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Environmental & Social Impact Assessment of the Proposed Moi's Bridge and Matunda Towns Sewerage Schemes

LAKE VICTORIA NORTH WATER SERVICES BOARD

26 May 2017
ESIA Study Report

Volume II – Appendices

Notice

This document and its contents have been prepared and are intended solely for Lake Victoria North Water Services Board's information and use in relation to the environmental and social impacts of the proposed Matunda and Moi's Bridge sewerage schemes and seeking approval from the National Environment Management Authority

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Declarations

This EIA Study Report for the Proposed **Moi's Bridge and Matunda Towns Sewerage Schemes** is prepared and submitted, on behalf of **Howard Humphreys (East Africa) Ltd** by**:**

Name	***Registration No.***	***Signature***	***Date***
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The Report is endorsed, on behalf of **Lake Victoria North Water Services Board** by:

Name: ……..

Designation: ……

Date: ……

Abbreviations

AIDS	Acquired Immune Deficiency Syndrome
CBD	Convention on Biological Diversity
CBO	Community Based Organisations
CEMMP	Construction Environmental Management and Monitoring Plan
CFU	Composite Filtration Unit
CIDP	County Integrated Development Plan
DEMP	Decommissioning Environmental Management Plan
EA	Environmental Audit
EIA	Environmental Impact Assessment
EMCA	Environmental Management and Coordination Act
ESIA	Environmental and Social Impact Assessment
GoK	Government of Kenya
HHEA	Howard Humphreys (East Africa) Limited
HIV	Human Immunodeficiency Virus
ISM	Integrated Safety Management
KEBS	Kenya Bureau of Standards
KIHBS	Kenya Integrated Household Budget Survey
KNBS	Kenya National Bureau of Statistics
Lat.	Latitude
Lon.	Longitude
LVNWSB	Lake Victoria North Water Services Board
MSDS	Materials Safety Data Sheets
masl	meters above sea level
NAC	No Additional Costs
NEMA	National Environment Management authority
NGO	Non-Governmental Organisation
OEMMP	Operational Environmental Management and Monitoring Plan
OP	Operational Policy
p.a	per annum
PPE	Personal Protective Equipment
RLCR	Reconnaissance Level Characterization Report
ROW	Right of Way
uPVC	unplasticized polyvinyl chloride
WRMA	Water Resources Management Authority
WWTP	Wastewater Treatment Plant

Executive Summary

Project background
Lake Victoria North Water Services Board (LVNWSB) is one of the eight Water Services Boards established under the Water Act 2002, as part of the reforms in the water sector. Part of the Board's mandate is to plan, manage and develop water and sewerage services.

The Board intends to develop Moi's Bridge and Matunda Towns' sewerage schemes through funding from the Government of Kenya. This is one of the flagship projects the Board has earmarked for implementation under the Kenya's Vision 2030 flagship projects.

The Proposed Project
The proposed project entails the design and construction of separate sanitation infrastructure for Moi's Bridge and Matunda Towns. The two towns are only 6 kilometers apart but due to topographical constraints, a combined sewerage scheme to serve both towns is not feasible. The schemes proposed include: wastewater collection systems; Wastewater Treatment Plants (WWTPs) and associated facilities; Sludge drying beds; and onsite sanitation facilities or pumping stations for areas that cannot be served by the centralized sewerage systems. The two towns are only 6 kilometers apart but due to topographical constraints, a combined sewerage scheme to serve both towns is not feasible.

ESIA Rationale
The Environmental Management and Coordination Act (EMCA) 1999 provides for the completion of an Environmental and Social Impact Assessment (ESIA) and the preparation and submission of a Study Report before undertaking a project of the proposed nature. Howard Humphreys was commissioned by LVNWSB to carry out an ESIA of the proposed project and submit an ESIA Report for review and approval by the National Environment Management Authority (NEMA).

The overall aim and purpose of the ESIA was to assess environmental and social impacts that are likely to arise from implementation of the proposed sewerage schemes. Specific objectives of the ESIA were to:

- Collect and analyze baseline environmental and socioeconomic data in the study area;
- Identify and assess potential environmental impacts in the design, construction and operation of the proposed schemes;
- Liaise with interested and affected parties in the area in order to seek their views on pertinent issues related to the proposed schemes;
- Identify mitigation measures for the actual and potential adverse impacts; and
- Develop environmental and social management plans suitable for the proposed works, activities and anticipated environmental impacts.

Study approach
The ESIA was carried out in line with the provisions of the Environmental Management and Coordination Act, 1999, the Environmental (Impact Assessment and Audit) Regulations 2003, as well as international guidelines on environmental and social impact management.

A scoping exercise was carried out to identify gaps in information and determine the range of issues to be addressed in the ESIA. The key methods that were used to gather information in the ESIA study included desktop studies, field surveys and stakeholders' consultations. A systematic approach was used to identify

and evaluate significant impacts of the proposed schemes based on project activity event magnitude and receptor sensitivity. Mitigation measures were then proposed to address the adverse impacts identified.

Stakeholder Consultations

Various methods were applied in stakeholder consultations including interviews, administration of questionnaires and stakeholder/community meetings. Outcomes of these consultations revealed that from the community's perspective, the sewerage schemes were a worthwhile investment that would solve the sanitation problems in Moi's Bridge and Matunda.

Prediction and evaluation of impacts and mitigation measures

Potential impacts of construction, operation and decommissioning the sewerage schemes were identified and their significance evaluated. In determination of impact significance, event magnitude (extent/scale, frequency, duration, and intensity) and receptor sensitivity (presence and resilience) were considered. Significance was either categorized as Negligible, Minor, Moderate or Major.

The Table below summaries the impacts identified, their significance, and mitigation measures proposed.

Aspect	Impact	Significance	Mitigation Measure
Environmental Impacts			
Air Quality	Nuisance and health effects on humans from dust exhaust gases	Major	• Maintenance of equipment and machinery to by regular servicing to maintain efficiency in combustion and reduce carbon emissions; • Use environmentally friendly fuels such as low sulphur diesel; • minimize idling of machinery; • ensure no burning of waste on sites/non-designated areas; • Sprinkling of all active construction areas as and when necessary; • Control of construction vehicle speeds by imposition of speed limits; • Immediate backfilling of trenches and rehabilitation of disturbed areas once completed; • Use of tarpaulins to cover trucks carting away spoil using public roads; • Proper planning in transportation of spoil to ensure that the number of trips done or the number of vehicles used is as minimum as possible; and • Provision of appropriate Personnel Protective Equipment such as dust masks to site workers.
	Stunted growth of crops and natural vegetation from dust deposition	Moderate	
	Foul odor from effluent treatment process, management of sludge and high residence		• Storage of screenings and grit in closed containers (dumpsters); • ensuring that all waste is hauled off-site on a scheduled and timely basis; • Covering of sludge processing facilities;

Aspect	Impact	Significance	Mitigation Measure
	time of sewage along sewer lines		• avoiding storage of dewatered sludge at the WWTPs; • suitable design of gravity sewers to shorten residence time, minimization of sediments deposition and mitigate septicity • Establishment of greenbelts around the WWTPs and pumping stations to serve as wind breaks
Visual and landscape	Visual disturbance effects on humans from disturbed sites, opened views and construction plant and machinery	Major	• Reinstatement in accordance with the project's reinstatement specification; • Avoidance of the removal of existing mature trees which form important visual focal points; and • Replacement of any removed trees during the reinstatement phase using indigenous species of local provenance.
	Adverse impacts on natural vegetation from clearance and topsoil removal	Moderate	
	Views opened permanently by works	Moderate	• Landscaped berms around treatment ponds; • Elaborate landscaping to limit the viewpoints to the facilities
Ecology	Damage/Loss of natural vegetation from bush clearing or pollution	Minor	• Development and implementation of a Reinstatement Plan; • Ensure that as much as possible, only the trench line is stripped of vegetation; • Development and implementation of pollution prevention plans and emergency response plans • Programming of construction activities to start after harvesting season
	Damage/Loss of planted crops during construction	Minor	
Soil Resources	Soil loss resulting from erosion and carting to spoil	Major	• Trench back-fill material to be compacted to a similar value to the original surrounding soils to avoid subsidence as a consequence of rain water channelling; • Use of excavated soil from the ponds in establishment of berms around the ponds • Implementation of a project specific Reinstatement Plan which includes mitigation for impacts to soils; and • Implementation of spillage prevention and control measures for hazardous materials in use and storage at sites.
	Soil contamination from pollution incidences	Major	
Energy Resources	Depletion of fossil fuel resources	Minor	• Minimize idling of machinery; • Avoid overloading of trucks and machinery; and

Aspect	Impact	Significance	Mitigation Measure
			• Regularly service vehicles, plant and machinery.
	Increased energy demand from staff housing and pumping stations	Minor	• Adopt energy conservation measures such as use of energy saving appliances in staff housing; • Explore renewable energy sources such as solar for lighting around facilities
Water Resources	Pollution of water resources from sediments and other contaminants	Moderate	• Programming of activities such that earthworks are completed during the short dry season of January and February • Establish measures to control soil erosion and prevent spillage of pollutants; • Implement a rigorous monitoring programme in order to ensure that the new WWTPs operate effectively and as designed
	Increased water demand for construction	Moderate	
	Potential discharge of untreated effluent into rivers causing nuisance and health effects on humans, and adverse impacts on aquatic life forms	Major	
Waste	Environmental pollution and creation of health and safety hazards from poor management of wastes during construction	Major	• Land-fill spoils as much as possible within the sites or identified fill areas; • Felled trees, shrubs and stumps can be isolated for collection by locals as firewood; • Organic wastes can be composted on site; • Provide pit latrines at the camp(s) and construction sites for use by workers; • Vehicle maintenance to be done off-site (at the construction camp's garage/workshop or commercial garage) and wastes (used oil, oily rugs, cans and used parts) disposed in a designated area; • Ensure that construction materials left over at the end of construction are used elsewhere rather than their disposal; • Put in place measures to ensure that construction material requirements are carefully budgeted and to ensure that the amount of construction materials left on site after construction is kept minimal; • Avoid mixing of excess concrete if possible, and discard excess

Aspect	Impact	Significance	Mitigation Measure
			concrete in a designated area away from water courses; • Washing of concrete coated vehicles or equipment to be done off-site or in a designated wash area a minimum of 50 feet away from drainage channels; • Runoff from the on-site concrete wash area to be contained in a temporary pit where the concrete can set; • The temporary pit to be lined with plastic or clay to prevent seepage of the wash water into the ground. The wash water should be allowed to evaporate or collected along with all concrete debris in a concrete washout system bin; and • To the extent possible, hydraulic test water should be discharged into the next section of the pipeline to be tested.
	Environmental pollution health and safety hazards from poor management of solid wastes and sludge from effluent treatment process during operations	Moderate	• Identify a suitable landfill site near Matunda and Moi's Bridge to appropriately dispose solid wastes from the WWTPs; • Dried sludge/cake to be sold off/collected for disposal as organic fertilizer for use in local farms; • Dried sludge can also be landfilled at an appropriate location; • Monitor sludge quality to ensure that human health is protected; • Ensure that proper sludge stockpiling, handling and soil conditioning procedures are followed.
Noise and Vibrations	Vibrations and noise nuisance to the community during construction work	Moderate	• Portable hoods to be installed to shield compressors and other small stationary equipment where necessary; • Pumps, generators and other mobile equipment to be sited as far as practicable from housing and other noise sensitive locations; • The contractor to endeavor to use equipment installed with noise abatement devices as much as practicable; • Idling time on trucks and other noisy equipment to be limited to a minimum; and • Personal protective equipment such as ear muffs will be provided to workers at the sites as necessary.

Aspect	Impact	Significance	Mitigation Measure
Occupational/public health and safety	Exposure of workers and the general public to health and safety hazards during construction work	Major	• Provision of all workers on site with the necessary Personal Protective Equipment; • Ensuring a safe and healthy environment for the construction workers; • Workers accidents to be mitigated by enforcing adherence to safety procedures and preparing contingency plans for accident response; • Safety education and training to be emphasized; • The Contractor to have qualified first aid personnel among the workers and maintain fully stocked first aid kits at the sites; • Hazards and accidents involving the public to be minimized by controlling access to the construction sites; • Contractor to lay pipes and backfill as soon as possible to reduce hazards exposure to the public such as open trenches; and • Contractor to ensure that workers have access to sanitary facilities at the sites and provide potable water.
	Exposure of treatment works staff to health and safety hazards	Moderate	• Develop and implement operating procedures cognisant of the health and safety hazards at the WWTPs and pumping stations • Provide training to staff at the facilities and ensure they have appropriate PPE for work at the sites • Secure the WWTPs and pumping stations with chain-link perimeter fencing and a guard to prevent unauthorised entry
Traffic	Nuisance and increased safety hazards to other road users from construction traffic and works	Moderate	• Development and implementation of a traffic management plan.
Socioeconomic Impacts			
Sanitation in Moi's Bridge and Matunda Towns	Improved access to sanitation Reduced incidence of water-borne diseases	Major (positive)	

Aspect	Impact	Significance	Mitigation Measure
Employment and business opportunities	Increased employment and business opportunities during construction work	Moderate (positive)	
Land acquisition	Loss of land and livelihoods for affected people	Moderate	• Cash compensation based on market value of land or provide with option of replacement land within the village if available of equivalent size and quality; • Cash compensation to be provided for lost agricultural productivity during the construction period; and • Reinstatement of land to a least the condition it was in prior to construction.

Conclusion

Although potential adverse impacts were identified in the construction and operation of the proposed sewerage schemes, various opportunities were also identified for the mitigation of these impacts. It is considered that with good environmental and social practices and procedures during construction, the schemes have potential to enhance benefits while avoiding environmental degradation. The requirements identified for the contractor(s) in this Report will ensure environmental protection, health and safety of the workers and the general public. Sound environmental management practices during operations of the schemes will also enhance community benefits and social acceptance of the proposed schemes.

An environmental audit of each scheme is recommended upon completion of the construction works to corroborate the implementation of the proposed mitigation measures. Any unforeseen project impacts shall be identified and addressed through annual environmental audits. The Consultant proposes that project approval and an Environmental Impact Assessment license be issued by NEMA based on the environmental management measures contained in this ESIA Study Report.

1. Introduction

1.1. Background

Lake Victoria North Water Services Board (LVNWSB) is one of the eight Water Services Boards established under the Water Act 2002, as part of the reforms in the water sector. The mandate of the Board is to: contract, monitor and enforce agreements between the Board and water service providers in accordance with regulations set by the Water Services Regulatory Board; ensure effective and economical provision of water services within its area of jurisdiction; monitor and acquire assets; plan, manage and develop water and sewerage services; and take custody of water services provision assets on behalf of the national government.

The Board intends to develop Moi's Bridge and Matunda Towns' sewerage schemes through funding from the Government of Kenya. This is one of the flagship projects the Board has earmarked for implementation under the Kenya's Vision 2030 flagship projects.

1.2. Project rationale

Moi's Bridge and Matunda towns have experienced rapid growth in the last 20 years but do not have sanitation systems for the appropriate disposal of sewerage generated. Further, the sewerage output is expected to increase with the continued population growth and the proposed augmentation of the water supply to these towns.

Modern sewerage systems for the two towns will greatly contribute to enhancement of public health and environmental protection. The sewerage systems will also be a key pillar towards achievement of millennium development goals and vision 2030 for the two towns in the following respects:

- Improving access to water and sanitation by investing in new water and sanitation infrastructure
- Achieving customer satisfaction from provision of reliable and adequate services
- Providing sustainable sewerage services to the population of both towns
- Enhancement of the level of hygiene;
- Reduction of water borne diseases;
- Facilitate higher retention of girls in school due to improved provision of water and sanitation services
- General improvement in the living conditions in the project area.

1.2.1. Existing sanitation systems

Matunda and Moi's Bridge Townships currently have no centralized wastewater disposal systems. The main forms of wastewater disposal in Matunda is pit latrines (approximately 60%), Ventilated Improved Pit (VIP) latrines (23%), septic tanks (15%) and others forms including bush (2%). For Moi's Bridge, 20% of the population uses pit latrines, 63% VIP and 17% septic tanks for wastewater disposal. It is not uncommon to see raw sewage flowing on open trenches in these towns, posing environmental health hazards.

Figure 1 - 1: Raw sewage discharge into the environment in Moi's Bridge Town

1.2.2. Population and wastewater discharge projections

In 2009, the population of Moi's Bridge and Matunda administrative units was 49,218 in 10,772 households (KNBS, 2009). However, the core urban and peri-urban population (which is the population considered for the sewerage systems) of the two towns was 21,627. With an annual growth rate of 3.5%, the urban population was estimated to be 30,273 in 2015, and is expected to reach 66,786 by the year 2038.

The water demand was estimated at 3,990m^3/d in 2015, and is projected to rise to 10,075 m^3/d by the year 2038. Applying a sewerage factor of 0.8 and a connection factor of between 70 -100% for the various land uses, up to 2,192 m^3/d and 1,542 m^3/d could be generated as wastewater by Moi's Bridge and Matunda Towns respectively, by the year 2038.

1.2.3. The Proposed Project

The proposed project entails the design and construction of separate sanitation infrastructure for Moi's Bridge and Matunda Towns. The two towns are only 6 kilometers apart but due to topographical constraints, a combined sewerage scheme to serve both towns is not feasible. The proposed schemes are comprised of: wastewater collection systems; Wastewater Treatment Plants (WWTPs) and associated facilities; Sludge drying beds; and onsite sanitation facilities or pumping stations for areas that cannot be served by the centralized sewerage systems.

A detailed description of the Project is provided in Chapter 2 of this Report.

1.3. ESIA Rationale

The Environmental Management and Coordination Act (EMCA) 1999 provides for the preparation and submission of an ESIA Study Report before undertaking a project of the proposed nature. This Study Report has been prepared to comply with Section 58 of the EMCA, 1999 and the Amendment Act 2015, Legal Notice No 150 on the Act, Part 2 Section 7 of the Environmental (Impact Assessment and Audit) Regulations, 2003, Legal Notice 101, and other relevant regulations.

1.4. Objectives of the ESIA

The overall aim and purpose of the study was to assess environmental and social impacts that are likely to arise from implementation of the proposed sewerage schemes. Specific objectives of the ESIA study were to:

- Collect and analyse baseline environmental and socioeconomic data in the study area;

- Identify and assess potential environmental impacts in the design, construction and operation of the proposed scheme;
- Liaise with interested and affected parties in the area in order to seek their views on pertinent issues related to the proposed scheme;
- Identify mitigation measures for the actual and potential adverse impacts; and
- Develop environmental and social management plans suitable for the proposed works, activities and anticipated environmental impacts.

1.5. ESIA methodology

The ESIA was carried out in line with the provisions of the Environmental Management and Coordination Act, 1999, the Environmental (Impact Assessment and Audit) Regulations 2003, as well as international guidelines on environmental and social impact management.

1.5.1. Scoping

A scoping exercise was carried out to determine the range of issues to be addressed in the ESIA, the significant issues that would need detailed study and those that were not significant. Determination of the boundaries of the ESIA in terms of the geographical extent and timing was also done.

1.5.2. Literature review

The Consultant reviewed literature related to the proposed project and the project area. These included architectural layouts, feasibility studies and design reports for Moi's Bridge and Matunda Sewerage Project, and other studies on physiography, geology, hydrogeology, water resources and socio-economics of the project area. Both local and international legislation, policies and procedures in social and environmental management were also reviewed.

1.5.3. Baseline data collection

Baseline data was collected on the proposed project sites and the immediate neighborhood. The data collected was on aspects such as: topography; local flora and fauna; soils and geology; existing and past activities including human settlements; local surface and ground water resources; ambient air quality and noise levels (qualitative); waste management practices; and natural resources and cultural heritage aspects of the project areas.

1.5.4. Identification, prediction and determination of environmental impacts

A systematic approach was used to rank identified impacts according to their significance determined by consideration of project activity **event magnitude** and **receptor sensitivity**. The expected significance of environmental impacts were assessed taking into account:

Event Magnitude determined based on the following parameters:

- **Extent** – the size of the area across which the effect of the activity extends;
- **Duration** – the length of time over which the effect of the activity occurs;
- **Frequency** – how often the activity occurs; and
- **Intensity** of the impact – concentration of an emission or discharge with respect to standards of acceptability that include applicable legislation and international guidance, its toxicity or potential for bioaccumulation, and its likely persistence in the environment, and degree and/or permanence of disturbance or physical impact

Receptor Sensitivity determined by:

- **Presence** – whether biological species present are unique, threatened, protected or not vulnerable and are present during a period of high sensitivity (e.g. breeding, spawning or nesting). For human receptors, whether they are permanently present to uncommon in the area of impact and for physical features whether those present are highly valued or of limited or no value. For physical receptors/features, whether they are national or international value (e.g. state protected monument), local or regional value and is sensitive to disturbance or none of the above; and
- **Resilience** – how vulnerable people and/or species and/or features are to the change or disturbance associated with the environmental interaction with reference to existing baseline conditions and trends (such as trends in ecological abundance/diversity/status, ambient air quality etc.) and their capacity to absorb or adapt to the change. For physical receptors/features, highly vulnerable, undergoes moderate but sustainable change which stabilizes under constant presence of impact source or unaffected or marginally affected.

Socio-economic impacts were also assessed taking into account event magnitude and receptor sensitivity. However, a more qualitative approach was applied, which considers how significant the change would be on social, economic and cultural dynamics, the potential for governmental and stakeholder intervention, the value of the receptor (on a local, regional, national or international scale) and the resilience of the receptor to change or adapt to a given change.

