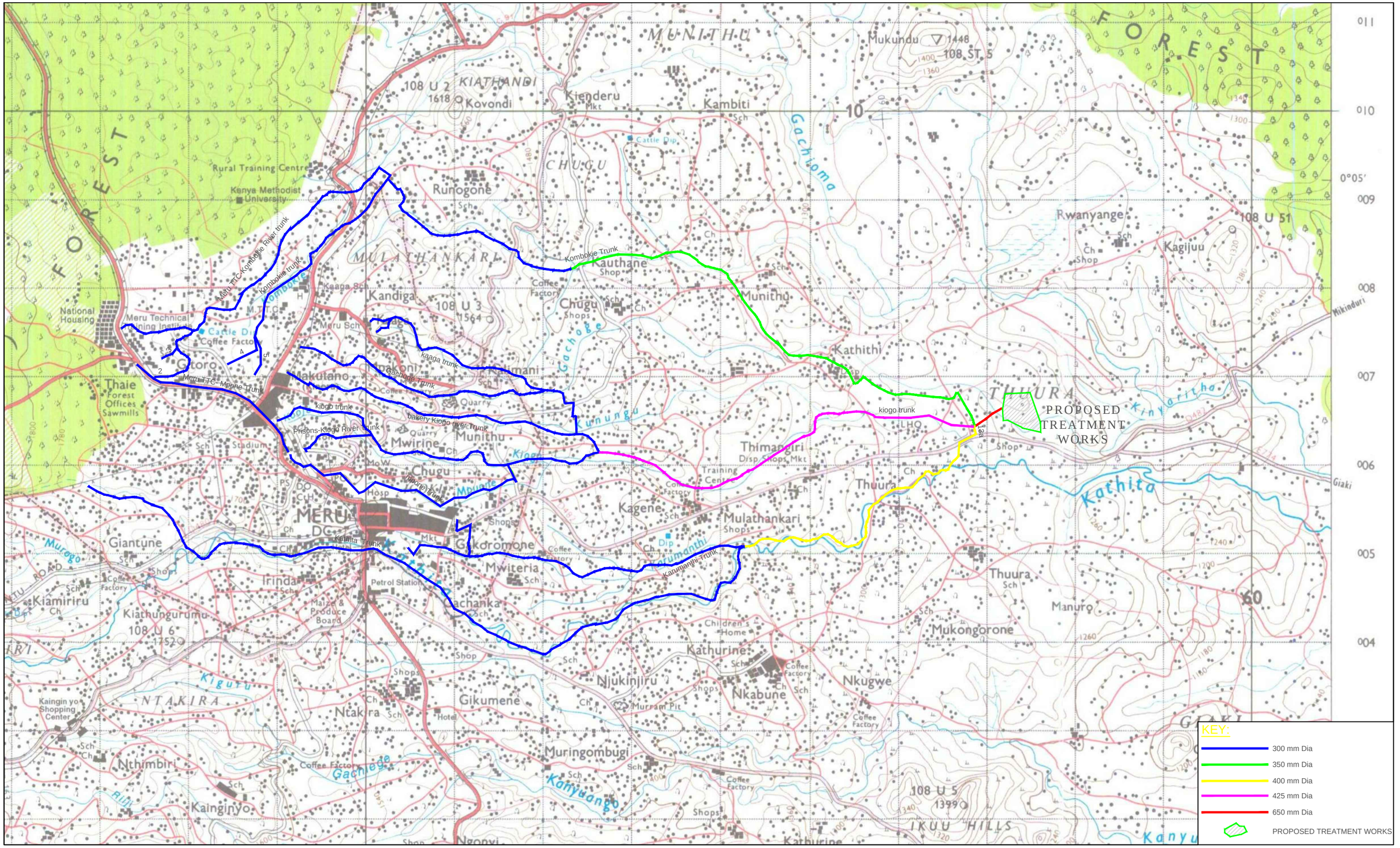
Appendix 1: Project design maps and drawings

Appendix 2: Public consultation documentation

Appendix 3: Land Purchase Agreement

Appendix 4: Firm of Experts/EIA Experts Practicing Licenses

APPENDIX 1
Project Design Maps and Drawings



REV. No.	DESCRIPTION	DATE	REV. No.	DESCRIPTION	DATE

CONSULTANT:

H. E. C

Ecosite Development Consultants Ltd

Consulting Civil and Development Engineers

P.O.BOX 56075-00200 NAIROBI.

CLIENT

TANA WATER SERVICES BOARD

PROJECT

CONSULTANCY SERVICES FOR DESIGN REVIEW AND CONSTRUCTION SUPERVISION OF MERU SEWERAGE PROJECT

DRG TITLE

PROPOSED MERU TRUNK SEWERS

GENERAL LAYOUT PLAN TRUNK SIZES

Date:	OCTOBER 2017
Designed:	NKT
Drawn:	JGG
Checked:	CMM
Approved:	WKM
Scale:	1:20,000 (AT A1)