Impact significance was assessed taking into account existing control measures that are incorporated into the project design.

Sets of criteria were defined for both impact magnitude and receptor sensitivity and these were then combined in an appraisal matrix to identify relative degrees of impact significance. The matrix was accompanied by ancillary definitions of the resulting final significance categories.

1.5.5. Stakeholder consultations

Stakeholder consultations were carried out in order to: inform project stakeholders of the proposed project; to explain the likely impacts (positive/negative) of implementing the project; and to obtain views, concerns, comments and suggestions from interested and affected parties regarding the proposed project.

Three categories of stakeholders were identified. These included:

a) **Internal Project Stakeholders**: These were the project 'insiders' who worked closely with the Consultant to ensure successful execution of the EIA study. They provided the Consultant with the project brief, information on the project area and on other stakeholders.
b) **The Local Community**: These were the key stakeholders important in the mapping of impacts and their magnitude/significance. Information from these stakeholders was gathered through questionnaires administered to a sample of the neighbouring population and through public meetings organized at Matunda, Moi's Bridge and Kachibora.
c) **Key Informants**: These were the key stakeholders who the Consultant selected on the basis of their knowledge of the goings-on in project host communities, as well as their knowledge of the proposed project. They included County Government officials, Project area MCAs, Chiefs and community elders, and Water Resource Users Associations (WRUAs). A key informant guide was used to gather information from these stakeholders.

1.5.6. The ESIA team

The Environmental and Social Impact Assessment was undertaken by a team of consultants from Howard Humphreys (EA) Limited that included the following:

- Simon N. Wandeto – Environmental Lead Expert;
- Lydia Njeru – Sociologist and Associate Environmental Expert

As required under Regulation 14 of the Environmental (Impact Assessment and Audit) Regulations 2003, Howard Humphreys (East Africa) Limited is registered by the National Environment Management Authority (NEMA) as a Firm of Experts. The above named environmental experts are registered and licensed by NEMA as Environmental Impact Assessment and Audit Experts. Registration certificates and licenses for the Firm of Experts and Lead Expert are attached in **Appendix A** of this Report. The ESIA team was also supported by other experts who included:

- Eng. Anthony Bichii – Water Engineer;
- Eng. George Muriithi – Water and Sanitation Engineer;
- Eng. Wambui Kebathi - Water and Sanitation Engineer;
- Judy Musilu – Water Engineer; and
- Peter Mugo – Surveyor

2. Project description

2.1. Geographical location

Moi's Bridge and Matunda Towns straddle the administrative boundaries of three Counties: Kakamega, Uasin–Gishu and Trans-Nzoia Counties. Matunda Town to the East of Eldoret-Kitale Road is in Uasin-Gishu County while to the West of the Road is Kakamega County. For Moi's Bridge Town, to the North of Nzoia River is Trans-Nzoia County, to the west of the railway is Kakamega County while to the East of the railway is Uasin-Gishu County.

The proposed project will cover Moi's Bridge and Matunda Townships which are approximately 6 kilometres apart and will entail establishment of separate sewerage networks and treatment facilities due to topographical limitations.

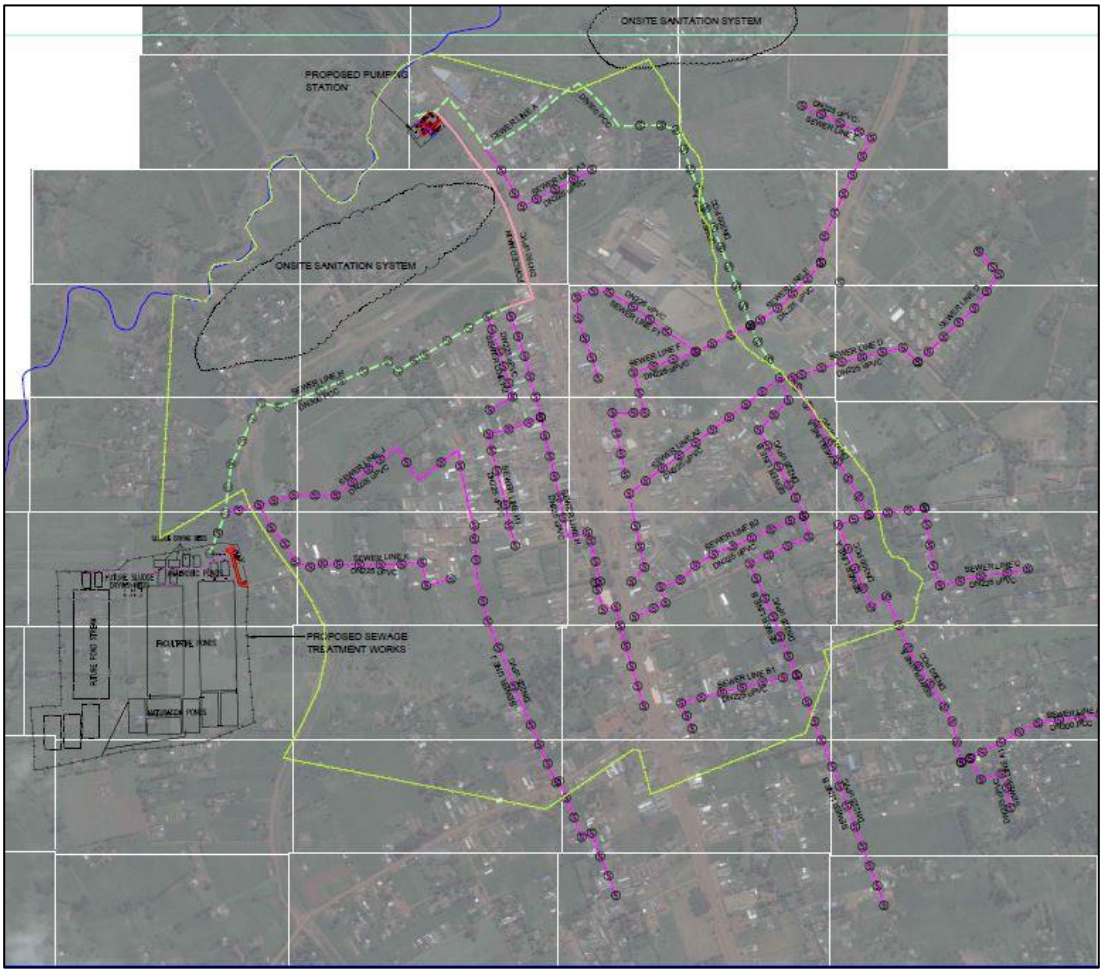


Figure 2 - 1: Arial Map of the proposed sewerage infrastructure for Moi's Bridge Town

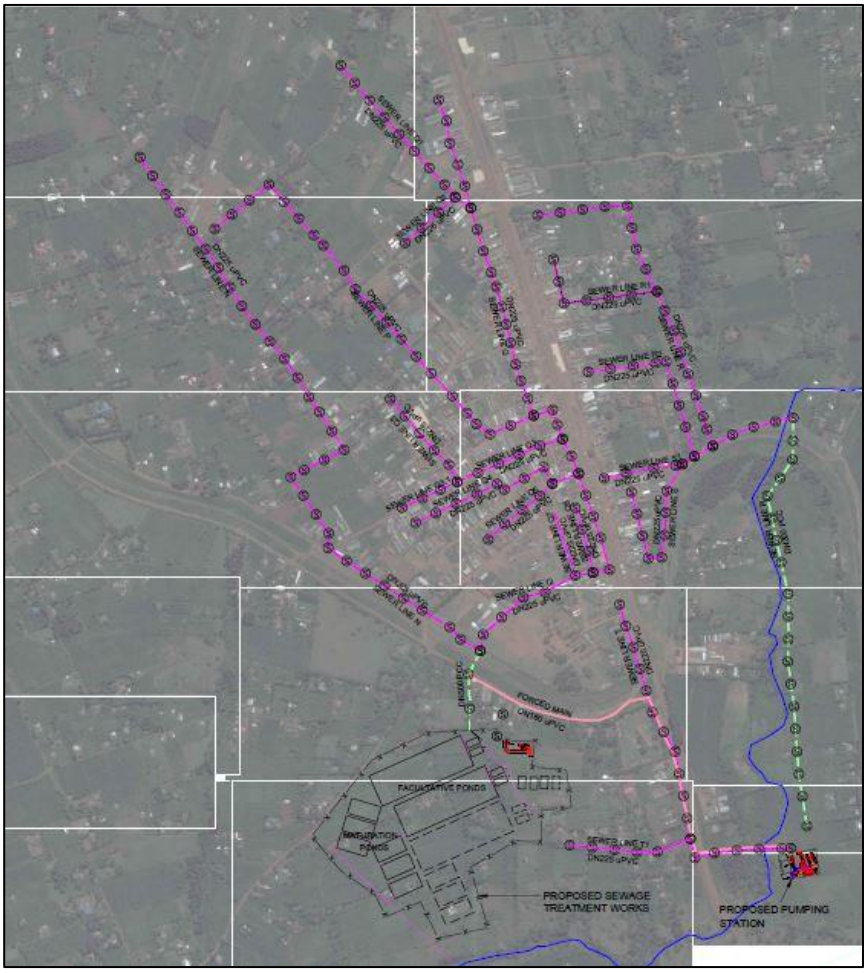


Figure 1 - 2: Arial Map of the proposed sewerage infrastructure for Matunda Town

2.2. Proposed sewerage schemes

2.2.1. Population, water demand and wastewater discharge projections

2.2.1.1. Population projections

2.2.1.1.1. Residential population

The project area includes the trading centres of Moi's Bridge and Matunda which comprise core urban and peri-urban populations. The Table below shows the 2009 population census and the projections over the design horizon for the urban and peri-urban population. The population growth rate used is 3.5% based on Kenya National Bureau of Statistics' figures.

Table 2 - 1: Population Projections for the Project Area

Location	Census (2009)	Year 2015	Initial (2018)	Future (2028)	Ultimate (2038)
Moi's Bridge					
Core urban	10,858	13,347	14,798	20,875	29,446
Peri-urban	3,738	4,595	5,095	7,186	10,137
Matunda					

Core urban	7,253	8,916	9,885	13,944	19,669
Peri-urban	2,778	3,415	3,786	5,341	7,534
Total	**24,627**	**30,273**	**33,564**	**49,346**	**66,786**

2.2.1.2. Institutions

The Table below shows the current (2015) population of students in schools & colleges and health institutions in the two towns as well as along the treated water pipeline route (not more than 1km from the pipeline) and the projections over the design horizon.

Table 2 - 2: Population in Institutions

Institution	Year 2015	Initial (2018)	Future (2028)	Ultimate (2038)
Educational				
Day Schools	25,363	28,120	39,667	55,954
Boarding Schools	5,062	5,612	7,916	8,228
Total	30,425	33,732	47,583	64,182
Health				
Out-patients	23,144	25,560	29,939	36,495
in-patients	147	155	190	231
Total	**23,291**	**25,715**	**30,129**	**36,726**

2.2.1.3. Water demand projections

The per capita demands used are guided by those recommended in the Practice Manual for Water Supply Services in Kenya (Water Design Manual). The demand for the core and peri-urban areas has been taken as 75l/c/d for both categories as the peri-urban areas are likely to be part of the core-urban area within the 20-year design period. This demand is between that for urban low income and medium income. The population to be served along the pipeline route, including trading centres areas, has been considered as medium income rural, with per capita demand of 50l/c/d.

It has been assumed that in the present and initial years, 20% of the population has individual connections (with 80% non-individual connections), rising to 40% and 80% in the future and ultimate years respectively.

The unit demands used for institutions (health and educational), commercial enterprises as well as livestock are those recommended in the design manual. The Table below shows a summary of the projected water demands over the design horizon.

The institutional demand covers that for schools, hospitals and dispensaries. Commercial demand covers bars, hotels, shops and other commercial establishments within the townships. Whereas it is arguable that the institutional population and corresponding demand are part of the general population/demand, these have been included in the analysis as additional demand to take care of migrant population who are not resident within the project area and who may not have been counted during the census.

Table 2 - 3: Summary of Water Demand Projections

Town	Population category	Water demand projections (m^3/day)			
		Current	Initial	Future	Ultimate
		2015	2018	2028	2038
Moi's Bridge	Urban	1,001	1,110	1,566	2,208
	Peri-urban	345	382	539	760
	Institutional	96	106	148	206
	Commercial	17	19	23	28
	TOTAL	**1,459**	**1,617**	**2,276**	**3,202**
Matunda	Urban	669	741	1,046	1,475
	Peri-urban	256	284	401	565
	Institutional	97	107	150	210
	Commercial	11	12	15	18
	TOTAL	**1,033**	**1,144**	**1,611**	**2,268**

2.2.1.4. Wastewater discharge projections

The estimated volumes of wastewater to be generated in the project area have been worked out as described hereunder.

2.2.1.4.1. Sewage Factors

The quantity of wastewater generated has been computed as a function of the water consumption by applying the sewage factors shown in the Table below as recommended by the "World Health Organization Sectorial Study Report No. 9 – Selection and Design Criteria for Sewerage Projects".

Table 2 - 4: Sewerage factor

Category of consumer	Sewage factor
High class housing	0.75
Average urban housing	0.80
Low cost housing	0.85
Schools, shops and offices	0.85
Other institutions	0.80
Communal Ablution	0.85

A sewage factor of 0.80 has been adopted in computing the wastewater projections for the project area.

2.2.1.4.2. Sewerage connection factor

It is noted that not all areas within each township will drain into the sewer network. Some of the residents supplied with water will prefer on-site facilities such as septic tanks, packaged treatment plants etc. This is as result of a combination of factors ranging from affordability to topographical constraints.

In determining these factors, the consultant relied on past experiences and studies undertaken in this respect. A study on recycling and re-use of sewage effluent and sludge undertaken for the Ministry of Water and Irrigation – Water Services Regulatory Board dated November 2009 gives sewer coverage for the main key towns in Kenya as summarized in the Table below.

Table 2 - 5: Sewer coverage for Key towns in Kenya[a]

Town	Sewer coverage
Kisumu	50% of the area supplied with water is sewered
Mombasa	10% of the population is served by the sewerage system
Nairobi	The sewerage network covers approximately 208km^2 representing about 30% of the total land area
Nakuru	40% of the municipal population is sewered.

From the draft Physical Development Plan (PDP) for Moi's Bridge obtained from Eldoret physical planning department, the Consultant overlaid the township boundary extents on the proposed sewer network. Based on this, approximately 90% of the area within the township can drain to the proposed sewage treatment works. Similar plans were not available for Matunda Township.

On the basis of the Moi's Bridge network coverage, the Consultant proposed sewage connection factors to be applied in computing wastewater discharges for both townships. These factors are presented in the Table below. The wastewater quantities have therefore been computed by multiplying the respective water demand by the sewage factors and further by the sewerage connection factor.

Table 2 - 6: Sewerage connection factor

Type of consumer		Connection factor
Urban		90%
Peri-urban		50%
	Day schools	80%
Institutional	Boarding schools	80%
	Health Facilities	80%
Commercial		90%

2.2.1.4.3. Wastewater quantity

The table below summarizes the wastewater discharges into the sewer network over the design horizon obtained on the basis of the above assumptions by multiplying the water demand with the sewage factor and connection factors.

Town	Population category	Wastewater discharge projections (m^3/day)			
		Current 2015	Initial 2018	Future 2028	Ultimate 2038
Moi's Bridge	Urban	721	799	1,127	1,590
	Peri-urban	207	229	323	456
	Institutional	58	64	89	124
	Commercial	14	15	18	22
	TOTAL	999	1,107	1,558	2,192

[a] The figures presented for these towns are as presented in the "Study on the Recycling and reuse of sewage effluent and sludge – Final report dated November 2009". The report was undertaken on behalf of Water Services Regulatory Board (WASREB).

Matunda	Urban	481	534	753	1,062
	Peri-urban	154	170	240	339
	Institutional	59	65	91	127
	Commercial	9	10	12	14
	TOTAL	703	779	1,096	1,542

2.2.2. Project design

2.2.2.1. Criteria for design of sewers

2.2.2.1.1. Scope of design

The system has been designed to carry peak domestic flow and 15% of dry weather flow allowance for infiltration. The sewer system has been designed to flow by gravity. This criteria could however not be fully met as the ground profile for some of the sewers is very gentle, thus leading to great depths at some sections. Further, topographical constraints were encountered in some of the drainage areas making it impossible for gravity flow. Pumping station(s) have thus been incorporated in the design for these areas as described elsewhere in this Report. For other areas that cannot drain by gravity and whose coverage is not extensive including market centres, on-site sanitation interventions have been proposed. The sewerage system has been designed to carry normal municipal and pre-treated industrial effluent, if any. The system does not allow for storm water drainage.

2.2.2.1.2. Velocity

The designs have adopted a minimum velocity of 0.6 m/s for self-cleansing and a maximum velocity of 3.5 m/s to avoid abrasion of sewers.

2.2.2.1.3. Slope

To achieve self-cleansing, a minimum slope of 1:250 (0.4%) and a maximum of 1:25 (4%) to avoid abrasion of concrete sewers have been adopted.

2.2.2.1.4. Materials

Pre-cast concrete (PCC) pipes are proposed for the main sewers with diameters of 300mm and above. For the branch sewers and laterals, uPVC pipes have been considered with minimum diameter being 225mm.

Manholes have been provided in reinforced concrete rings for depths up to 3m, and in-situ reinforced concrete for depths beyond 3m. Manhole covers have been proposed to be medium duty composite covers within areas with no vehicular traffic, and heavy duty composite covers in areas with vehicular traffic. Composite manhole covers which are manufactured from Fibre Resin, a type of Glass Reinforced Polyester Resin (GRP) have been recommended. They have minimal theft value and are unattractive to thieves thereby reducing the risk of vandalism.

Drop inlets shall be provided where the inlet/outlet pipe elevation differences are greater than 600mm to avoid splashing inside the manholes.

As per WHO Sectorial Study Report No 9, the recommended spacing of manholes will be provided on the designed sewers at all changes in direction, change in sewer level or gradient, change of size and at all junctions. For a straight alignment, to allow for ease of cleaning and/or unblocking, the recommended maximum spacing of manholes is as summarized in the Table below.

Table 2 - 7: Recommended maximum spacing of sewer manholes

Sewer diameter (mm)	Manhole spacing (m)
100 to 200	40
225 to 450	60
525 to 825	90
900 and above	120

The minimum cover to the pipes (crown) will be 0.9 m in non-trafficked areas, and 1.2 m in trafficked areas. Where this is not possible, a protective concrete slab or concrete surround will be provided.

2.2.2.1.5. Sewer trenches

Based on the anticipated external load on the sewer, and assuming that the trench widths are kept to minimum, the estimated trench widths for the common size sewer pipes are as shown in the table below.

Table 2 - 8: Recommended sewer pipe trench widths

Sewer size (mm)	Trench width (mm)
225	675
300	750
375	875
450	975
525	1050
600	1150

2.2.2.1.6. Peak Factors

The Table below shows the peak factors that have been applied to the dry weather flows in design of the sewers.

Table 2 - 9: Sewer pipes peak flow factors

Sewer diameter	Peak flow factor
12 inch (300mm) or less	2½
15 inch (375mm) to 21 inch (525mm)	2
24 inch (600mm) or more	1½

2.2.2.1.7. Flow depth

The sewers have been designed to flow at between 30 to 80% full bore at peak flows. This ensures that there is adequate sewage flow in the pipe to suspend and transport the solids in sewage. Additionally, consideration has been made in design to ensure that self-cleansing velocities are attained at least once in a day for solids deposited in the system during periods of low flow to be re-suspended and transported by subsequent flushes.

2.2.2.2. Criteria for design of sewage pumping stations

2.2.2.2.1. Inlet works

The inlet works to the sewage pumping station will comprise of a screening section (with coarse and fine screens) and grit removal channel to remove floating matter and grit that may consequently damage the

pumps and or cause clogging within the pump station. The screens have been inclined at 45˚ to the horizontal to facilitate hand raking. The maximum head loss adopted for the design of the screens is 0.3 metres.

2.2.2.2.2. Sewage sump, dry well and pumps

A dry well configuration is proposed. The designs have adopted a minimum pump cycling time of 15 minutes and a maximum of 30 minutes to keep the retention time of sewage in the pond to a minimum and avoid solids settling in the sump which may lead to anaerobic conditions.

The effective sump volume has been divided into two interconnected compartments for maintenance purposes.

2.2.2.2.3. Forced main

The sewage forced main has been designed to deliver ultimate year 2038 flow. The size of the forced mains has been limited to a minimum 160mm to reduce the risk of blockages.

2.2.2.2.4. Emergency overflow pond

An emergency overflow pond has been provided and is sized to hold 12 hours of average daily sewage flow.

2.2.2.3. Criteria for design of sewage treatment plant

2.2.2.3.1. Treatment process description

All available wastewater treatment technologies for the project were considered at feasibility design stage. Waste stabilization ponds and oxidation ditches were also subjected to detailed financial and economic analysis. Waste stabilization ponds technology was recommended for adoption as it presented the least cost over the life cycle of the project. This treatment method, when designed and operated optimally, has the following advantages:

- It makes use of sunlight, wind, temperature, bacteria and algae to produce a high quality of re-usable final effluent;
- Construction of the ponds is simple and straightforward which mainly comprises of earthmoving and minor concrete and pipe works, which can be executed easily; and
- Wastewater stabilization ponds (WSP) are highly efficient in removal of BOD (up to 70%) and pathogens (up to 99.99%) in wastewater.

The proposed wastewater stabilization ponds system would comprise of a combined series of the following:-

Anaerobic ponds: These are deep ponds that receive high organic loadings such that anaerobic conditions prevail throughout the entire pond depth. The depths range up to 4m. There has been need for inclusion of anaerobic ponds due to land constraint.

Facultative ponds: The depths range from 1-2 m in which there is an anaerobic lower zone, facultative middle zone, and an aerobic upper zone maintained by photosynthesis and surface re-aeration. A depth of 1.5m has been adopted.

Maturation or Tertiary ponds: These are ponds used for polishing effluents from the preceding biological processes. Dissolved oxygen is furnished through photosynthesis and surface re-aeration. The depths rarely exceed 1.5m.

2.2.2.3.2. Advantages of wastewater stabilization ponds

The advantages of wastewater stabilization ponds include:

- No mechanical and electrical equipment is needed, so no power is used in the process;
- The process takes place in simple lagoons and so the plant can be operated and maintained using only a small number of unskilled workers;
- Bacterial reduction and the removal of helminth eggs are superior to any other technology;
- They are well able to absorb hydraulic and organic shock loads;
- Continuous sludge handling is not necessary. Anaerobic ponds only need to be de-sludged once every 2-5 years, while facultative ponds need to be emptied every 15-20 years. The sludge is stable and requires no treatment other than drying on beds;
- Construction of the ponds is very simple and so the cost is generally lower than other plants. If required, the land can also easily be reinstated at the end of the plant's useful life;
- Pond systems can easily be upgraded by installing anaerobic ponds prior to the facultative ponds or by converting the ponds into aerated lagoons;
- Ponds usually provide minimal negative environmental impact.

The major handicap of waste stabilization ponds is the large land area that is required. Approximately 67 acres of land is required for Moi's Bridge WWTP and associated facilities while 47 acres is required for Matunda WWTP and its associated facilities.

2.2.2.3.3. Sludge treatment and management

Properly engineered structures are required at the site for handling and managing sludge from the ponds. Many different types of unit operations and processes are employed to aid the stabilization of the organic matter, to kill off pathogens, and to reduce the volume of sludge by removing water. The removal of water from sludge can also be done by a variety of methods, but the most common approaches are:

- Thickening in gravity tanks;
- Anaerobic digestion; and
- De-watering on drying beds.

In waste stabilization ponds, the retention times for the sludge allows complete digestion of the sludge to take place and the sludge needs no further treatment other than drying on beds. Therefore, drying beds have been adopted for this project.

2.2.2.4. Wastewater stabilization ponds process design

2.2.2.4.1. Sewage quality standards

Helminth egg removal: For restricted irrigation usage, the helminth egg count in the final effluent should be not more than one egg per litre (1 per litre)

BOD5 Removal: Removal in anaerobic and or facultative ponds is approximately 90%. Removal in maturation (filtered BOD) = 25% in each maturation pond.

2.2.2.5. Criteria for design of onsite sanitation interventions

Onsite sanitation interventions as described below have been considered for areas that are not served by the sewer network but lie within the project area jurisdiction.

2.2.2.5.1. Septic and conservancy tanks

These receive both excreta and flush water from flush toilets and all other household wastewater, including the communal ablution blocks. The mean hydraulic retention time in the tank is usually 1 to 3 days. During this time the solids settle to the bottom of the tank where they are digested anaerobically, and a thick layer of scum is formed at the surface. Although digestion of the settled solids is reasonably effective, some sludge accumulates and the tank must be de-sludged at regular intervals, usually once every 2 to 5 years.

The effluent from septic tanks is, from a health point of view, not as dangerous as raw sewage as it has undergone biological treatment and so is ordinarily discharged to soak-aways or leaching fields. For conservancy tanks, no leaching of effluent is allowed. They shall be considered for areas where soils are non-free draining.

Septic tanks are recommended for individual establishments including ablution blocks in market/town centres that cannot drain by gravity to the proposed sewerage system.

2.2.2.5.2. Packaged treatment plants

Packaged treatment plants comprise of an integrated unit providing for complete conventional waste water treatment process as follows:

- ***Solids separation***; incoming waste water is passed into a stabilization chamber, where settling of large particles and grit occurs;
- ***Aeration***: waste water then flows into an aeration chamber. An aerator is installed in the chamber and supplies oxygen to the wastewater thereby creating aerobic conditions necessary for breakdown of biodegradable wastes;
- ***Sedimentation and recycling***; the effluent from the aeration chamber flows into the sedimentation chamber, in which final settlement occurs. A submersible pump may be installed in this chamber to recycle sludge back into the stabilization chamber. This introduces more microorganisms into the stabilization chamber hence enhancing the treatment process.
- ***Filtration and chlorination***; Clear water from the sedimentation tank flows into a clarification chamber comprising of mixed bed of sand media/activated carbon filters after which the treated water is chlorinated. At this stage, the water is of suitable quality for irrigation use or disposal through a storm drain.

Packaged waste water plants are proposed for large commercial and residential apartments including factories that cannot drain by gravity to the proposed sewer network. The treated water is to be of quality suitable for lawn irrigation, and shall comply with relevant NEMA standards for discharge into the environment.

2.2.2.6. Composition of Wastewater

2.2.2.6.1. Domestic Wastewater

Domestic sewage will form the largest proportion of wastewater generated in the study area due to the large coverage of residential and commercial dwellings within Moi's bridge and Matunda Townships. Domestic wastewater is expected to comprise blackwater from the water closets and greywater from the showers, laundries, wash hand basins and sullage from the kitchens. The typical composition of domestic wastewater is shown in the Table below.

Table 2 - 10: Typical composition of untreated domestic wastewater

(All values except settle-able solids are expressed in mg/l)

Constituent	Concentration		
	Strong	Medium	Weak
Solids, total:	1200	720	350
Dissolved, total	850	500	250
Fixed	525	300	145
Volatile	325	200	105
Suspended, total	350	220	100

Constituent	Concentration		
	Strong	Medium	Weak
Fixed	75	55	20
Volatile	275	165	80
Settleable solids (ml/l)	20	10	5
BOD_5, 20°C	400	220	110
Total organic carbon	290	160	80
COD	1000	500	250
Nitrogen (total as N)	85	40	20
Organic	35	15	8
Free ammonia	50	25	12
Nitrites	0	0	0
Nitrates	0	0	0
Phosphorous (total as P)	15	8	4
Organic	5	3	1
Inorganic	10	5	3
Chlorides	100	50	30
Alkalinity (as $CaCO_3$)	200	100	50
Grease	150	100	50

2.2.2.6.2. Institutional / Commercial Wastewater

Institutional and commercial wastewaters comprises all wastewater discharged from schools, health centres, offices, churches, market centres, police station, law courts and other institutions. There are a number of institutions in the project area, and the quantity of wastewater generated by this category is expected to be relatively substantial.

Wastewater discharged from these institutions would predominantly be the same as domestic wastewater, and would therefore exhibit characteristics similar to those outlined in Table 11.

2.2.2.6.3. Industrial effluent

Only a few industries were identified in the project area. Many of these are light engineering workshops and small scale industries. The National Cereals and Produce Board Silo in Moi's bridge was one of the notable small scale dry industry identified during field investigations. Wastewater discharged from this industry will be the same as domestic wastewater. In designing the sewerage project, provision has not been made to accommodate raw wastewater from industries. It has been assumed that industries will pre-treat their wastewater before discharging into the proposed sewerage system, as required by law. The Table below shows the effluent discharge standards into public sewers as stipulated by the Environmental Management and Co-ordination Act, 1999.

Table 2 - 11: Effluent discharge standards into public sewers

Parameter	Maximum Permissible Levels
Suspended solids (mg/l)	250
Total dissolved solids (mg/l)	2000
Temperature (°C)	35
pH	6-9

Parameter	Maximum Permissible Levels
Oil and grease (mg/l)	Nil
Ammonia Nitrogen (mg/l)	20
Substances with an obnoxious smell	Shall not be discharged into the sewers
Biochemical Oxygen Demand BOD_5 at 20^oC (mg/l)	500
Chemical Oxygen Demand COD (mg/l)	1000
Arsenic (mg/l)	0.02
Mercury (mg/l)	0.05
Lead (mg/l)	1.0
Cadmium (mg/l)	0.5
Chromium VI (mg/l)	0.05
Chromium (Total) (mg/l)	2.0
Copper (mg/l)	1.0
Zinc (mg/l)	5.0
Selenium (mg/l)	0.2
Nickel (mg/l)	3.0
Nitrates (mg/l)	20
Phosphates (mg/l)	30
Cyanide Total (mg/l)	2.0
Sulphide (mg/l)	2.0
Phenols (mg/l)	10
Detergents (mg/l)	15
Colour	Less than 40 Hazen units
Alkyl Mercury	Not detectable
Free and saline Ammonia as N (mg/l)	4.0
Calcium Carbide	Nil
Chloroform	Nil
Inflammable solvents	Nil
Radioactive residues	Nil
Degreasing solvents of mono-di-trichloroethylene type	Nil

(Source: Environmental Management and Coordination Act (Water Quality) Regulation 2006 – Fifth Schedule)

2.2.2.6.4. Storm Water Surface Runoff

The proposed sewerage system has been designed as a separate system and does not allow for the drainage of storm water surface runoff. The existing engineered storm water drainage systems in the project area are inadequate. It is proposed that an effective storm water drainage system be constructed to mitigate any impact of the ingress of surface runoff into the proposed sewerage system. Manhole cover levels shall be slightly higher than the finished ground and/or road levels to minimize ingress of storm water into the proposed sewerage system.

2.2.3. Proposed Sewerage System for Moi's Bridge

The proposed works for Moi's Bridge sewerage scheme include:

- Laying of 12.9km DN225 uPVC and 2.35km DN375 PCC sewers;
- Construction of a sewage pumping station;
- Laying of 0.6km DN225 PN10 uPVC sewer forced main;
- Acquisition of approximately 67 acres of land for WWTP, pump station and sewer wayleaves;
- Construction of a WWTP;
- Construction of ancillary site works at the proposed WWTP site; and
- Procurement of an exhauster to attend to onsite sanitation systems

A schematic diagram of the above proposed works is shown in the Figure below.

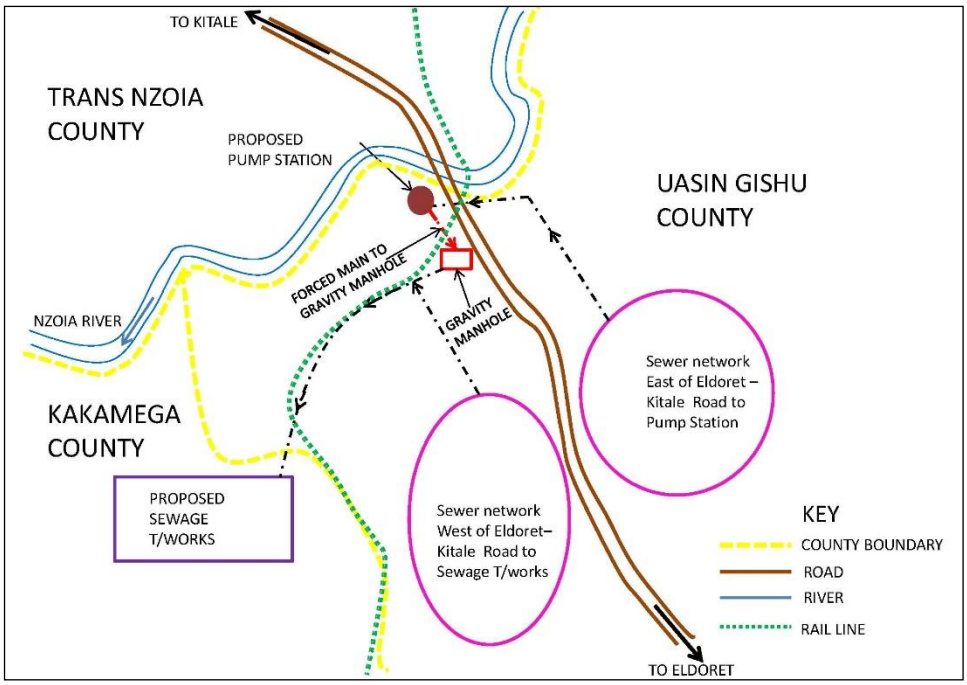


Figure 2 - 2: Schematic layout of the proposed Moi's Bridge Sewerage System

2.2.3.1. Sewer network

2.2.3.1.1. Sewer routes

The routes for the main sewers were identified jointly with water service provider (sub-county water office) in the project area. Proposed sewers have been routed on existing Right of Way (ROW) as much as possible for ease of maintenance operations and to minimize land acquisition for wayleaves. Main sewers have been provided for areas currently served with piped water or those with the potential of being served with piped water soon.

The trunk lines have been laid only on one side of the existing right of way that is currently highly settled or shows potential of high settlements while favouring ease of future connections from the opposite side.

Where there exists no right of way to lay the sewers, wayleaves will be acquired.

2.2.3.1.2. Sewer slopes

The minimum and the maximum slopes for the proposed sewers computed for half bore flow at peak discharge are 0.4% and of 4% respectively.

2.2.3.1.3. Pipe size and material

A hydraulic analysis indicates that the proposed sewer reticulation network will require sewers of diameters ranging from 225 to 375 mm.

The Table below shows the peak flows for the proposed sewer outfalls at 30% bore, half full and 80% bore flow capacities at design minimum and maximum slopes.

Table 2 - 12: Flows into proposed new sewer outfalls in the ultimate year 2038

Bore Flow Depth (%)	Pipe Slope (%)		Pipe Capacity (l/s)		Flow velocity (m/s)	
	Min	Max	Min	Max	Min	Max
Diameter 375 PCC Sewer						
30%	0.4%	4.0%	12.0	37.9	0.67	2.12
50%	0.40%	4.00%	30.6	96.7	0.87	2.74
80%	0.40%	4.00%	59.8	189.0	0.99	3.12
Diameter 225 uPVC Sewer						
30%	0.4%	4.00%	7.2	22.9	0.72	2.28
50%	0.40%	4.00%	18.5	58.4	0.93	2.94
80%	0.40%	4.00%	36.1	114.1	1.06	3.35

The Dry Weather Flow (DWF) into the proposed Moi's Bridge outfall sewer is 25.37l/s whereas the peak flow is 54.55l/s. From the analysis presented in the Table above, a DN375 PCC outfall sewer is proposed. The main laterals and collector network are proposed to be constructed in DN225 uPVC.

The length of proposed Phase I sewer network for Moi's Bridge township is as summarized in the Table below.

Table 2 - 13: Proposed sewers for Moi's Bridge Town

Item	Description	Unit	Length
	Phase 1 (up to 2038)		
1	225mm diameter uPVC sewers	m	12,900
2	375mm diameter PCC sewers	m	2,350
3	DN160 uPVC forced main	m	560

2.2.3.1.4. Manholes

The manholes have been provided at all sewer junctions, at changes in slope, changes in direction, changes in size, and ensuring that the maximum spacing between successive manholes is to standard.

2.2.3.1.5. Plot connections

Individual plot connections are not included in the designs. It is assumed that these will be the responsibility of the relevant County Government and/or Water Service Provider.

2.2.3.1.6. Sewage pumping station

The general topography of the project area does not favor gravity flow for the proposed sewerage system. The town lies on a ridge. The areas east of the Eldoret-Kitale road generally slope away from the road eastwards towards the main Nzoia River. The general slope of Nzoia River within the proximity of the

project area is mild with an approximate average slope of 0.6%. A pump station has been proposed to collect sewage from the eastern part of the town along the Eldoret Kitale road.

The pump station is situated next to the resident water and sewerage company offices. Sewage will be pumped from the proposed pump station to the nearest gravity manhole from where it will flow by gravity to the proposed WWTP. A duty and a standby pumps have been proposed. The average flow into the pump station has been estimated to be 19.5l/s in the ultimate year 2038. The total pumping head has been estimated to be 32m. Since there exists 2No staff houses for the existing water supply scheme and due to proximity of the pump station to the existing staff quarters, only one staff house has been proposed for the attendants at the pumping station.

2.2.3.2. Sewage Treatment Works Design

2.2.3.2.1. Proposed site for sewage treatment plant

The proposed WWTP site is located approximately 1.2 km from Eldoret-Kitale Road along the railway line. The site is located in Kakamega County near the border with Uasin-Gishu County at *UTM 735217.92E, 96499.76N* (WGS84 global reference system).

The site for the proposed sewerage scheme has been sized to accommodate treatment works for 20year capacity of 2,521m^3/day (dry weather flow + 15% allowance for infiltration). However, for present purposes, only Phase I ponds of capacity 1,792m^3/day have been designed. The WWTP has been sited approximately 350 metres from the banks of Nzoia River as the areas downstream of the proposed facility adjacent to the river are waterlogged (marshy). The areas are also susceptible to flooding in periods of heavy rain spell. It has been reported by the local residents that this was witnessed in the 2011-2012 period.

The location of the site favors drainage of most of the town to the proposed WWTP site. The parcel of land identified for the proposed treatment works will be acquired and a fence installed around it.

2.2.3.2.2. Proposed treatment philosophy

Raw sewage will be directed to an inlet structure comprising of coarse and fine screens for removal of floating matter in the incoming sewage. A flow measuring flume will also be incorporated at the inlet works for purpose of flow measurements. Screened waste water will pass through a grit chamber for removal of suspended solids in sewage. From here, wastewater will be directed to a series of ponds comprising of anaerobic, facultative and maturation ponds for subsequent treatment. Due to the high water table at the proposed treatment works site, the proposed anaerobic ponds will be lined. A 1.0mm thick high density polyethylene dam liner has been proposed for this purpose.

2.2.3.2.3. Ancillary works

The civil and ancillary works proposed for the treatment works site include the following:-

- Gravel standard access road to the WWTP;
- Grit storage;
- Sludge drying beds;
- Fencing of the entire sewage treatment works and gate;
- Flood lighting of the WWTP;
- Storm water drainage infrastructure at the WWTP;
- Water supply to the WWTP;
- Administration building and gate house;
- Fully equipped laboratory;
- One Staff house; and
- Afforestation and landscaping around the treatment works i.e. planting of trees and creation of bunds for both aesthetics, wind break, safety and odour control

2.2.3.2.4. Disposal of treated effluent

The treated effluent from the WWTP is expected to meet NEMA standards for discharge into the environment and therefore will be discharged directly into Nzoia River.

2.2.3.2.5. Disposal of sludge

Desludging of the waste stabilization ponds will take place every 5-10 years particularly the anaerobic ponds. Onsite sludge drying beds have been proposed. These will be constructed adjacent to the anaerobic ponds to cushion against long sludge haulage distances for effective operation of the system. The layout drawings for the proposed WWTP are included in **Appendix B** of this Report showing the location of the proposed sludge drying beds.

2.2.4. Proposed Sewerage System for Matunda

The proposed works for Matunda sewerage system include:

- Laying of 8.5km DN225 uPVC and 1.54km DN300 PCC sewers;
- Construction of a sewage pumping station;
- Laying of 0.9km DN160 PN10 uPVC sewer forced main;
- Acquisition of approximately 47 acres of land for WWTP, pump station and sewer wayleaves;
- Construction of a WWTP;
- Construction of ancillary site works at the proposed WWTP site; and
- Procurement of an exhauster to attend to onsite sanitation systems

A schematic diagram of the above proposed works is shown in the Figure below.

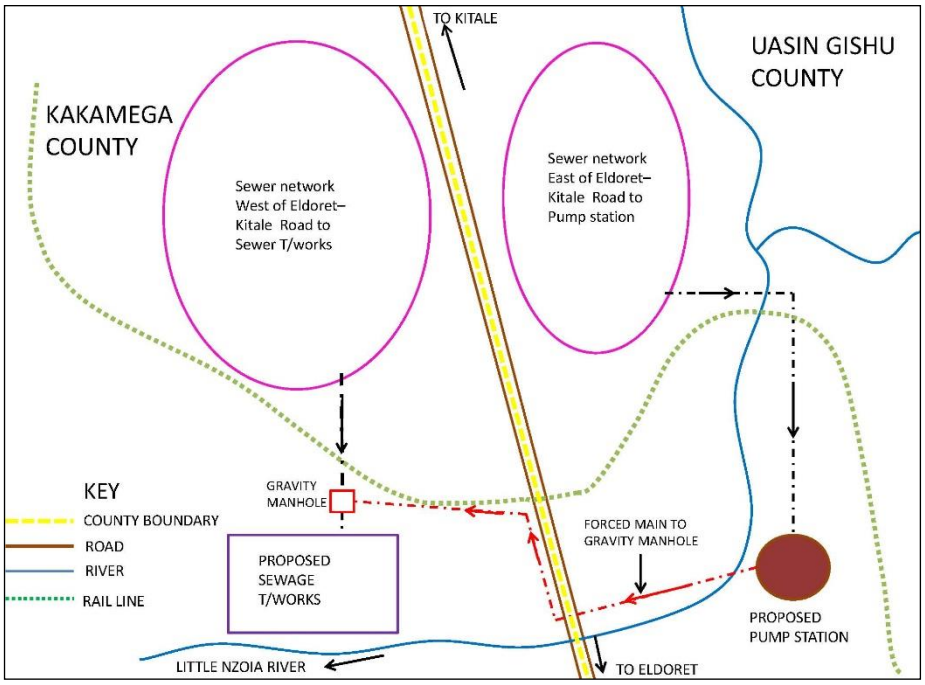


Figure 2 - 3: Schematic layout of the proposed Matunda Sewerage System

2.2.4.1. Sewer network

The sewer network for Matunda Township has been designed similar to that for Moi's bridge as described in preceding sections of this Report.