JOB No. K1373

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DRG. No. MSP/K1373/01

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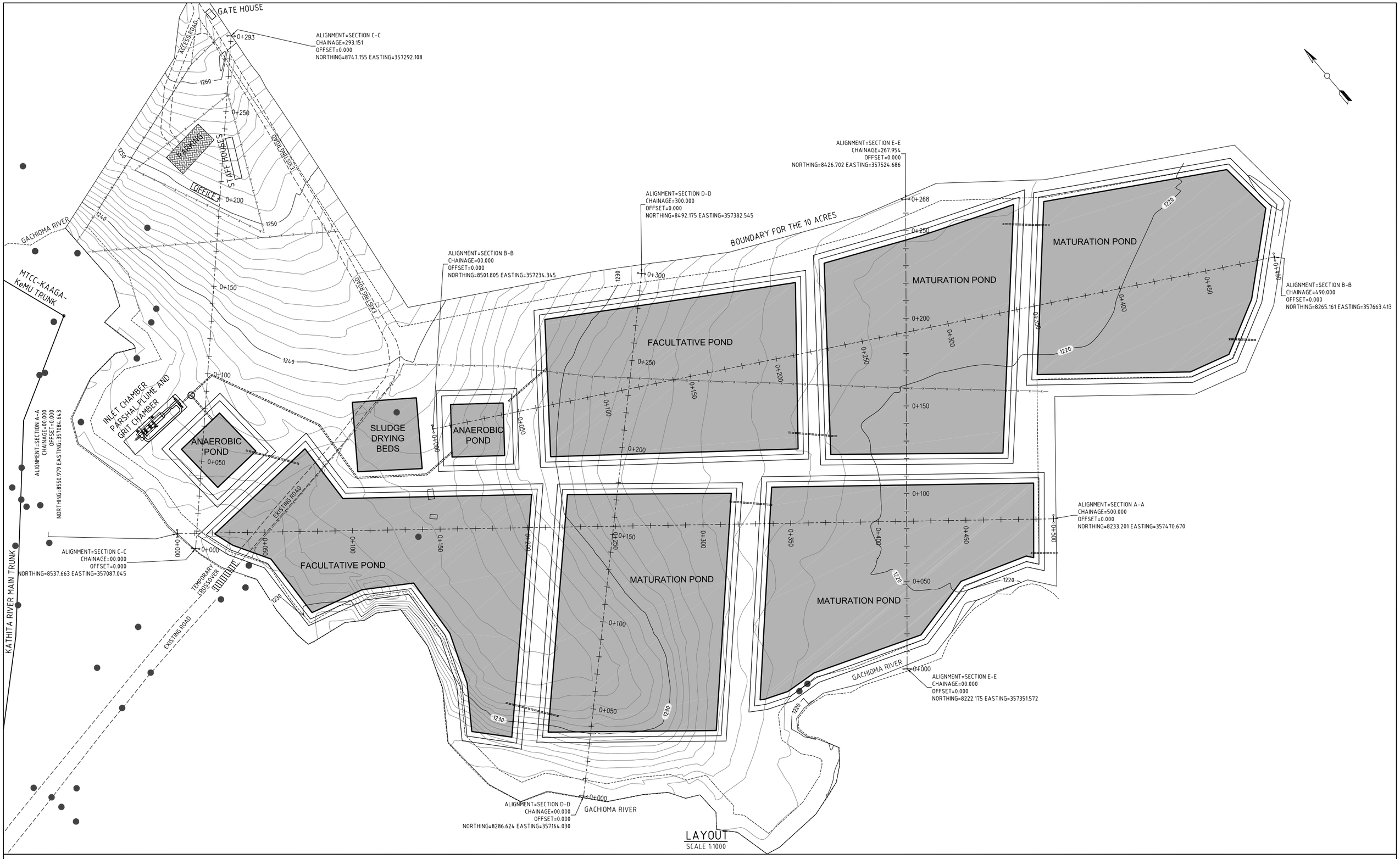

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REV. No.	DESCRIPTION	DATE	REV. No.	DESCRIPTION	DATE

CONSULTANT:

Hankuk Engineering Consultants H. E. C

Ecosite Development Consultants Ltd
Consulting Civil and Development Engineers
P.O.BOX 56075-00200 NAIROBI.

CLIENT

TANA WATER SERVICES BOARD

PROJECT

CONSULTANCY SERVICES FOR DESIGN REVIEW AND CONSTRUCTION SUPERVISION OF MERU SEWERAGE PROJECT

DRG TITLE

PROPOSED MERU TRUNK SEWERS

PROPOSED TREATMENT WORKS
SITE LAYOUT PLAN

Date:	MAY 2018	JOB No.	001
Designed:	NKT		
Drawn:	JGG	Cad Filename	001\MERU\CAD\TWKS
Checked:	CMM		
Approved:	WKM	DRG. No.	MERU/TWKS/LYT/001
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APPENDIX 2
Public Consultation Documentation

APPENDIX 3
Land Purchase Agreement

APPENDIX 4
Firm of Experts/EIA Experts Practicing Licenses

FORM 7 (r.15(2))

nema
mazingira yetu | uhai wetu | wajibu wetu

NATIONAL ENVIRONMENT MANAGEMENT AUTHORITY(NEMA)

THE ENVIRONMENTAL MANAGEMENT AND CO-ORDINATION ACT

ENVIRONMENTAL IMPACT ASSESSMENT/AUDIT (EIA/EA) PRACTICING LICENSE

License No : NEMA/EIA/ERPL/9372

Application Reference No: NEMA/EIA/EL/12904

M/S **Eng. William M. Kamau**
(individual or firm) of address

P.O. Box 22993-00400, Nairobi.

is licensed to practice in the

capacity of a (Lead Expert/Associate Expert/Firm of Experts) **Lead Expert**
registration number **0312**

in accordance with the provision of the Environmental Management and Coordination Act Cap 387.

Issued Date: **2/13/2019**

Expiry Date: **12/31/2019**

Signature.....

(Seal)
Director General
The National Environment Management Authority

P.T.O.

ISO 9001 BUREAU VERITAS Certification

ISO 9001: 2008 Certified