The Dry Weather Flow (DWF) into the proposed Matunda outfall sewer is 17.85l/s whereas the peak flow is 38.38l/s. A DN300 PCC outfall sewer is proposed. The main laterals and collector network are proposed to be constructed in DN225 uPVC.

The length of proposed Phase I sewer network for Matunda township is as summarized in the Table below.

Table 2 - 14: Proposed sewers for Matunda Town

Item	Description	Unit	Length
	Phase 1 (up to 2038)		
1	225mm diameter uPVC sewers	m	8,500
2	300mm diameter PCC sewers	m	1,540
3	DN160 uPVC forced main	m	905

2.2.4.1.1. Sewage pumping station

Similar to Moi's Bridge, the general topography of Matunda does not favor gravity flow for the entire network. The topography is such that the ground generally slopes south-easterly towards the Eldoret-Kitale road and consequently towards the little Nzoia River.

A sewage pumping station has been proposed since areas to the east of Eldoret-Kitale road (approx. 36% of the project area) cannot drain by gravity to the proposed sewage treatment works. The pump station will be situated along little Nzoia river where the river crosses the Eldoret-Kitale road. A forced main has been proposed to convey sewage from the pump station to the nearest gravity manhole cited above Matunda police station, from where it will flow by gravity to the proposed sewage treatment works. A duty and a standby pumps have been proposed.

The average flow into the pump station has been estimated to be 6.6l/s in the ultimate year 2038. The total pumping head has been estimated to be 34m. Areas lying to the west of the Eldoret-Kitale road (approx. 66% of the project area) will drain to the proposed WWTP by gravity. Two staff houses have been proposed for the attendants at the pumping station.

2.2.4.1.2. Sewage Treatment Works Design

A new WWTP will be constructed for the proposed project along the little Nzoia river valley. The treatment plant will be located in Kakamega County approximately 1.5 kilometres behind Matunda police station at *UTM 735899.68E, 90433.61N* (WGS84 global reference system).

The site for the proposed sewerage scheme has been sized to accommodate treatment works for 20year capacity of 1,774m^3/day (dry weather flow + 15% allowance for infiltration). However, for present purposes, only Phase I ponds of capacity 1,261m^3/day have been designed. Waste stabilization ponds treatment technology has been proposed. Due to a high water table, the ponds have been cited away from the banks of little Nzoia river. The anaerobic ponds will as well be lined. The treated effluent will be discharged into the little Nzoia River.

The configuration of the proposed pond treatment works for Matunda including the ancillary works is similar to that for Moi's bridge as described in preceding sections of this Report.

2.2.4.1.3. Sludge management

Desludging of the waste stabilization ponds will take place every 2-5 years particularly the anaerobic ponds. Onsite sludge drying beds have been proposed. These will be constructed adjacent to the anaerobic ponds to cushion against long sludge haulage distances for effective operation of the system. The layout drawings

for the proposed WWTP included in **Appendix B** of this Report show the location of the proposed sludge drying beds for both projects.

2.2.4.1.4. Odor control and management at the WWTP sites

Planting of tree belts around treatment works is proposed to mitigate against odor. However, there are emerging technologies in the market designed to enhance the performance of wastewater treatment plants. These technologies have been employed and tested outside the region particularly in Japan and Korea. They have been designed particularly to solve need for plant expansion within existing WWTP due to rapid population growth and industrial development. In so doing, they are also reported to lessen odor at the WWTP. They are however mechanical and require specialized operation. In this regard these systems are expected to have high Capital Expenditure (CAPEX) and Operation Expenditure (OPEX) requirements. Further, these technologies have not been installed and tested in this region. Considerations can be made in subsequent phases to adopt such technologies after they have been tested and proven to be successful in this region.

2.2.4.2. Onsite sanitation interventions

Effort has been made to ensure that almost the entire area proposed to be served with water within the project boundaries will drain to the proposed WWTP. However, not the whole population within the sewered area will be connected to the sewerage system in the ultimate year. This population will continue relying on on-site sanitation which will include septic tanks, ablution blocks and packaged wastewater treatment plants. The septic tanks need to be emptied periodically (generally every 2-5 years). Exhauster services will be provided for attendance to the septic tanks. The exhauster can also be rented out when not in use to generate income that can be channeled to the operation and maintenance of the sewerage network in the project area.

Consideration can also be made for small modular treatment plants to serve high density residential precincts and commercial establishments including factories. These as well will be emptied (de-sludged) once every 2-5 years.

2.2.4.3. Operations, maintenance and management requirements

Maintenance is a key element of water supply and sewerage systems which, when planned and executed properly, ensures minimal breakdown of systems and continuous supply of water and management of wastewater.

For a project of this complexity, routine maintenance systems will need to be put in place and executed with persistent efficiency to keep the plant in good state of repair.

Routine maintenance practices for the proposed project will be prepared with detailed Operations, Maintenance and Management Manuals. These will be based on the recommendations contained in the Practice Manual for Water Supply Services in Kenya, and on the actual brochures, catalogues and details of all equipment as provided under the construction contract. The manuals will be simple, user friendly and with illustrations where necessary.

2.2.4.4. Land requirements

The proposed project components will require the acquisition of land from individuals (for the WWTPs, pumping stations and trunk sewers) or securing a Right of Way (for the trunk sewers).

The following land areas are required:

- 41 acres for the proposed Matunda Town WWTP and 1.0 acre for the pumping station, and 5 acres for sewer wayleaves;

- 60 acres for the proposed Moi's Bridge Town WWTP and 1.0 acre for the pumping station and 6 acres for sewer wayleaves;
- A 6m by 26.8Km (10.95km for Matunda and 15.81km for Moi's Bridge) construction corridor for the sewer line ROW (this is temporary and only for the construction period. Affected land owners may be able to use the land with some restrictions)
- Land for the construction camp(s), materials and equipment storage

2.2.5. Outline of project construction activities

2.2.5.1. Construction overview

Construction of the sewerage infrastructure will be undertaken by a Contractor (or Contractors), experienced in the type of work, who will be contractually obliged to complete the works in accordance with an approved construction programme, project specifications, applicable government regulations and requirements, project permits and authorizations.

The Contractor will develop a construction programme which will take into account factors such as ground conditions, topography, hydrology, presence of pre-existing infrastructure and weather conditions.

Within the regulatory framework, the selection of a detailed construction methodology and plant for the sewerage project will be the responsibility of the Contractor. As such, a detailed approach in terms of the construction methodology has yet to be defined. The sequencing of the construction activities and the direction of construction will also be at the Contractor's discretion.

Prior to the commencement of the construction programme, the construction Contractor will develop method statements for the work to be performed. These documents will incorporate the reasonable requirements of landowners, occupiers and other project –affected people, the mitigation measures outlined in this ESIA and the requirements of the regulatory authorities in Kenya.

2.2.5.2. Pre-construction works

All construction activities will be undertaken within demarcated areas for trunk sewers, WWTPs, and pumping stations on the basis of the design and the Contractor's method statements. Sewer line construction will be on a strip of land known as the 'working width', which will generally be 6m wide. Before construction begins, the route will be surveyed and marked to establish the precise route alignment. As far as practicable, the route has been chosen to avoid and/or minimize direct impacts on private property and on known resources.

2.2.5.3. Access roads

To give adequate and safe access for equipment, materials and personnel to the construction sites and permanent facilities, construction of new access roads will be required. Existing tracks to any of the proposed facilities such as WWTPs and pumping stations will also require upgrading and/or widening.

2.2.5.4. Materials and equipment transport

An important aspect of the construction process is the transport of aggregate, sand, cement, steel, pipe sections, plant and other equipment to the construction areas, dedicated storage areas and construction camps. Transportation will be accomplished through the use of the existing road infrastructure in the area. Pipe delivery will represent the majority of movements associated with the construction phase.

Although some of the pipe sections may be transported directly to the ROW, it is likely that most will be stored initially in the pipe yards. From the pipe yards, pipe sections will be transported to the ROW on trucks that will travel along approved access routes.

2.2.5.5. Temporary construction facilities

Temporary facilities comprise storage yards, project offices and construction camps. The location and number of sites will be determined by the construction contractor and agreed with the Project Management Team. The construction contractor will be required to assess the environmental/social sensitivity of the site(s) prior to their approval for adoption.

Potential sites for construction camp and storage yards will be identified based upon but not limited to the following criteria:

- Sufficient ground for pipe storage to meet anticipated quantities;
- Reasonable road access/egress; and
- Proximity and access to construction sites.

2.2.5.6. Construction procedures

Broadly, the following are the expected construction procedures in advancing the project. These procedures also include best practices for environmental, health and safety management in construction activities:

2.2.5.6.1. Setting out/staking of the facilities and pipeline route

The initial activity associated with construction is the final surveying and setting out or staking of the plinth areas, sewer line Right of Way (ROW) and any additional temporary workspaces. This may include flagging to indicate the construction workspace boundaries. Environmental compliance personnel will participate in the pre-construction identification (e.g. flagging) of environmental resources to be protected during the construction process.

Other activities such as the location and exposure of existing pipelines and other services will also be conducted at this time.

2.2.5.6.2. Surface preparation and grading

The proposed WWTP sites are on slightly sloped areas and clearing, cutting and filling will be necessary to obtain the necessary levels for the facilities. The sewer line routes will also need to be cleared and graded in some areas to permit their safe installation. This process will include the levelling and stripping of cultivated areas and the removal of scrub, trees and shrubs. Clearance work will be undertaken using hand tools and earth-moving equipment.

To ensure that the sewer-line ROW can be properly reinstated and to allow the re-growth of vegetation, the topsoil and subsoil will be removed as required and stored separately. Areas such as roads that are subject to open trench crossings will be prepared by removing material only directly over the width of the pipe trench. This material will be kept separate from other stripped or excavated material.

Only where necessary, topsoil will be stripped across the working width by appropriate earth moving equipment and stored on the ROW. The topsoil stacks will not exceed 2m in height and will be kept free from disturbance to reduce the risk of physical damage and compaction.

2.2.5.6.3. Trenching

The first step of trenching is the staking and marking of the trench centerline. Where possible, existing third-party services (e.g., underground cables or pipelines) will also be located and marked prior to the commencement of excavation work.

The trench will be dug to a depth that allows pipeline installation with a minimum of 1m of cover from the top of the pipe to the pre-existing ground surface. The presence of sub-surface structures (such as other pipelines) and surface features (such as hills) may require deeper installation of the pipeline in some areas.

The trenching operation will be undertaken using methods to suit the local terrain and ground conditions. It is expected that trenching equipment will include backhoes and/or excavators. In confined areas, such as areas adjacent to existing pipes, a combination of backhoes and hand tools will be used to open and reinstate the trench.

Where the ROW is near settlements, measures will be taken to limit public access to the ROW or excavated trench. At locations where it is necessary to provide public access across the trench, safe trench crossings will be constructed. Warning signs and barricades will be erected around the trench, and adequate warning lights/reflective material will be provided during the hours of darkness. The Contractor will be restricted to no more than 100m of excavated trench for pipe laying and backfilling.

2.2.5.6.4. Sewer-line crossings

Crossings are defined as the intersection between the proposed sewer-line route and pre-existing features such as public roads/ tracks, and underground services.

Main road crossings will be accomplished by open trenching of one-half of the road at a time, maintaining one lane of through traffic at all times. Smaller access roads may be closed to through traffic, following consultation with local officials and residents. Appropriate signs, barricades, diversions and other traffic management measures will be used to minimize road user inconvenience and promote safety during temporary closure of roads.

2.2.5.6.5. Construction of the Sewerage Treatment Plants

The sequence of the construction programme for the WWTPs is likely to be as follows:

- Site surveying to determine the geotechnical, geophysical and topographical features of the sites;
- Perimeter demarcation and setting out;
- Establishment of access roads;
- Establishment of temporary fences and gates;
- Site clearance and preliminary grading;
- Establishment of construction facilities (e.g., materials stores, laydown areas, offices etc);
- Site excavation and placement to achieve the required cut and fill profiles for the facilities;
- Construction of ponds, buildings and other structures;
- Connection of the facilities to the trunk sewers;
- Installation of all above ground utilities and services;
- Placing of granular surfacing to all unpaved areas;
- Landscaping (as necessary) including the supply, planting and establishment of trees and other appropriate plant species;
- Reinstatement of temporary and permanent roads, services and other items that have been damaged as a consequence of the work;

2.2.5.6.6. Testing of jointed pipes and manholes

All testing will be done in accordance with the procedure of the British Standard Code. Sealed jointed drains shall be tested in sections (e.g. between manholes) by filling with water under a head of not less than 1 metre. Drains found to be water-tight after a period of 30 minutes will be passed as satisfactory but the water must be retained in the pipes until a depth of at least 450mm of filling has been deposited and compacted on top thereof. The displaced test water will be transferred to the next section of drain to be tested. Drains failing to stand the test shall be taken out and the pipes re-laid and re-jointed until completely water-tight.

Manholes shall be tested by completely filling with water, and there shall be no appreciable loss over a period of 2 hours.

Testing may also entail a smoke test before covering up of the drains. Both ends of the lengths of drain to be tested shall be sealed, and smoke shall then be pumped into the section from an approved machine. Should any joint in the section show an escape of smoke, the section shall be taken out and the pipes re-laid and re-jointed until there is no further escape of smoke.

On completion of the works, or at suitable intervals during construction, infiltration tests will be carried out. The permissible amount of infiltration shall be 1 litre per hour per linear metre of nominal internal diameter.

2.2.5.6.7. Reinstatement and erosion control

Prior to the commencement of the construction programme, the Contractor will develop a project-specific Reinstatement Plan based on the project Reinstatement Specification. The full width of the sewer line ROW and all other project areas will be re-instated in accordance with the Reinstatement Plan on completion of the works. The Contractor will also be required to incorporate reinstatement measures in his method statements for each critical element of the construction programme. The key areas that will require reinstatement include:

- Working areas at the WWTP sites and pumping stations;
- The sewer lines ROW;
- Construction camp(s) and materials storage yards; and
- Waste management and disposal sites

2.2.5.6.8. Reinstatement philosophy

The project reinstatement specification will be based on the following principles:

- Reinstatement of disturbed areas to pre-construction conditions (e.g. contours) to the greatest practicable extent;
- Stabilization of disturbed areas to minimize potential impacts associated with erosion, transportation and sedimentation of material from disturbed areas;
- Re-vegetation of disturbed areas to achieve conditions similar to those that exist immediately adjacent to the construction sites; and
- Undertaking of regular monitoring of all reinstated areas until environmental requirements and goals are achieved

2.2.5.6.9. Timing of reinstatement

Reinstatement of facilities and the sewer line ROW will be undertaken on a sequential basis dependent on the completion of construction and testing activities in each area. Following successful completion of testing, construction sites will be cleared of any residual construction debris, construction signs, and equipment. Reinstatement of the construction sites will then be started.

2.2.5.6.10. 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.

2.2.5.6.11. Permanent reinstatement

Permanent reinstatement will be undertaken on completion of the sewer line testing. The first stage of the reinstatement programme will comprise the re-grading of all working areas to achieve a final surface that is sympathetic to the natural landform contours where practical. Any required permanent erosion control measures will also be installed at this time.

To facilitate natural re-vegetation of the sewer line ROW, the separately stockpiled topsoil and vegetation debris will be spread over the surface of the ROW following completion of grading, as appropriate. The Contractor will be required to comply with all requirements for the reinstatement of environmentally and ecologically sensitive areas, and will be required to submit a reinstatement schedule and methodology which, as a minimum, complies with the project Reinstatement Specification and the ESIA requirements. In some instances, areas of sensitive natural habitats or high erosion potential may be seeded with a mixture of native plant species to facilitate re-vegetation.

2.2.5.7. Operational activities

The main activities to be undertaken during project operations include:

- Collection of sewage from establishments through the sewer networks and conveying to the WWTPs;
- Treatment of the sewage at the WWTPs;
- Discharge of treated effluent into neighboring rivers; and
- Maintenance of the WWTPs.

2.2.5.8. Project decommissioning and abandonment plans

The Environmental (Impact Assessment and Audit) Regulations 2003 provide for outlining of activities that shall be undertaken during the project construction, operation and **decommissioning** phases. Further, the environmental management plan shall detail project activities, impacts, mitigation measures, time schedule, costs, responsibilities and commitments proposed to minimize environmental impacts of activities, including monitoring and environmental audits during implementation and **decommissioning** phases of a project.

Decommissioning and abandonment plans for the sewerage infrastructure shall entail:

- Removal of all surface installations;
- Abandonment or demolition of buildings and structures at the WWTPs and pumping stations;
- Disconnection of the sewer lines from establishments and abandonment in place or removal (through excavation of sewer lines, demolition and backfilling of manholes) where abandonment causes a risk to the environment;
- Re-vegetation of the sites consistent with the terrain features and other prevailing conditions

An ESIA will be prepared prior to implementation of this plan, to assess and minimize potential environmental and social impacts arising from the decommissioning and abandonment operations. This decommissioning/abandonment ESIA will be submitted to NEMA for approval.

2.2.5.9. Inputs and Outputs

Table 2 - 15: Inputs and outputs

Phase	Inputs	Outputs
Pre-construction (Site clearance)	Fossil fuels for running machinery/ equipment; human labour	Biomass from cleared vegetation; Exhaust emissions Dust, noise and vibrations
Construction	Fossil fuels for running machinery/ equipment; Water Raw materials such as ballast, sand, cement, gravel, iron/steel bars, PCC and uPVC pipes, masonry blocks, etc	Exhaust emissions; Material spoils (wastes); dust, noise and vibrations; construction wastewater
Operation	Routine maintenance/ repairs; Various consumables by dwellers	Solid and effluent waste from staff housing; Sludge

	Chemicals for treatment of water	from water treatment process
Decommissioning	Fossil fuels for running machinery/ equipment	Solid waste/ rubble; Exhaust emissions; Dust, noise and vibrations

2.2.5.10. Project Costs

The Table below outlines the estimated costs for the Moi's Bridge and Matunda Towns sewerage schemes.

Table 2 - 16: Cost Estimates of Proposed Works

Description	Moi's Bridge Sewerage Scheme	Matunda Sewerage Scheme
Sewers	92,064,021.00	54,114,503.00
Pumping station and forced main	39,132,290.00	38,073,435.00
Sewage treatment works	205,227,035.00	160,659,591.00
Preliminary and general Items	33,642,334.57	25,284,752.90
Contingencies	55,509,852.04	41,719,842.28
Sub-Total -1	425,575,532.00	319,852,124.00
Add 16% VAT	68,092,085.00	51,176,340.00
Total Cost of Works (Phase 1)	493,667,618.00	371,028,464.00
Cost of Land to be acquired for the works	52,345,325.00	38,324,864.00
Grand Total Cost of Project	**546,012,943.00**	**409,353,328.00**

2.2.5.11. Project construction period

It is expected that the project will be completed within 24 months of commencement.

3. Analysis of alternatives

3.1. Overview

Various options were analyzed for the Moi's Bridge and Matunda Towns sewerage schemes. The options included considerations for different locations for the WWTPs, sizing/capacity of the WWTPs, various sewage treatment technologies, and the No Development option.

3.2. The No Development option

Forgoing development of the sewerage infrastructure project would remove all potential environmental and social impacts due to construction, operation and decommissioning. The need for development has however been brought about by the rapid population growth of Moi's Bridge and Matunda towns and the lack of adequate sanitation systems to dispose generated sewage. As a result, waterborne diseases are prevalent in the region due to contamination of water sources (boreholes, wells etc) by effluent disposed in pit latrines. This population is also expected to more-than double in the next 20 years further compounding the sanitation problem.

The No development option was therefore discounted on the basis that sanitation and proper sanitary facilities are critical for population health and prevention of environmental pollution.

3.3. Location, sizing and treatment technology options

3.3.1. Moi's Bridge sewerage scheme

Three options were considered for the location, sizing and treatment technology of the WWTP for this scheme. For all three options, pumping of sewage is inevitable since areas to the east of Eldoret-Kitale road (approx. 55% of the project area) cannot drain by gravity to the proposed WWTP site.

3.3.1.1. Option 1

This option considered siting the WWTP with a design capacity of 2,269m^3/day (dry weather flow + 15% allowance for infiltration) at a site marked "Sewage Treatment Site 1" in the figure below.

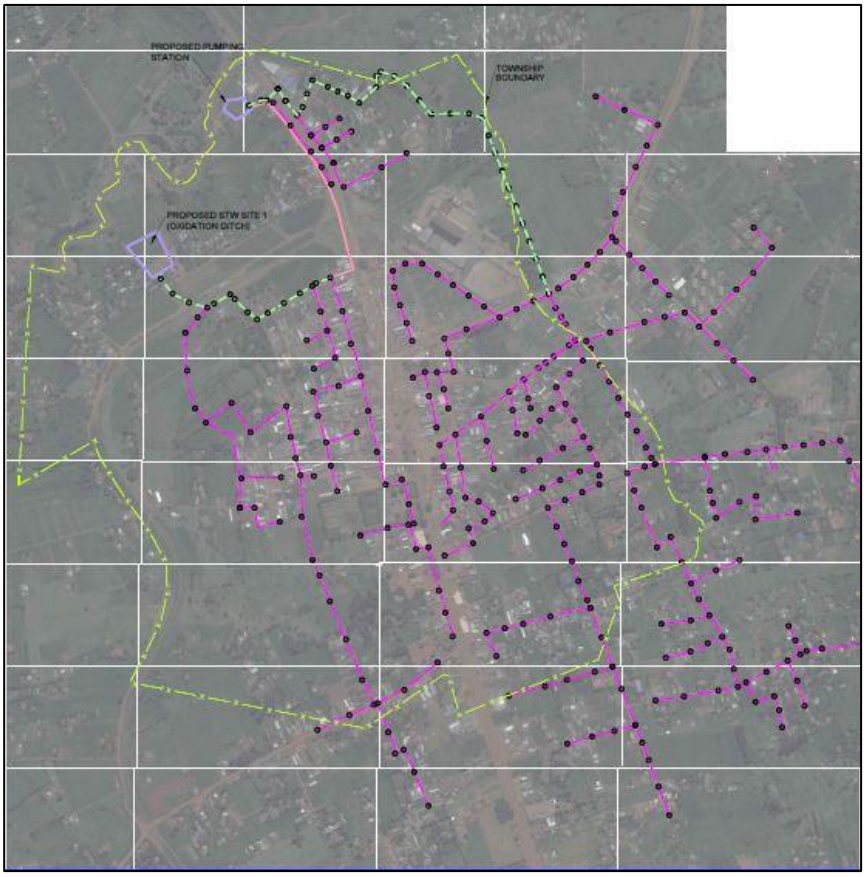


Figure 3 - 1: Option 1 location of proposed WWTP for Moi's Bridge sewerage scheme

The site whose coordinates are *UTM 735385.44E, 97285.87N* (WGS84 global reference system) is located in Uasin Gishu County and had been identified by the Client as a possible site for the WWTP. With the entire Moi's Bridge Town being the treatment plant's sewerage catchment basin, cross-county conflicts would be least expected. The available land (approximately 2.1 acres) is however not large enough to accommodate waste stabilization ponds but is sufficient for oxidation ditches. Mechanized treatment technology (oxidation ditch) would therefore be more appropriate for the site.

The Table below is a summary of the proposed sewers for Option 1 for Moi's Bridge sewerage scheme.

Table 3 - 1: Proposed sewers for option 1, Moi's bridge scheme.

Item	Description	Unit	Length
	Phase *1 (up to 2028)*		
1	225mm diameter uPVC sewers	m	17,620
2	300mm diameter PCC sewers	m	1,890
3	DN110 uPVC forced main	m	600

3.3.1.2. Option 2(a) and (b)

Option 2(a) considered siting the WWTP with a design capacity of 2,521m^3/day (dry weather flow + 15% allowance for infiltration) at a site marked "Sewage Treatment Site 2" in the figure below.

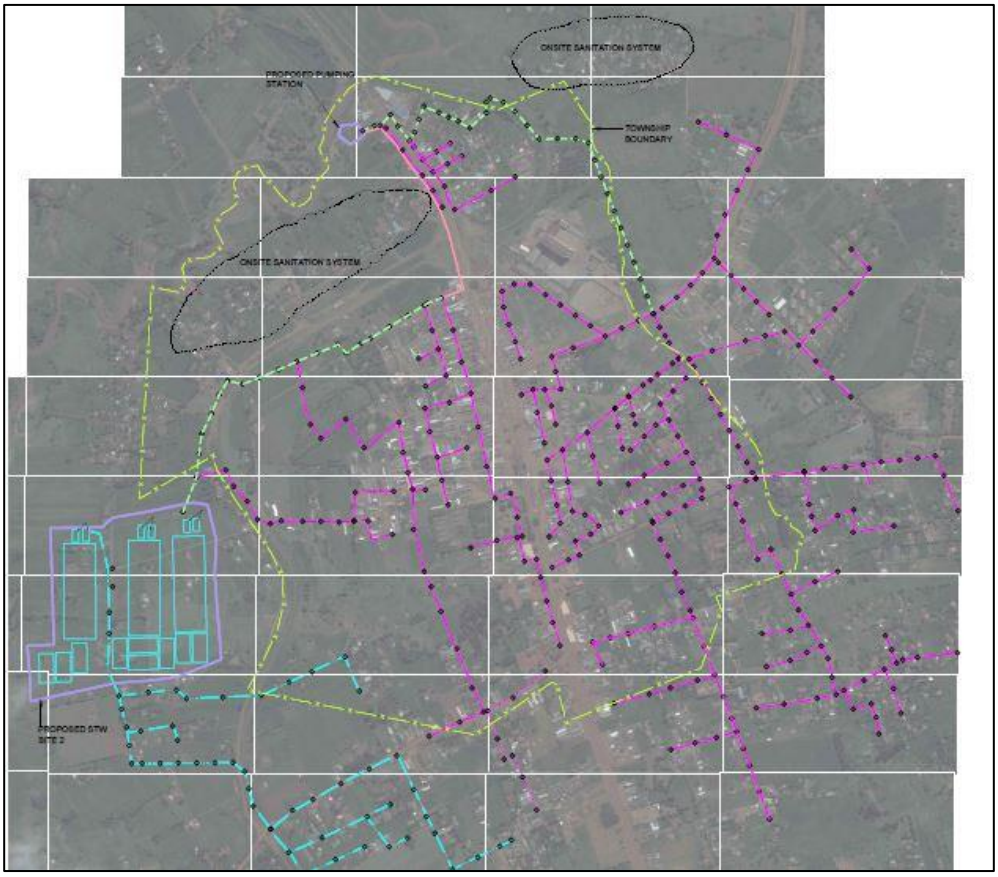


Figure 3 - 2: Option 2(a) and 2(b) location of proposed WWTP for Moi's Bridge sewerage scheme

The site whose coordinates are *UTM 735217.92E, 96499.76N* (WGS84 global reference system) is located in Kakamega County. Cross-county conflicts would be expected if this site was preferred since the largest proportion of sewerage catchment basin is in Uasin-Gishu County. The WWTP for this option would be sited approximately 350 metres from the banks of Nzoia River, since the areas downstream of the proposed plant adjacent to the river are waterlogged (marshy). The areas are also susceptible to flooding in periods of heavy rainfall. For Option 2(a), waste stabilization ponds treatment technology was proposed. Due to the high water table at this site, the proposed anaerobic ponds would be lined with a 1.0mm thick high density polyethylene dam liner.

On the other hand, Option 2(b) proposed mechanized treatment technology (oxidation ditch) for the sewerage.

The Table below is a summary of the proposed sewers for Option 2(a) and 2(b) for Moi's bridge sewerage scheme.

Table 3 - 2: Proposed sewers for option 2(a) and 2(b), Moi's bridge scheme

Item	Description	Unit	Length
	Phase 1 (up to 2028)		
1	225mm diameter uPVC sewers	m	18,150
2	300mm diameter PCC sewers	m	2,300
3	DN110 uPVC forced main	m	600
	Phase 2 (by 2038)		

Item	Description	Unit	Length
1	225mm diameter uPVC sewers	m	2,860

The Table below gives a comparison of all the options considered for the proposed sewerage system for Moi's Bridge including the merits and shortcomings of each.

Table 3 - 3: Comparison of the various options for the proposed Moi's Bridge sewerage system

Description	Moi's Bridge Sewerage System		
	Option 1	Option 2(a)	Option 2 (b)
Treatment technology	Oxidation Ditch	Waste stabilization ponds	Oxidation Ditch
Proposed site location (WGS 84 UTM)	Site 1 735385.44E,97285.87N	Site 2 735217.92E,96499.76N	Site 2 735217.92E,96499.76N
Land requirement for STW (acres)	2	42	2
Overall sewer network description	• Main sewers range (DN225 to DN300) • Pumping station required for areas east of Eldoret-Kitale road	• Main sewers range (DN225 to DN300) • Pumping station required for areas east of Eldoret-Kitale road	• Main sewers range (DN225 to DN300) • Pumping station required for areas east of Eldoret-Kitale road
Approximate Coverage (%)	72%	80%	80%
Merits	• Site is in Uasin-Gishu County, therefore cross-county conflicts not envisaged since Moi's bridge town is in Uasin-Gishu. • low land-take for oxidation ditch • low level of human displacement anticipated • site earlier identified as possible site for STW is sufficient for oxidation ditches	• Low O&M due to biological treatment technology (WSP) • Much wider area can be covered by the sewer network • Site off the township and clustered human settlements • Site away from flood plain	• Much wider area can be covered by the sewer network Site off the township and clustered human settlements • Low level of human displacement anticipated • low land-take for oxidation ditch
Shortcomings	• High proportion of site on a flood plain. Ponds may be flooded or swept away by flood waters • High O&M due to mechanized treatment • Available land (approx. 2.1 acres) not adequate to	• Site in Kakamega, therefore cross-county conflicts expected since Moi's Bridge is in Usain-Gishu County • High land-take for WSP including wayleave for trunk sewer • Longer lengths of trunk main	• Site in Kakamega, therefore cross-county conflicts expected • High O&M due to mechanized treatment • Longer lengths of trunk main • Wayleave acquisition for the trunk main

Description	Moi's Bridge Sewerage System		
	Option 1	Option 2(a)	Option 2 (b)
	accommodate WSP but sufficient for OD. • Site closer to town and clustered human developments • Areas to the south and south west along the railway station cannot drain to the proposed STW by gravity (approx. 10%)	• Site adjacent to the river and a swampy plain. Lining of ponds inevitable • High level of human displacement anticipated • Wayleave acquisition for the trunk main	

3.3.2. Matunda sewerage scheme

Three options were considered for the Matunda sewerage scheme.

3.3.2.1. Option 1

This option considered siting a WWTP with a design capacity of 1,502m^3/day (dry weather flow + 15% allowance for infiltration) at the site marked "Sewage Treatment Site 1" in the figure below.

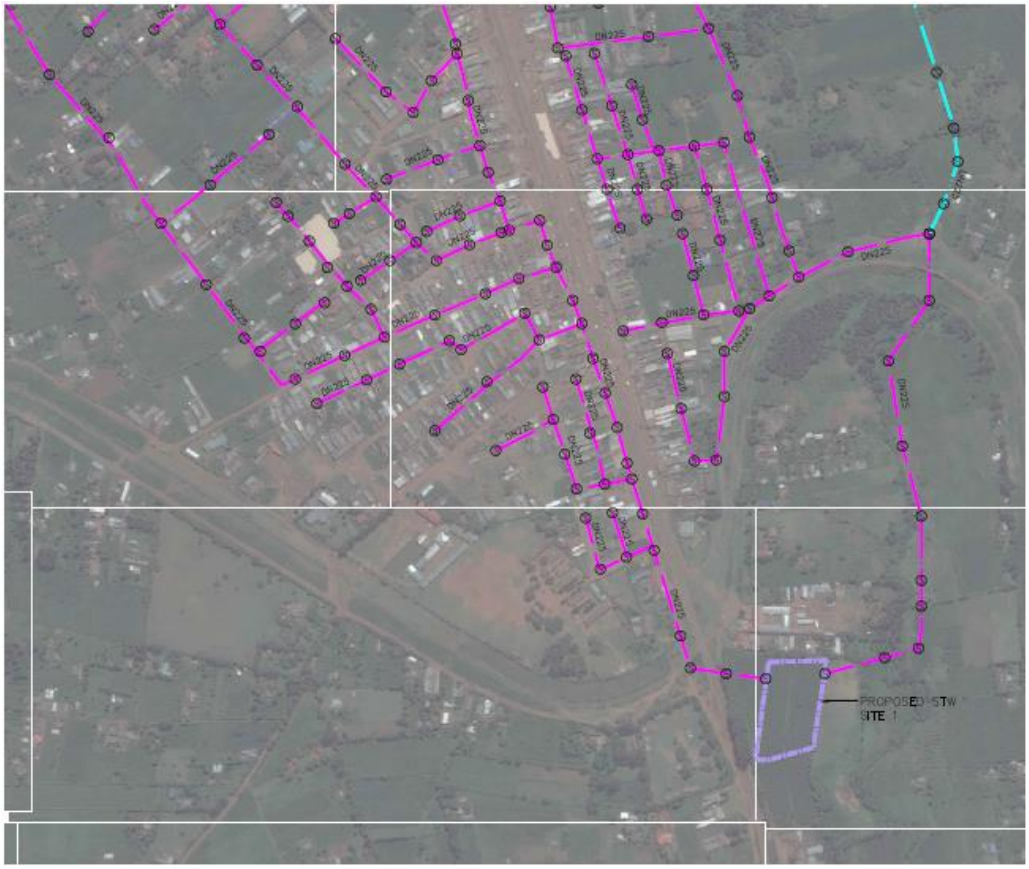


Figure 3 - 3: Option 1 location of proposed WWTP for Matunda Sewerage scheme

The site is located in Uasin Gishu County along the little Nzoia river adjacent to the main Eldoret-Kitale road, and its coordinates are *UTM 736707.73E, 904460.44N* (WGS84 global reference system)

The main advantage of this site is that the entire town of Matunda would be drained by gravity to the WWTP, therefore pumping would not be required. However, the site is located adjacent to the main Eldoret-Kitale road and may not be an aesthetically or socially ideal location for the siting of a WWTP. Cross-county conflicts would also be expected if this site preferred since the largest proportion of the WWTP sewerage catchment basin is in Kakamega County.

The identified land (approximately 2.0 acres) is not large enough to accommodate waste stabilization ponds but is sufficient for oxidation ditches. Mechanized treatment technology (oxidation ditch) would therefore be more appropriate for the site.

The table below is a summary of the proposed sewers for Option 1 for Matunda sewerage scheme.

Table 3 - 4: Proposed sewers for option 1, Matunda scheme

Item	Description	Unit	Length
	Phase 1 (up to 2028)		
1	225mm diameter uPVC sewers	m	11,350
	Phase 2 (by 2038)		
1	225mm diameter uPVC sewers	m	4,200

3.3.2.2. Option 2(a) and 2(b)

Options 2(a) and 2(b) considered siting the WWTP with a design capacity of 1,774m^3/day (dry weather flow + 15% allowance for infiltration) at a site marked "Sewage Treatment Site 2" as shown in the figure below. The treatment works would be sited approximately 150 metres from the banks of little Nzoia river, since the areas adjacent to the river are waterlogged (marshy).

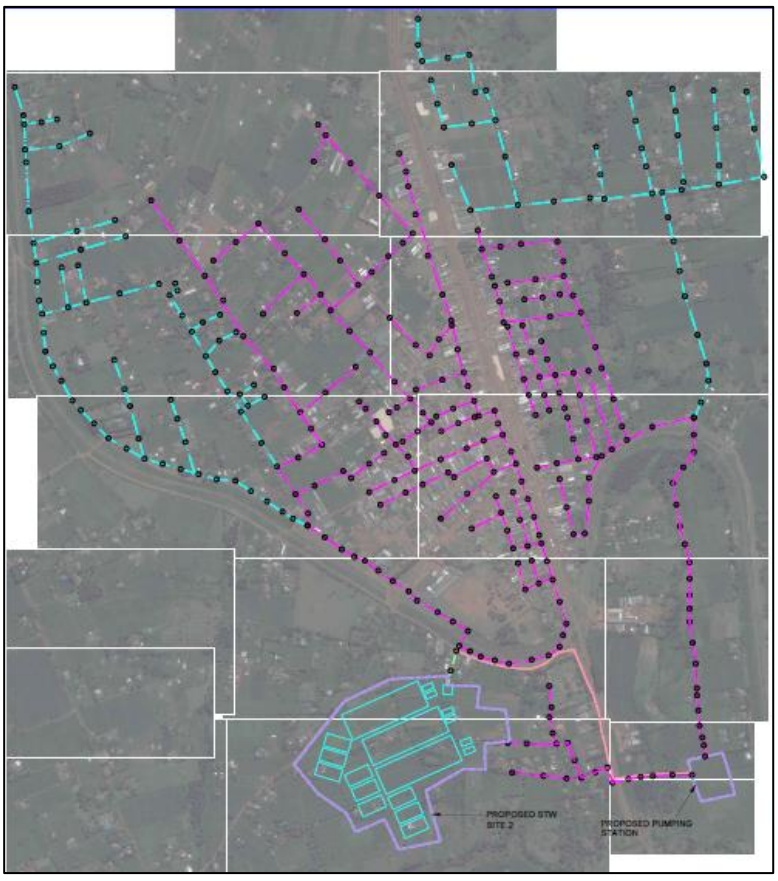


Figure 3 - 4: Option 2(a) and 2(b) location of proposed WWTP for Matunda Sewerage scheme

The site is located in Kakamega County on coordinates *UTM 735899.68E, 90433.61N* (WGS84 global reference system). Cross-county conflicts are least expected if this site is preferred since the largest proportion of the sewerage catchment basin is in Kakamega County.

A sewage pumping station would be necessary since areas to the east of Eldoret-Kitale road (approx. 35% of the project area) cannot drain by gravity to the proposed WWTP. Areas lying to the west of the Eldoret-Kitale road (approx. 65% of the project area) would drain to the proposed sewage treatment works by gravity.

For Option 2(a), waste stabilization ponds treatment technology was proposed. Due to the high water table at this site, the proposed anaerobic ponds would be lined with a 1.0mm thick high density polyethylene dam liner. For Option 2(b), mechanized treatment technology (oxidation ditch) was proposed

The Table below is a summary of the proposed sewers for Option 2(a) and 2(b) for Matunda sewerage scheme.

Table 3 - 5: Proposed sewers in option 2(a) and 2(b) for Matunda sewerage scheme

Item	Description	Unit	Length
	Phase 1 (up to 2028)		
1	225mm diameter uPVC sewers	m	14,000
2	300mm diameter PCC sewers	m	150
3	DN110 uPVC forced main	m	900
	Phase 2 (by 2038)		
1	225mm diameter uPVC sewers	m	7,800

The Table below gives a comparison of all the options considered for the proposed sewerage system for Matunda including the merits and shortcomings of each.

Table 3 - 6: Comparison of the various options for the proposed Matunda sewerage system

Description	Matunda Sewerage System		
	Option 1	Option 2(a)	Option 2 (b)
Treatment technology	Oxidation ditch	Waste stabilization ponds	Oxidation Ditch
Proposed site location (WGS 84 UTM)	Site 1 736707.73E,90460.44N	Site 2 735899.68E,90433.612N	Site 2 735899.68E,90433.612N
Land requirement for STW (acres)	2	32	2
Overall sewer network description	• Main sewers range from (DN225 to DN300) • No pumping required for the sewer network	• Main sewers range (DN225 to DN300) • Pumping station required for areas east of Eldoret-Kitale road	• Main sewers range (DN225 to DN300) • Pumping station required for areas east of Eldoret-Kitale road
Approximate Coverage (%)	75%	85%	85%

Description	Matunda Sewerage System		
	Option 1	Option 2(a)	Option 2 (b)
Merits	• Low land take for oxidation ditch • No pumping required for the sewer network	• Low O&M due to biological treatment technology • Site in Kakamega County. Cross-county conflicts minimized • Much wider coverage	• Low land take • Low level of human displacement anticipated • Site in Kakamega County. Cross-county conflicts minimized • Much wider coverage
Shortcomings	• Site close to human settlements and the Eldoret-Kitale road • High O&M due to mechanized treatment • Site prone to flooding • Available land (Approx. 2acres) not adequate to accommodate WSP but sufficient for OD • Site in Usain-Gishu County. Cross county conflicts expected as majority of Matunda township is in Kakamega County • Wayleave acquisition for the trunk main	• Pumping of sewage inevitable • High land take for STW including wayleaves for sewers • Site adjacent to a swampy plain. Lining of ponds inevitable. • High level of human displacement anticipated • High Wayleave acquisition for the trunk main	• Pumping of sewage inevitable • High O&M due to mechanized treatment • High Wayleave acquisition for the trunk main

3.3.3. Combined Moi's Bridge/Matunda sewerage scheme

Two options were considered for the combined scheme:

3.3.3.1. Option 1

This Option considered locating a WWTP with a design capacity 4,295m^3/day (dry weather flow + 15% allowance for infiltration) in Matunda at the same location as Figure 9 above, to serve both towns.

Two pumping stations would be required for this scheme; one for Moi's Bridge and another for Matunda. The drainage configuration for Matunda would remain as described in Section 3.2.2.2 while for Moi's Bridge, the entire network would flow by gravity to one pumping station to be located near the existing Moi's Bridge/Matunda water and sewerage company headquarters. The Moi's bridge forced main would convey sewage from the pump station to the highest peak (ridge) along the Eldoret-Kitale road for a distance of approximately 4.3 kilometers. From this peak, sewage would then flow by gravity to the proposed WWTP in Matunda.

The Table below is a summary of the proposed sewers for the combined scheme.

Table 3 - 7: Proposed sewers for combined sewerage scheme

Item	Description	Unit	Length
	Phase 1 (up to 2028)		
1	225mm diameter uPVC sewers	m	26,000
2	300mm diameter PCC sewers	m	1,890
3	375mm diameter PCC sewers	m	480
4	DN110 uPVC forced main	m	900
5	DN160 DCI forced main	m	4,450
	Phase 2 (by 2038)		
1	225mm diameter uPVC sewers	m	7,800

3.3.3.2. Option 2

Considerations were made to lay the main trunk sewer from Moi's Bridge along the Nzoia River to the confluence with the little Nzoia River where a combined sewage treatment works could be cited. However, owing to the mild slope of the river, several lift stations would be required along the main trunk line which would be approximately 30 kilometers in length. This would inevitably result in very high operation and maintenance costs coupled with very high costs for wayleave acquisition for the entire trunk main in addition to the land required for the combined WWTP. On this basis, this option was not considered for further analysis.

The Table below gives a summary of the combined system including its merits and shortcomings.

Table 3 - 8: summary of the combined sewerage system for Moi's Bridge and Matunda Towns

Description	Moi's Bridge/Matunda Combined System
Treatment technology	Oxidation Ditch
Proposed site location (WGS 84 UTM)	Matunda Site 2 (735899.68E, 90433.612N)
Land requirement for STW (acres)	4

Description	Moi's Bridge/Matunda Combined System
Overall sewer network description	• Main sewers range (DN225 to DN300) • Pumping stations required for areas east of Eldoret-Kitale road in Matunda and for the entire of Moi's Bridge scheme
Approximate Coverage (%)	77%
Merits	• Low land take • Only one scheme as opposed to two independent schemes
Shortcomings	• Site in Kakamega County. Cross-county conflicts likely to prevail as majority of project area is in Uasin-Gishu County • Highest O&M due to pumping of sewage for entire of Moi's bridge and Mechanized treatment for combined system. • Available land not adequate for WSP for entire scheme but sufficient for OD

4. Environmental baseline conditions

4.1. The bio-physical environment

4.1.1. Topography

The topography of the project area ranges from 1850masl in Matunda Town to 1,813masl in Moi's Bridge Town. A ridge that rises to about 1920m separates the two towns.

4.1.2. Geology and soils

The project area in Moi's Bridge and Matunda is underlain by soils developed on undifferentiated basement system rocks (predominantly gneisses). These are well drained, very deep, red to dark red, very friable to friable clays (rhodic FERRALSOLS) (Sombroek, Braun, & van der Pouw, 1982).

4.1.3. Hydrology, hydrogeology and water resources

The project area lays in the upper catchment of Nzoia River Basin. The river is fed by tributaries flowing from the south-eastern slopes of Mt. Elgon and the Kapcherop forest. Other rivers from the eastern side of the catchment include Moiben, Noigameget, Koitobos, Sergoit, Sosiani, Nureri, Kipkaren and Little Nzoia Rivers, which form a dendritic drainage pattern.

The Nzoia River and its spring water resources, are the major communal water supply for domestic use and animal requirements. The demand for water is generally increasing due to population growth and economic development. On the other hand, these water resources are increasingly being degraded due to unplanned settlements and lack of collaborative rehabilitation and management. Stream flow during seasonal low-flow periods has decreased in many areas due to greater degradation of the catchments. In addition, studies have established that most springs normally expected to have clean water are now contaminated with thermo-tolerant coliform bacteria. These may soon result into outbreaks of water-borne diseases and adversely affect the communities' livelihoods (Simiyu, Adams , & Esipila, 2008).

4.1.4. Climatic conditions

The climate of Moi's Bridge and Matunda Towns is mild, generally warm and temperate. According to the Köppen and Geiger system, this climate is classified as Cfb. The Table below gives a summary of the climatic variables for the three locations.

Table 4 - 1: Summary of climatic conditions in the project area

	Matunda and Moi's Bridge
Average Rainfall	1115mm
Average annual Temperature	18.6°C
Driest Month/rainfall	January/23mm
Rainfall Peak	August/169mm

(Source: http://en.climate-data.org)

4.1.5. Flora and fauna

The project area is mainly an agricultural area intensively cultivated for food crops such as maize, beans, wheat etc. Food crops form >90% of the land cover away from the towns' commercial zones, meaning that at certain times of the year, this land is bare. Many farms however have woodlots of *Eucalyptus sp*. Other tree species mainly forming plot boundaries or found around homesteads include *Grevillea robusta*, *Acacia*

sp., *Jacaranda mimosifolia*, *Senna sp*., *Spathodea nilotica*, *Croton macrostyches*, *Cupressus lusitanica*, and *Persea americana*.

Much of the fauna found in the project area are domesticated animals such as cows, sheep, and goats. Avian fauna found in the area includes birds such as chicken, swallows, weavers, starlings etc. Birds' species are mostly distributed on the basis of microhabitats. Thus, pockets with woodlots/dense vegetation and high plant diversity such as riverine areas are also likely to have higher birds' species composition. This is the case especially along the banks of Little Nzoia River.

4.2. Socioeconomic environment

4.2.1. Population

According to the Kenya Population and Housing Census (2009) Report, Moi's Bridge Location (which is comprised of Moi's Bridge and Matunda sub-locations) in Eldoret West sub-County of Uasin Gishu County had a population of 49,218 in 10,772 households. The population density was 491 people per square kilometer. However, the two towns of Moi's Bridge and Matunda also fall under Nzoia sub-location of Likuyani Location in Lugari sub-County, Kakamega County. The population of the towns was 19,911 in 4,376 households. The population density of Matunda was 1,250 people per square kilometer while that of Moi's Bridge was 486.

4.2.2. Land use and local economy

The Nzoia River Basin is of great economic importance at local as well as national levels. The area is considered of high to medium potential for agriculture. The economy of the region is still largely rural, and more than 90% of the population earns its living from agriculture and livestock. The farms are privately owned with an average of 1–3 hectares (ha). However, large commercial farms averaging 50–100 ha, or more, characterize Trans Nzoia and Uasin Gishu Counties.

The main food crops include maize, sorghum, millet, bananas, groundnuts, beans, potatoes, and cassava while the cash crops consist of coffee, sugar cane, tea, wheat, rice, sunflower and horticultural crops. Dairy farming is also practiced together with traditional livestock keeping.

4.2.3. Livelihoods and poverty Levels

According to the Kenya Integrated Household Budget Survey (KIHBS) 2005/06, Lugari District (sub-County) had a poverty rate of 47%. On the other hand, the First County Integrated Development Plan (CIDP) for Kakamega (2013 – 2017) advances that the overall poverty level in the County stands at 51.3%.

The causes of high poverty levels include poor farming methods, overdependence on one cash crop such as sugarcane, poor quality livestock, overdependence on rain fed agriculture, high population density, poor infrastructure, inaccessibility to quality health, low level of entrepreneurial skills, inadequate capital to invest in high yielding areas, high HIV and AIDS prevalence rate, increasing number of orphans and vulnerable children due to HIV and AIDS. Other effects of HIV and AIDS include the disease burden resulting from the cost of treatment for HIV and AIDS and loss of productivity (County Government of Kakamega, 2013).

In 2006, majority (94%) of the households were engaged in crop farming mainly growing maize and beans. only 21.6 % of all households in Lugari received other income apart from employment, business or agriculture income. It was also established that 42.2% of the households were headed by females.

4.2.4. Household social amenities

4.2.4.1. Access to water

The survey revealed that most of the people in Lugari lived in their own homes mainly constructed from mud/wood with corrugated iron sheet roofing. The main sources of water for these households were boreholes and dug wells/springs. The table below shows the distribution of households by the main source of drinking water in Lugari.

Table 4 - 2: Percentage distribution of Households by main source of drinking water

Water source	% of the households
Piped into dwelling	1.3
Piped into plot/yard	1.2
Public tap	0.1
Borehole with pump	25.4
Protected dug well	10.9
Protected spring	24.8
Rain Water collection	0.7
Unprotected dug well/spring	24.3
River/ponds streams	10.3
Tanker – truck/ vendor	1.1

According to the CIDP (2013), access to quality water remains a challenge with only 29.5% of the County population with access to portable water while only 5.9% have access to piped water.

The CIDP acknowledges that the level of the county's household access to portable water is still very low as compared to the UN standards that require each person is entitled to between 20-50 liters of water a day. With only a small fraction of households connected to piped water, springs are the main source of water providing for 41.6% of households in the County. About 53.1% of the existing springs are unprotected. This exposes people to the risk of contracting various water borne diseases. The rest of the County populace depends on water sourced from boreholes, shallow wells and roof catchments. About 44.2% of the households take between 5-14 minutes to fetch water - a chore considered for women and children. The terrain to the water points makes these water sources inaccessible.

The CIDP proposes to increase by twofold the percentage of the county's population with access to clean and safe water by 2017, i.e. 49% with access to portable water and 11.8% with access to piped water. A strategy that has been put forward in the CIDP to ensure access to quality water supply is to construct water treatment plants at various designated centres and joint school-community water projects. Rainwater harvesting and storage by individual persons and institutions is also proposed as well as a combined effort between water and housing subsectors focusing on ensuring that upcoming county structures have the element of water harvesting and storage in their design. Protection and fencing of natural and pure sources of water, and increase in the number of well-managed boreholes at strategic positions for community use in the County is also proposed (County Government of Kakamega, 2013).

4.2.4.2. Sanitation

In 2006, majority of the households (85%) made use of a pit latrine as the main toilet facility. To dispose their domestic wastes, 54.5% of the households disposed their domestic wastes in the farm garden while 28.6% disposed in a garbage pit. A small fraction of the households (10%) disposed their waste by burning.

The CIDP of 2013 estimated that Kakamega County has 88.0% of the population using pit latrines as the main waste disposal type, 1.9% of the population use flush toilet while 5.9% use VIP Latrines - a trend that is generally reflected in the major towns in the County.

4.2.4.3. Energy

To meet their energy needs, 86% of the households used firewood as the source of cooking fuel while 94% used paraffin as the main source of lighting fuel (KNBS, 2006).

4.2.5. Environmental and social Issues

4.2.5.1. Issues in urban settlements

The Kakamega CIDP (2013) cites the following issues as emerging in urban settlements of which Matunda and Moi's Bridge Towns are amongst:

- Indiscriminate solid waste disposal;
- Urban sprawl/ Unplanned settlements;
- Inadequate water supply;
- Pollution (land, air, and water);
- Poor waste water disposal;
- Encroachment on restricted areas e.g. road reserves, riparian reserves or environmentally fragile land; and
- Inadequate sanitation facilities e.g. public toilets, waste receptors, waste disposal sites.

The general strategies proposed for addressing the above problems revolve around planning of the urban centres, upgrading of water supply systems, development of sewage systems, enforcement of by – laws by county government, and provision of sanitation facilities (County Government of Kakamega, 2013).

4.2.5.2. Catchment/watershed degradation

Most of the Nzoia River watershed has been deforested and is continuously under crop production. 60% of the land in this area is arable and mostly under cultivation for maize and sunflower. The few remaining forested areas are Mt Elgon and Cherangany forests - which are currently being heavily deforested, and the steep sloping escarpments - originally Government trust land - are quickly being de-vegetated due to charcoal burning and illegal farming. This has led to high soil erosion and transport of sediments, which impacts on the livelihoods of the lake basin communities. Erosion along the River's banks has resulted in a noticeable large plume of sediments entering Lake Victoria and the production of an extensive algal bloom.

Catchment degradation due to increased population, urbanization and climate changes have led to contamination of the spring water sources. It is not uncommon to find spring water contaminated with thermo-tolerant coliform bacteria, in both developed and undeveloped springs (Simiyu & Adams, 2009). In other incidences, some springs have dried up or have shifted their outlets immediately after development denying the local communities their normal access to water (Simiyu, Ngetich, & Esipila, 2009).

The greatest vulnerabilities are likely to be in unmanaged water systems and systems that are currently stressed or poorly and unsustainably managed due to inadequate watershed governance that has been worsened by conflicts among riparian communities. Land cover changes are likely to change the natural ecology and water resources. Exogenous factors such as climate change, drought and floods will also impact the already serious water resource and pollution problems.

The Nzoia River watershed is exposed to several environmental problems such as land degradation and deforestation. Extensive clearing of vegetation and increased rainfall would cause soil erosion leading to high sedimentation in rivers (Okoth-Ogendo & Ojwang, 1995).

Sedimentation in Nzoia River is high during the rainy season compared to dry season. The significant impact of sedimentation is siltation of shallow unconfined spring aquifers and eventual drying up of springs.

Environmental degradation is leading to interference and the disappearance of some small wetlands. Ground water recharge would also decrease under this scenario, with lowering of water tables and a reduction in borehole and spring yields. Climate change is likely to exacerbate the current pressures on the limited surface and ground water resources in the area (Simiyu, Adams , & Esipila, 2008).

5. Policy, legal and regulatory framework

5.1. Introduction

This section sets out the policy, legal and regulatory framework relevant to the proposed Project. It identifies the most pertinent policies, legislation, regulations and standards governing the anticipated activities in implementation of the proposed project.

5.2. National policies

Table 5 - 1: Relevant National Policies

National Policy	Summary
National Policy on Water Resources Management and Development (Seasonal Paper No.1 of 1999).	The management of water resources in Kenya is guided by four specific policy objectives, namely: • Preserve, conserve, and protect available water resources and allocate it in a sustainable rational and economic way; • Supply water of good quality in sufficient quantities to meet the various water needs, including poverty alleviation, while ensuring the safe disposal of wastewater and environmental protection; • Establish an efficient and effective institutional framework to achieve a systematic development and management of the water sector; and • Develop a sound and sustainable financing system for effective water resources management, water supply and sanitation development.
The National Water Policy 2012 (Draft)	The Policy is built on the achievements of the sector reform commenced with the Water Act 2002 and based on the sector principles lined out in the National Water Policy 1999. On water resources management, the policy seeks the management of water resources along natural catchment/basin boundaries following the Integrated Water Resource Management approach. It aims to ensure a comprehensive framework for promoting optimal, sustainable, and equitable development and use of water resources for livelihoods of Kenyans through: • progressive restoration and protection of ecological systems and biodiversity in strategic water catchments; • increasing per capita water availability above the international benchmark of 1000 m^3 by 2030; • Maximizing use of trans-boundary water resources in coordination with other riparian countries; • Enhancing storm water management and rainwater harvesting; • Enhancing inter-basin water transfer in Kenya as a strategic intervention for optimized used of water resources; • Enhancing pollution control;

National Policy	Summary
	• Improving effluent waters treatment and recycling for use; • Ensuring sustainable groundwater resources for present and future generations; and • Developing a water management system which contributes to the protection of the environment.
Kenya Vision 2030	The Vision for the water and sanitation sector is "to ensure water and improved sanitation availability and access to all by 2030". Kenya is a water-scarce country with renewable fresh water per capita at 647 m^3 against the United Nations recommended minimum of 1,000 m^3. The water strategy aims to intensify Kenya's access to safe water and better sanitation using the national network of water services boards, and the private sector, where necessary. The water programmes will integrate both water and sanitation components, thereby ensuring simultaneous development of water and sanitation with the right pricing. This is expected to bring individual and social benefits that will outweigh the investment costs. In the vision, specific strategies will be introduced to raise standards of the country's overall water, resource management, storage and harvesting capability. Some of the flagship projects for water and sanitation include the rehabilitation and expansion of urban water supply and sanitation in the key satellite towns identified under the economic pillar With the expected increase in urban population and development of the 15 medium towns (towns of Narok, Machakos, Maralal, Wajir, Wote, Hola, Chuka, Ruiru, Athi River, Siaya, Ol Kalou, Matuu, Maua, **Moi's Bridge** and Limuru) and the new resort cities at the Coast, Isiolo and Lodwar, water and sanitation systems in those sites will be accorded priority (GoK, 2012).
The National Environment Policy, 2013	The goal of the policy is to ensure a better quality of life for present and future generations through sustainable management and use of the environment and natural resources. The objectives of the Policy are *inter alia* to: • Provide a framework for an 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. Some of the guiding principles in the implementation of the policy include: • **Environmental Right**: Every person in Kenya has a right to a clean and healthy environment and a duty to safeguard and enhance the environment;

National Policy	Summary
	• **Right to Development**: The right to development will be exercised taking into consideration sustainability, resource efficiency and economic, social and environmental needs; • **Sustainable Resource Use**: 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 • **Public Participation**: A coordinated and participatory approach to environmental protection and management will be enhanced to ensure that the relevant government agencies, county governments, private sector, civil society and communities are involved in planning, implementation and decision making processes.
The National Environment Action Plan Framework 2009 - 2013	The NEAP framework recognizes that the high population growth rate and expansion of economic activities have caused pressure on water resources. This is expected to increase unless urgent measures are taken to boost supply and rationalise demand. Water resources are under pressure caused by soil erosion and siltation, water catchments destruction, low level compliance to water quality regulations, inefficient water use strategies, invasive alien species, uncontrolled sand harvesting and over-abstraction of water resources. The framework proposes such interventions as: • Implementation of soil and water conservation measures; Provision of incentives for conservation of water catchments • Enforcement of EMCA, 1999 and other subsidiary regulations • Enforcement of the Water Act 2002 and other related legislations; • Promotion of efficient water harvesting, storage and usage; • Strengthening hydrological monitoring systems; • Promotion of integrated water resource management;
The National Land Policy (Sessional Paper No. 3 of 2009)	The overall object of the national land policy is to secure land rights and provide for sustainable growth, investment, and the reduction of poverty in line with the governments overall development objectives.
The Kenya National Biodiversity Strategy and Action Plan, 2000	The overall objective of the NBSAP is to address the national and international undertakings elaborated in Article 6 of the Convention on Biological Diversity' (CBD). It is a national framework of action for the implementation of the Convention to ensure that the present rate of biodiversity loss is reversed, and that present levels of biological resources are maintained at sustainable levels for posterity.
Economic Recovery For Wealth And Employment Creation Strategy 2006	The overall goal of the strategy is to ensure clear improvement in the social and economic wellbeing of all Kenyans; thereby giving Kenyans a better deal in their lives, and in their struggle to build a modern and prosperous nation. The key areas covered in the strategy are:

National Policy	Summary
	• Expanding and improving infrastructure; • Reforms in trade and industry; • Reforms in forestry; • Affordable shelter and housing; • Developing arid and semi-arid lands, and • Safeguarding environment and natural resources.

5.3. National legislation

Table 5 - 2: Relevant Legislation/Regulation/Standard

Legislation/Regulation/ Standard	Provisions	Relevance to the Project/ License or Permit Required/ or Activity requiring regulation
The Constitution of Kenya (2010)	• Provides for protection and conservation of the environment and ensuring ecologically sustainable development and use of natural resources; • Mandates the State to: - Establish systems of environmental impact assessment, environmental audit and monitoring of the environment; - eliminate processes and activities that are likely to endanger the environment; - utilise the environment and natural resources for the benefit of the people of Kenya; and - Encourage public participation in the management, protection and conservation of the environment. • Accords every person the right to a clean and healthy environment and where this is being or is likely to be, denied, violated, infringed or threatened, the person may apply to a court for redress in addition to any other legal remedies that are available in respect to the same matter	• Consultations and agreement is required with the community and County government before developments are executed; • The Nzoia River and its tributary – the Little Nzoia River which are the receiving waters of the discharge from the WWTPs are a critical water resource that requires sustainable utilization
Environmental Management and Coordination Act 1999	Provides for protection and conservation of the environment, environmental impact assessment, and environmental auditing and monitoring.	An EIA of the proposed project should be carried out and EIA License to be acquired before commencement of development

Legislation/Regulation/ Standard	Provisions	Relevance to the Project/ License or Permit Required/ or Activity requiring regulation
Environmental (Impact Assessment and Audit) Regulations, 2003	• Provides for the procedure for carrying out Environmental Impact Assessment (EIA) and Environmental Audit (EA). • Provides for the carrying out of an environmental audit study following commencement of project operations. • Provides for the contents of an EIA and an EA Report.	• The EIA to be carried out on the proposed project should be carried out in accordance to the regulations. • An initial environmental audit should also be carried out in the first year of operation of the project.
Environmental Management and Co-ordination (Water Quality) Regulations 2006	• Provides for the protection of ground and surface water resources. • Provides the water quality standards for effluent discharged into public sewers and effluent discharged into the aquatic environment.	• The discharge from the WWTPs into Nzoia River must be within the specified range after treatment

Parameter	Maximum Allowable(Limits)
1,1,1-trichloroethane (mg/l)	3
1,1,2-trichloethane (mg/l)	0.06
1,1-dichloroethylene	0.2
1,2-dichloroethane	0.04
1,3-dichloropropene (mg/l)	0.02
Alkyl Mercury compounds	Nd
Ammonia, ammonium compounds, NO_3 compounds and NO_2 compounds (Sum total of ammonia-N times 4 plus nitrate-N and Nitrite-N) (mg/l)	100
Arsenic (mg/l)	0.02
Arsenic and its compounds (mg/l)	0.1
Benzene (mg/l)	0.1
Biochemical Oxygen Demand (BOD 5days at 20 ^oC) (mg/l)	30
Boron (mg/l)	1.0
Boron and its compounds – non marine (mg/l)	10
Boron and its compounds –marine (mg/l)	30
Cadmium (mg/l)	0.01
Cadmium and its compounds (mg/l)	0.1
Carbon tetrachloride	0.02
Chemical Oxygen Demand (COD (mg/l)	50
Chromium VI (mg/l)	0.05
Chloride (mg/l)	250
Chlorine free residue	0.10
Chromium total	2
cis –1,2- dichloro ethylene	0.4
Copper (mg/l)	1.0
Dichloromethane (mg/l)	0.2
Dissolved iron (mg/l)	10
Dissolved Manganese(mg/l)	10
E.coli (Counts / 100 ml)	Nil
Fluoride (mg/l)	1.5
Fluoride and its compounds (marine and non-marine) (mg/l)	8

Legislation/Regulation/ Standard	Provisions	Relevance to the Project/ License or Permit Required/ or Activity requiring regulation
Lead (mg/l)		0.01
Lead and its compounds (mg/l)		0.1
n-Hexane extracts (animal and vegetable fats) (mg/l)		30
n-Hexane extracts (mineral oil) (mg/l)		5
Oil and grease		Nil
Organo-Phosphorus compounds (parathion,methyl parathion,methyl demeton and Ethyl parantrophenyl phenylphosphorothroate, EPN only) (mg/l)		1.0
Polychlorinated biphenyls, PCBs (mg/l)		0.003
pH (Hydrogen ion activity----marine)		5.0-9.0
pH (Hydrogen ion activity--non marine)		6.5-8.5
Phenols (mg/l)		0.001
Selenium (mg/l)		0.01
Selenium and its compounds (mg/l)		0.1
Hexavalent Chromium VI compounds (mg/l)		0.5
Sulphide (mg/l)		0.1
Simazine (mg/l)		0.03
Total Suspended Solids, (mg/l)		30
Tetrachloroethylene (mg/l)		0.1
Thiobencarb (mg/l)		0.1
Temperature (in degrees celious) based on ambient temperature		± 3
Thiram (mg/l)		0.06
Total coliforms (counts /100 ml)		30
Total Cyanogen (mg/l)		Nd
Total Nickel (mg/l)		0.3
Total Dissolved solids (mg/l)		1200
Colour in Hazen Units (H.U)		15
Detergents (mg/l)		Nil
Total mercury (mg/l)		0.005
Trichloroethylene (mg/l)		0.3
Zinc (mg/l)		0.5
Whole effluent toxicity		
Total Phosphorus (mg/l)		2 Guideline value
Total Nitrogen		2 Guideline value

Legislation/Regulation/ Standard	Provisions	Relevance to the Project/ License or Permit Required/ or Activity requiring regulation
Environmental Management and Co-ordination (Noise and Excessive Vibration Pollution) (Control) Regulations 2009	• Prohibits the generation of unreasonable, unnecessary or unusual noise which annoys, disturbs, injures or endangers the comfort, repose, health or safety of others and the environment. • Provides for the maximum noise levels permissible in various environmental set ups such as residential areas, places of worship, commercial areas and mixed residential	• Sound level limits of 55dB (day) and 35dB (night) to be observed during construction and operations. • License to emit noise/vibrations in excess of permissible levels to be acquired if necessary.

Legislation/Regulation/ Standard	Provisions	Relevance to the Project/ License or Permit Required/ or Activity requiring regulation

Zone		Sound Level Limits dB(A) (Leq, 14h)		Noise Rating Levels (NR) (Leq, 14h)	
		Day	Night	Day	Night
A	Silent Zone	40	35	30	25
B	Places of worship	40	35	30	25
C	Residential: Indoor	45	35	35	25
	Outdoor	50	35	40	25
D	Mixed residential (with some commercial & places of entertainment)	55	35	50	25
E	Commercial	60	35	55	25

Environmental Management and Co-ordination (Waste Management) Regulations 2006	• Provides for standards for handling, transportation and disposal of various types of wastes including hazardous wastes. • Requirements to ensure waste minimization or cleaner production, waste segregation, recycling or composting. • Provides for licensing of vehicle transporting waste. • Provides for the licensing of waste disposal facilities.	• Disposal of generated waste including soil, vegetation, boulders; and • Generation of hazardous wastes such as used oil and oily parts from construction machinery.
Environmental Management and Co-ordination (Fossil Fuel Emission Control) Regulations 2006	Provides for emission standards for internal combustion engines.	• Use of diesel-powered engines in construction machinery
Environmental Management and Coordination (Air Quality) Regulations, 2014	• Provides for ambient air quality tolerance limits. • Prohibits air pollution in a manner that exceed specified levels. • Provides for installation of air pollution control systems where pollutants emitted exceed specified limits. • Provides for the control of fugitive emissions within property boundary. • Provides for the control of vehicular emissions.	• Exhaust emissions from construction machinery. • Site clearance and excavation of foundations. • Transportation and disposal of spoil.

Legislation/Regulation/ Standard	Provisions	Relevance to the Project/ License or Permit Required/ or Activity requiring regulation
	• Provides for prevention of dispersion of visible particulate matter or dust from any material being transported. • Provides for acquisition of an emission license.	
The Physical Planning Act, 1996	• Provide for controls on the use and development of land and buildings in the interest of proper and orderly development of an area. • Requires that development permission be sought through a development application.	• Development of buildings and other infrastructure on land under the jurisdiction of Uasin Ngishu and Kakamega County Governments
The Public Health Act (Cap 242)	• Provides for the prevention of the occurrence of nuisance or conditions dangerous/injurious to humans. • Provides that the relevant local authority shall take all lawful, necessary and reasonably practicable measures -: - for preventing any pollution dangerous to health of any supply of water which the public within its jurisdiction has a right to use and does use for drinking or domestic purposes (whether such supply is derived from sources within or beyond its jurisdiction); and - for purifying any such supply which has become so polluted, and to take measures (including, if necessary, proceedings at law) against any person so polluting any such supply or polluting any stream so as to be a nuisance or danger to health.	• Generation of wastes during construction of the sewerage infrastructure • Handling and storage of waste at the site • Protection of the water source from pollution • Conveyance of noxious matter/waste through the sewer network and discharge of treated effluent into Nzoia river
Occupational Safety and Health Act (OSHA), 2007	• Provides for the safety, health and welfare of workers and all persons lawfully present at work places. • Provides for the registration of workplaces. • Outlines safety requirements in use of machinery to prevent accidents and injuries.	• Construction sites require registration as a workplace; • Safety measures are required in use of tools and machinery on site; and • Protection of the workers and general public with any form of interaction with the construction sites is necessary.

Legislation/Regulation/ Standard	Provisions	Relevance to the Project/ License or Permit Required/ or Activity requiring regulation
The Factories and Other Places of Work (Noise Prevention and Control) Rules, 2005	• Rules provide for the maximum noise exposure levels for workers in places of work and for the provision of protective equipment for those exposed to high noise levels. • Provide that an occupier shall also institute noise reduction measures at the source of noise in the workplace.	• Use of noisy machinery at the construction sites will require provision of PPE to workers
Water Act 2016	• provides that subject to the Land Act, 2012, land required for national public water works may be acquired in any manner provided by law for the acquisition of land for public purposes • Compensation on just terms shall be payable by the Government to the owner of the land on which any such works are constructed • A permit is required for the discharge of a pollutant into any water resource • Every person in Kenya has the right to clean and safe water in adequate quantities and to reasonable standards of sanitation • 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 • A person shall not, without authority conferred under this Act throw, convey, cause or permit to be thrown or conveyed, any rubbish, dirt, refuse, effluent, trade waste or other offensive matter or thing into or near to any water resource in such manner as to cause, or be likely to cause, pollution of the water resource	• Compensation will be necessary for sites acquired to construct the WWTPs and pumping stations; • Easement will be required where the sewer lines traverse private land • Permits will be required for discharge of treated effluent into Nzoia and Little Nzoia Rivers
Water Resource Management Rules 2007	• Provides that no person shall discharge or apply any poisonous, toxic, noxious or obstructing matter, radioactive waste or other pollutants or permit any person to dump or discharge such matter into any water resource unless the discharge of	• Waste water from the WWTPs to be treated to acceptable standards before discharge into the rivers • An application for a discharge permit to be made and obtained for treated effluent

Legislation/Regulation/ Standard	Provisions	Relevance to the Project/ License or Permit Required/ or Activity requiring regulation
	such poisonous, toxic, noxious or obstructing matter, radioactive waste or pollutant is treated to permissible standards as authorized by the Authority • Provides that No person shall: - Discharge effluent into a water resource without a valid discharge permit issued by the Authority. - Discharge wastewater or effluent, which does not meet the water quality requirements stipulated in the effluent discharge permit. - Generate and discharge effluent onto land or into any water resource without compliance with an approved Effluent Discharge Control Plan. - Discharge into any water resource effluent from a sewage treatment plant, trade or industrial facility without a calibrated flow measuring device approved by the Authority. • Provides for an application for water resource use with respect to an effluent discharge point • Provides for maintenance of records of all water discharged giving the date, time quality, quantity and methods of discharge • Provides Guidelines for Effluent Discharge into surface water resources	discharge into Nzoia and Little Nzoia Rivers for Matunda and Moi's Bridge WWTPs • Discharge Control Plans to be prepared for the two WWTPs • Records of the discharge into the rivers to be maintained for the two WWTPs

Parameter	Max Allowable (Limits)
Arsenic as As (mg/1)	0 1
Biochemical Oxygen Demand (BOD 5days at 20 °C) (mg/1)	30
Cadmium as Cd (mg/1)	1 0
Chemical Oxygen Demand (COD (mg/1)	100
Chromium as Cr (mg/1)	Less than 0 01
Lead as Pb (mg/1)	Less than 0 01
Oil and grease	Absent
pH (Hydrogen ion activity)	5 0-9 0
Phenols total (mg/1)	0 05
Sulphide as S (mg/1)	2 0
Total Suspended Solids (mg/1)	30
Temperature (in degrees Celsius) based on ambient temperature	± 5

Legislation/Regulation/ Standard	Provisions	Relevance to the Project/ License or Permit Required/ or Activity requiring regulation
	Cyanides as CN (mg/1)	Less than 0 2
	Nickel as Ni (mg/1)	Less than 2 0
	Detergents (ABS) (mg/1)	Less than 5 0
	Mercury as Hg (mg/1)	Less than 0 01
	Total Phosphorus as P (mg/1)	
	Total Nitrogen as N (mg/l)	10
	Total pesticide residues	Absent
The Land Act 2012	• Mandates the Land Commission and other public officers to use the following guiding principles and values: - equitable access to land; security of land rights; - security of land rights; - sustainable and productive management of land resources; - conservation and protection of ecologically sensitive areas • provides for the conversion of private land to public land through compulsory acquisition, transfer, surrender or reversion of leasehold interest to Government; • provides that just compensation shall be paid promptly in full to all persons whose interests in the land have been determined; and • Provides for the creation of a public rights of way (ROW) or wayleave by the National Land Commission.	• conservation and protection of ecologically sensitive areas such as the river system, riverine areas, and other significant terrestrial habitats is required in development of the water supply scheme; • compulsory acquisition may be necessary if land owners are not willing to avail the land for development of the water supply scheme; • just compensation is required for all whose land will be acquired; and • Creation of ROW will be necessary where the proposed water pipeline passes through private land.

5.4. International guidelines

Table 5 - 3: International guidelines

Standard/Guideline	Provision	Relevance to the Project
International Finance Corporation (IFC) Performance Standard (PS) 1 on Assessment and Management of Environmental and Social Risks and Impacts	• Provides for identification and evaluation of environmental and social risks and impacts of a project; • Provides for the adoption of a mitigation hierarchy to anticipate and avoid, minimize, and, where residual impacts remain, compensate/offset for risks and impacts to workers, affected communities, and the environment.	• Environmental and Social Risks to be evaluated through an Environmental and Social Impact Assessment; • Measures to avoid, minimize and compensate for risks and impacts on communities and environment will be developed in the ESMPs; and

Standard/Guideline	Provision	Relevance to the Project
	• Provides for improvement in environmental and social performance through the effective use of management systems; • Provides for mechanisms to ensure that grievances from affected communities and external communications from other stakeholders are responded to and managed appropriately; • Provides for mechanisms for adequate engagement with affected communities throughout the project cycle on issues that could potentially affect them; • Provides for measures to ensure that relevant environmental and social information is disclosed and disseminated	• Elaborate stakeholder engagement will be carried out during project planning and implementation.
World Bank OP 4.01 on Environmental Assessment	• Provides for environmental assessment (EA) of projects proposed for Bank financing to help ensure that they are environmentally sound and sustainable, and thus to improve decision making	• An Environmental and Social Impact Assessment of the project will be carried out.
IFC PS 2 on Labour and Working Conditions	• Provides for measures to promote the fair treatment, non-discrimination, and equal opportunity of workers; • Provides for measures to establish, maintain, and improve the worker-management relationship; • Provides for measures to promote compliance with national employment and labor laws; • Provides for measures to protect workers, including vulnerable categories of workers such as children, migrant workers, workers engaged by third parties, and workers in an organization's supply chain; • Provides for mechanisms to promote safe and healthy working conditions, and the health of workers; and • Provides for measures to avoid the use of forced labor.	• Appointed contractor will be bound by local employment and labor laws; and • Contractor will also be bound by the Occupational Safety and Health Act, 2007 to ensure safe and healthy working conditions.
IFC PS 3 on Resource efficiency and Pollution Prevention	• Provides for measures to avoid or minimize adverse impacts on human health and the environment by avoiding or minimizing pollution from project activities.	• The ESIA will identify all potential pollution sources and provide measures to prevent/mitigate pollution and impacts; and

Standard/Guideline	Provision	Relevance to the Project
	• Provides for measures to promote more sustainable use of resources, including energy and water. • Provides for measures to reduce project-related GHG emissions.	• Measures to ensure conservation of energy and water during construction will be proposed.
IFC PS 4 on Community Health, Safety and Security	• Provides for mechanisms to anticipate and avoid adverse impacts on the health and safety of the affected community during the project life from both routine and non-routine circumstances; and • Provides for measures to ensure that the safeguarding of personnel and property is carried out in accordance with relevant human rights principles and in a manner that avoids or minimizes risks to the affected communities.	• Appointed contractor will be bound by the Occupational Safety and Health Act, 2007 to mitigate risks to the surrounding communities from project activities.
IFC PS 5 on Land Acquisition and Involuntary Resettlement & World Bank OP 4.12 on Involuntary Resettlement	• Provides for measures to ensure the avoidance, and when avoidance is not possible, minimization of displacement by exploring alternative project designs; • Provides for measures to ensures the avoidance of forced eviction; • Provides for measures to ensure the anticipation, avoidance or minimization of adverse social and economic impacts from land acquisition or restrictions on land use by (i) providing compensation for loss of assets at replacement cost and (ii) ensuring that resettlement activities are implemented with appropriate disclosure of information, consultation, and the informed participation of those affected; • Provides for measures to ensures the improvement or restoration of the livelihoods and standards of living of displaced persons; and • Provides measures to ensure the improvement of living conditions among physically displaced persons through the provision of adequate housing with security of tenure at resettlement sites.	• Project designs (especially pipeline route) have to the extent possible attempted to avoid displacement of communities by following established road reserves; and • A Resettlement Action Plan will be prepared for those being displaced by project components.
IFC PS 6 on Biodiversity Conservation and	• Provides for measures to ensure the protection and conservation of biodiversity;	• ESIA will identify areas with high biodiversity and provide measures for protection

Standard/Guideline	Provision	Relevance to the Project
Sustainable Management of Living Natural Resources	• Provides for measures to ensure the maintenance of benefits from ecosystem services; and • Provides for measures to promote the sustainable management of living natural resources through the adoption of practices that integrate conservation needs and development priorities.	
World Bank OP 4.04 on Natural Habitats	• Provides for the application of a precautionary approach to natural resource management to ensure opportunities for environmentally sustainable development; • Provides for measures for the identification of (a) natural habitat issues and special needs for natural habitat conservation, including the degree of threat to identified natural habitats (particularly critical natural habitats), and (b) measures for protecting such areas in the context of the country's development strategy; • Provides for measures to rehabilitate degraded natural habitats; • Discourages the significant conversion or degradation of critical natural habitats; and • Provides for measures to take into account the views, roles, and rights of groups, including local nongovernmental organizations and local communities, affected by Bank-financed projects involving natural habitats, and to involve such people in planning, designing, implementing, monitoring, and evaluating such projects.	• Baseline studies to identify natural habitats that require conservation. ESIA to provide measures for protection of the natural habitats
IFC PS 7 on Indigenous Peoples & World Bank OP 4.10 on Indigenous Peoples	• Provides for measures to ensure that the development process fosters full respect for the human rights, dignity, aspirations, culture, and natural resource-based livelihoods of Indigenous Peoples; • Provides for measures to ensure the anticipation and avoidance of adverse impacts of projects on communities of Indigenous Peoples, or when avoidance is not possible, to minimize and/or compensate for such impacts; • Provides for measures to promote sustainable development benefits and	• No indigenous people have been identified in the project area.

Standard/Guideline	Provision	Relevance to the Project
	opportunities for Indigenous Peoples in a culturally appropriate manner; • Provides for measures to establish and maintain an ongoing relationship based on Informed Consultation and Participation (ICP) with the Indigenous Peoples affected by a project throughout the project's life-cycle; and • Provides for measures to respect and preserve the culture, knowledge, and practices of Indigenous Peoples.	
IFC PS 8 on Cultural Heritage & World Bank OP 4.11 on Physical Cultural Resources	• Provides for measures to protect cultural heritage from the adverse impacts of project activities and support its preservation; • Provides for measures to promote the equitable sharing of benefits from the use of cultural heritage; and • Provide for measures to address impacts on physical cultural resources in projects proposed for Bank financing, as an integral part of the environmental assessment (EA) process.	• ESIA will propose measures for protection of identified cultural resources.

6. Stakeholder consultations

6.1. Introduction

The need for public involvement in project development is enshrined in the Constitution of Kenya, 2010. This requirement is also provided for in the EMCA, 1999, the Environmental (Impact and Audit) Regulations, 2003, and is one of the guiding principles of the National Environment Policy, 2013.

Public participation ensures that communities and stakeholders are part and parcel of the proposed developments. It presupposes that the public has access to timely and accurate information on the environment and the proposed development(s), and therefore assures that the developments are sustainable and resources are also used sustainably. It has also been demonstrated successfully that projects that go through this process acquire a high level of acceptance and accrue benefits to a wider section of society.

Public consultation also forms a useful component for gathering, understanding and establishing likely impacts of projects, determining community and individual preferences and selecting alternatives.

6.2. Benefits of public consultation

6.2.1. Benefits to the developer

- The developer is likely to benefit from local knowledge;
- Costs may be saved as key issues are identified by the public and studies are focused on key issues as opposed to a broad range of issues;
- Measures to reduce adverse impacts and enhance benefits will be identified with stakeholders;
- Relations with the communities in the vicinity of the development are likely to be improved;
- Delays in decision making may be reduced because of good participation early in the process;
- The public are unlikely to raise objections to the project; and
- The developer's image and reputation is likely to be enhanced.

6.2.2. Benefits to the public

- Capacity is built through people playing an active role during the process. The skills learnt can be used in other community projects;
- Public rights are exercised and protected in participating; and
- Inputs are likely to influence the form and nature of the development and is likely to lead to better development that takes society's needs into account.

6.2.3. Benefits to decision makers

- Public participation is likely to improve decisions since there is access to a broader range of perspectives and opinion on the proposed rehabilitation/augmentation;
- The development is likely to be more sustainable as it takes people's needs and views into account; and
- The legitimacy of project commencement and implementation is likely to be improved.

6.3. Public consultations in the project area

The Public consultation process involved visiting the project area and its environs. Project stakeholders were identified and consulted with the aim of informing them about the proposed project, collect their views on anticipated positive and/or negative impacts, get recommendations on how the adverse impacts can be mitigated or avoided, and gather local knowledge that would be useful to the proposed project.

6.3.1. Objectives

The main objectives of the public consultation process were as follows:

- To inform stakeholders about the proposed project;
- To share with stakeholders, the impacts(positive and/or negative) that they should expect from the proposed project during construction and operation; and
- To collect stakeholders' views, comments, concerns and local knowledge regarding the proposed project.

6.3.2. Engagement methodology

In order to complete this public consultations exercise, the Consultant implemented a systematic approach that consisted of a reconnaissance visit to the project area, review of relevant documentation, conducting interviews, administration of questionnaires to the project stakeholders and holding stakeholders' meetings.

6.3.2.1. Reconnaissance visit

The Consultant visited the project site in July 2016 to familiarise himself with the project area and scope. During this visit, the Consultant also identified would-be project stakeholders covering government institutions, individual stakeholders and the community in the project area.

6.3.2.2. Literature review

Prior to commencement of the assignment and throughout the assignment, the Consultant reviewed relevant information including the Feasibility Study and Detailed Design Reports for the proposed project, County Data Sheets for Kakamega and Uasin Gishu Counties, County Baseline profiles and the Population and Housing Census Report, 2009. This desktop review formed the basis on which subsequent field visits would be made and reports compiled.

6.3.2.3. Stakeholder identification

The Public consultation exercise commenced in July 2016 with the Consultant's reconnaissance visit. The visit identified the following as the project stakeholders:

6.3.2.3.1. Community

- Residents of Moi's Bridge Town
- Residents of Matunda Town

6.3.2.3.2. Kakamega County Government

Table 6 - 1: Identified stakeholders in Kakamega County Government

Position	Institution
The Governor	Kakamega County
County Minister of Environment, Water and Natural Resources	Ministry of Water, Environment, & Natural Resources
Minister for Agriculture, Livestock, Cooperatives and Fisheries.	Ministry of Agriculture, Livestock, Cooperatives and Fisheries.
County Director of Environment	NEMA
Deputy County Commissioner	Likuyani Sub county
County Lands Officer	Kakamega County
County Agricultural Officer	Kakamega County
County Social Affairs Officer	Kakamega County
County Chambers of Commerce Officer	Kakamega County

Position	Institution
Member of County Assembly (MCA)	Moi's Bridge
Ward Administrator	Moi's Bridge
Sub county Administrator	Moi's Bridge
Chief	Moi's Bridge
Chief	Nzoia location-Matunda
Sub County Water Officer	Likuyani
Sub County Water Officer	Turbo/Soy
County Director Water Affairs	Kakamega County

6.3.2.3.3. Uasin Gishu County Government

Table 6 - 2: Identified stakeholders in Uasin Gishu County Government

Position	Institution
The Governor	Uasin Gishu County
The Chief Officer	Ministry of Environment, Energy, Water and Natural Resources
County Director of Environment	NEMA
Deputy County Commissioner	
Chief Officer	Department of Lands , Housing & Physical Planning
Chief Officer	Department of Agriculture, Fisheries & Livestock
Chief Officer	Department of Education, Culture, Youth Affairs, Sports & Social Services
Chief Officer	Department of Trade, Industrialization, Enterprise Development, Cooperatives, Tourism and Wildlife Management.
Member of County Assembly (MCA)	Maji mazuri
Ward Administrator	Maji mazuri
Sub county Administrator	Maji mazuri
Chief	Maji Mazuri
County Director Water Affairs	Uasin Gishu County

6.3.2.3.4. Water sector stakeholders in the project area

Table 6 - 3: Other water Sector stakeholders in the project area

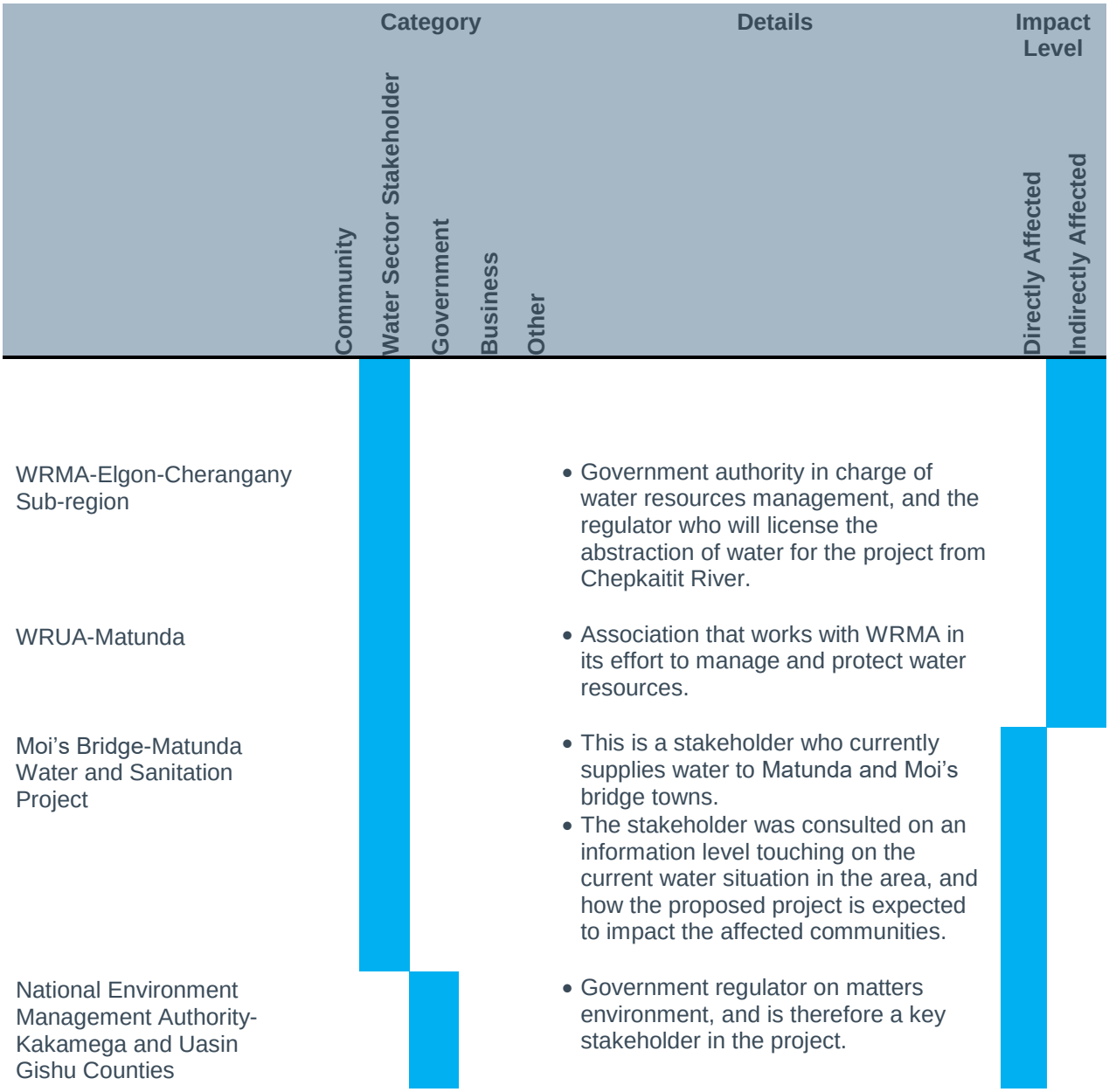
Position	Institution
Regional Manager	Lake Victoria North Catchment-(WRMA)
Sub-Region Manager	WRMA Kipkarren-Upper Yala Sub-region
Sub-Region Manager	WRMA-Elgon-Cherangany Sub-region
Water Resource Users Association	WRUA-Matunda
Moi's Bridge-Matunda Water and Sanitation Project	Moi's Bridge

6.3.2.4. Stakeholder analysis

In this study, the 'importance' of a stakeholder is defined by whether the stakeholder is directly or indirectly affected by project activities. For instance, stakeholders directly affected by the proposed Rehabilitation/augmentation works are viewed as more 'important' as they are first-hand recipients of the concomitant impacts. The stakeholders are as analysed below:

Table 6 - 4: Stakeholder analysis

	Category					Details	Impact Level	
	Community	Water Sector Stakeholder	Government	Business	Other		Directly Affected	Indirectly Affected
Residents of Moi's Bridge and Matunda Towns	■					• Major beneficiaries of the proposed project. • Community living in the project area: some neighbouring the proposed WWTP sites, pumping stations and others along the trunk sewer pipeline. • Some of the land owners are likely to be affected by the land acquisition process for the WWTPs and pumping stations.	■	
Kakamega County Government			■			• The County Government of Kakamega hosts several technical stakeholders whose inputs will be sought on project components to be located in Kakamega County. • Some of them include but are not limited to the following: Department of Water, Agriculture, Commerce and NEMA	■	
Uasin Gishu County Government			■			• The County Government of Uasin Gishu hosts several technical stakeholders whose inputs will be sought on project components to be located in Uasin Gishu County. • Some of them include but are not limited to the following: Department of Water, Agriculture, Commerce and NEMA	■	
WRMA Kipkarren-Upper Yala Sub-region		■				• Government authority in charge of water resources management, and a key stakeholder as he manages part of the river where effluent discharge for the proposed project will happen.		■



6.3.2.5. Stakeholder consultations

The stakeholders were consulted through the following methods:

6.3.2.5.1. Interviews

This method was applied in engaging various institutional stakeholders. Stakeholders consulted through interviews included: the Deputy County Commissioner-Likuyani Sub County, Deputy County Commissioner-Transnzoia East Sub County, WRMA-Kipkarren Upper Yala Sub region, WRMA-Elgon Cherangany Sub region, the Chief-Nzoia location (Matunda), the Chief – Moi's Bridge.

6.3.2.5.2. Administration of Questionnaires

A public consultation and participation form was administered to members of the community living in the project area. Convenience sampling was applied to select respondents for participation. However, the sample was further guided by NEMA's minimum questionnaires requirement, and stakeholders' availability to participate. A total of 85 questionnaires were administered and filled. These are attached as **Appendix C**.

6.3.2.5.3. Stakeholders' meetings

Three meetings were held in this consultation exercise:

- Stakeholders' workshop for the opinion leaders held on 13 March 2017 at Kachibora;
- Kachibora community participation meeting held on 15 March at Kachibora town;
- Community participation meeting held on 16 March 2017 in Moi's Bridge Town;
- Community participation meeting held on 17 March 2017 in Matunda Town.

Figure 6 - 1: Opinion leaders meeting in Kachibora

Figure 6 - 2: Community participation meeting in Kachibora Town

Figure 6 - 3: Community participation meeting in Moi's Bridge Town

Figure 6 - 4: community participation meeting in Matunda Town

Minutes of meetings are attached in **Appendix C** of this Report.

6.4. Consultations findings

6.4.1. WRMA, Kipkarren Upper Yala Sub region – Sub-region Manager

The following are WRMA's requirements for the proposed project:

- ✓ Apply for a permit;
- ✓ The Proponent should show how discharge will be disposed;
- ✓ The Proponent should develop an Effluent Discharge Control Plan (EDCP). WRMA will approve and monitor its implementation but the Proponent will also be required to carry out self-monitoring;
- ✓ The project's treatment works should be located away from the riparian reserve. NB: The riparian reserve can be 30m or more depending on the highest flood mark of the river in question;
- ✓ Local knowledge from the Water Resource Users Associations (WRUAs) will be very useful to the proposed project as they understand the river behavior best.

6.4.2. Findings from questionnaires administration

6.4.2.1. Community's perception of the proposed project

95% (81) of the respondents reported that the proposed construction of the Matunda and Moi's Bridge sewerage schemes was a worthwhile investment in the community while 5% (4) of the respondents felt that it was not as shown in the figure below:

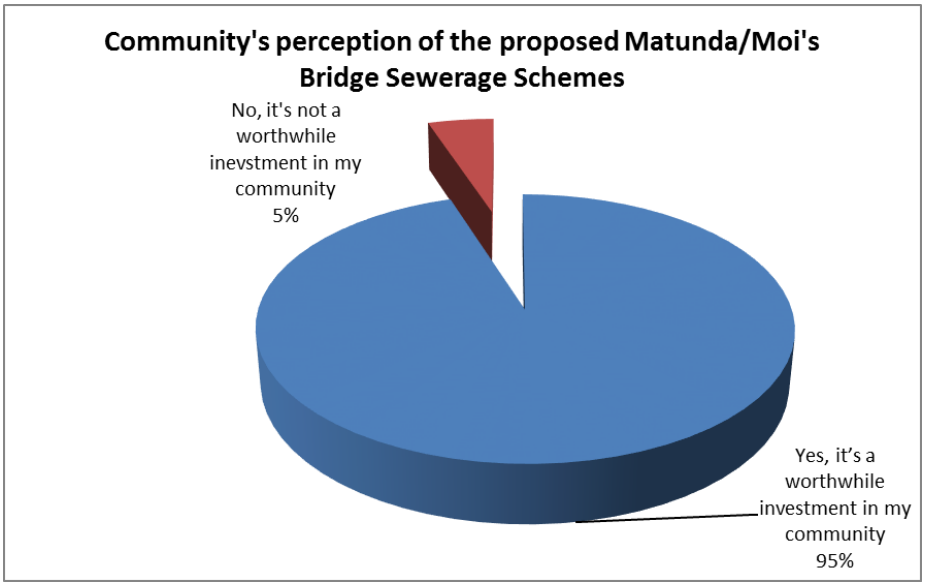


Figure 6 - 5: Community's perception of the proposed Matunda and Moi's Bridge sewerage schemes

Respondents who felt that the proposed sewerage schemes were a worthwhile investment in their community cited the following reasons:

- They will improve hygiene in the two towns through proper wastewater disposal;
- Improved hygiene will promote good health by through a reduction in waterborne diseases;
- They will reduce the unhygienic conditions around the towns and air pollution experienced from open, uncontrolled sewerage flows in the area;
- They will lead to use of more hygienic and flushable toilets which are aesthetically appealing as opposed to the current pit latrines in use;
- The schemes will reduce the cost of exhausting and digging of new pit latrines;
- There will be less pollution of nearby rivers by effluent once the schemes are operational;

6.4.2.2. Impacts of the proposed sewerage schemes

The respondents opined that the proposed project will have the following positive and adverse impacts during construction and operation phases:

6.4.2.2.1. Construction phase impacts

- Creation of job opportunities for the local community leading to improved living standards. Engaging the youth in construction activities will minimise idleness and consequently, a reduction in crime rates;
- Destruction of property and displacement of some of the community members due to land take intended to host some of the project components. This can be addressed by just and fair compensation and proper engagement of the host community concerning the proposed schemes;
- Possible theft/vandalism of construction materials and equipment. This can be avoided by employing security personnel;

6.4.2.2.2. Operation phase impacts

- Improved hygiene in the two towns and their environs with the proper handling and disposal of sewerage. This will also result in improved health and living/working conditions in the project area; and
- The infrastructural development is likely to attract more investors in the two towns;
- Possible sewage collection system failures if substandard materials are used;
- Air pollution as a result of odour from the WWTPs.

6.4.3. Findings from stakeholder/community meetings

Key concerns from the community meetings were:

- What are the environmental and social impacts of the proposed sewerage schemes?
- Will the affected people be paid for the land required for the WWTPs and pumping stations?
- Who will pay for the land?
- What happens if the community refuses to cede the land required for the WWTPs?
- How will odor from the WWTPs be mitigated?
- Why is sewerage generated in one county (Uasin Gishu) planned for disposal in another (Kakamega) County?
- Can the WWTPs be relocated to less populated areas?

The community concerns above were responded to by outlining the potential impacts and mitigation measures identified during the ESIA studies, and the considerations made in project siting during design of the schemes.

6.5. Conclusion

The stakeholders' consultation exercise established that majority of the host community welcomes the proposed sewerage schemes. They perceive the schemes as a worthwhile investment that will solve the challenge of waste disposal in the project area, improve residents' health and ultimately improve the quality of life.

However, some of the land owners in Moi's Bridge feel the required acreage for the treatment works site is too large, and relocation of the project to a less populated area would be ideal.

Proposals presented by the community included offering jobs to local residents, ensuring just compensation for affected property/land owners, and engaging the host communities during the lifespan of the proposed projects.

7. Prediction and evaluation of impacts

7.1. Introduction

This Chapter sets out the methodology used to assess impact significance. In this Report, an impact is defined as "*Any change to the environment, whether adverse or beneficial, wholly or partially resulting from a project developer's activities or products and which can interact with the environment*".

An impact is defined where an interaction occurs between a project activity and an environmental receptor. The ESIA process ranks impacts according to their significance determined by considering project activity **event magnitude** and **receptor sensitivity**.

Determination of event magnitude will entail the identification and quantification (as far as practical) of the sources of potential environmental and socio-economic effects from routine and non-routine project activities. Determining receptor sensitivity requires an understanding of the biophysical and human environment.

The approach to evaluating the significance of potential environmental and socio-economic impacts is outlined below.

7.2. Environmental impacts

7.2.1. Method for Determining Event Magnitude

Event magnitude is determined based on the following parameters, which are equally weighted and are each assigned a rating of 1, 2, or 3

7.2.1.1. Extent/Scale

Events range from those where the effect extends across an area:

1 – Near to the source (in the range of tens to hundreds of metres);

2 – At intermediate distance from the source (in the range of hundreds to thousands of metres); and

3 – At far distance from the source (in the range thousands of metres and above).

7.2.1.2. Frequency

Events range from those occurring:

1 – Once or twice; to

2 - Repeatedly but intermittently; to

3 – Frequently and persistently.

7.2.1.3. Duration

Events range from those where effects occur over:

1 – Instantaneous/short term (i.e. hours to days); to

2 - Medium term (between a week and 3 months); to

3 - Long term (more than 3 months to permanent).

7.2.1.4. Intensity

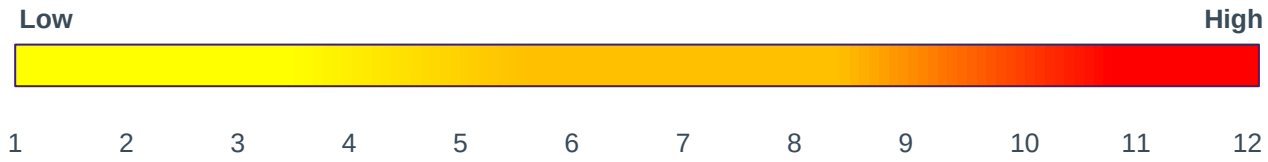
Concentration of an emission or discharge with respect to standards of acceptability that include applicable legislation and international guidance, its toxicity or potential for bioaccumulation, and its likely persistence in the environment. And degree/permanence of disturbance or physical impact (e.g. disturbance to species, loss of habitat or damage to cultural heritage). Ranges from:

1 - A low intensity event; to

2 - A moderate intensity event; to

3 - A high intensity event

Overall, event magnitude is scored from low (1) to high (12) by adding the individual parameter scores:



Resulting individual ratings are summed to give the overall event magnitude ranking. The Table below presents the score ranges for magnitude rankings of Low, Medium and High.

Table 7 - 1: Event Magnitude Rankings

Event Magnitude	Score (Summed Parameter Rankings)
Low	1 - 4
Medium	5 - 8
High	9 - 12

7.2.2. Method for Determining Receptor Sensitivity

Receptor sensitivity considers the type of receptor (namely, biological/ecological, human and physical receptor/feature); and is determined based on the following parameters, which are equally weighted and are each assigned a rating of 1, 2, or 3:

7.2.2.1. Biological/Ecological Receptors

Presence ranges from:

3 – Internationally threatened species/protected area within the area impacted by the project activities during period of high sensitivity (e.g. during breeding, spawning or nesting) and during routine or reliably predictable peak presence; to

2 - Internationally threatened species/protected area within the area impacted by the project activities outside of period of high sensitivity or during routine or reliably predictable peak presence.

Internationally near threatened species within the area impacted by the project activities during period of high sensitivity (e.g. during breeding, spawning or nesting) and/or during routine or reliably predictable peak presence.

Nationally protected species and/or species which are of importance to the local and regional ecosystem within the area impacted by the project activities.

1 - Presence of species which is none of the above.

Resilience (to the identified stressor) ranges from:

3 - Species and/or population which has little or no capacity to absorb or adapt to change (i.e. little or no capacity to move away from or adapt to the project impact), leading to potential for substantial change of character and/or loss of ecological functionality.

2 - Species and/or population which has moderate capacity to absorb or adapt to change (i.e. has capacity to move away from or adapt to the project impact), leading to potential temporary but sustainable effect which does not substantially alter character or result in significant loss of ecological functionality.

1 - Species and/or population has high capacity to absorb or adapt to change (i.e. has capacity to move away from or adapt to the project impact), and is potentially unaffected or marginally affected.

7.2.2.2. Human Receptors

Presence ranges from:

3 - People being permanently present (e.g. residential property) in the geographical area of anticipated impact; to

2 - People being present some of the time (e.g. commercial property); to

1 - People being uncommon in the geographical area of anticipated impact.

Resilience (to the identified stressor) ranges from:

3 - Most vulnerable groups (i.e. ambient conditions such as air quality are at or above adopted standards); to

2 - People being vulnerable to change or disturbance (i.e. ambient conditions such as air quality are below adopted standards); to

1 - People being least vulnerable to change or disturbance (i.e. ambient conditions such as air quality are well below applicable legislation and international guidance)

7.2.2.3. Physical Receptors/Features:

Presence (to the identified stressor) ranges from:

3 - Presence of feature which has, in reverse order, national or international value (e.g. state protected monument); to

2 – Feature with local or regional value and is sensitive to disturbance; to

1 - Feature which is none of the above.

Resilience (to the identified stressor) ranges from:

3 – Highly vulnerable (i.e. potential for substantial damage or loss of physical integrity);

2 – Undergoes moderate but sustainable change which stabilises under constant presence of impact source, with physical integrity maintained; and

1 – Feature/receptor is unaffected or marginally affected (i.e. resilient to change);

Overall, receptor sensitivity is then scored on a scale from low (1) to high (6) by adding the individual parameter scores:

The Table below presents the score ranges for sensitivity rankings of Low, Medium and High

Table 7 - 2: Receptor sensitivity ranking

Receptor Sensitivity	Score (Summed Parameter Rankings)
Low	1 - 2
Medium	3 - 4
High	5 - 6

7.3. Socio-economic impacts

The socio-economic impact assessment uses a semi-qualitative assessment approach to describe and evaluate potential impacts based on the event magnitude and receptor sensitivity rankings set out in the tables above. Indirect socio-economic impacts (i.e. induced effects) will also be assessed using a similar approach.

Table 7 - 3: Event magnitude rankings

Magnitude	Criteria
Low	Changes in social, economic or cultural dynamics with slight and temporary effect on any given sector performance and/ or population wellbeing. These impacts are unlikely to result in concerns being raised by governmental bodies or stakeholders. Events may include: • Minor disruption to livelihoods or living conditions resulting in a localized, reversible and temporary nuisance; • Temporary disruption to businesses that does not result in a loss of revenue or any reputational damage; • No change in the health status of local communities; and • Temporary disruption to public infrastructure (such as a road closure) that results in minor inconveniences to affected communities.
Medium	Changes in social, economic or cultural dynamics with moderate and noticeable adverse effect on any given sector performance and/or population wellbeing. Such impact may result in concerns being raised by governmental bodies or stakeholders. Events may include: • Negative change in livelihood status, household assets/income or living conditions; • Temporary disruption to businesses resulting in a small drop in business revenue;

	• Increased risk to public health that can be controlled using detailed mitigation measures; and • Disruption to public infrastructure (such as a road closure, or failure of a sewer) that results in an inconvenience to other users.
High	Changes in social, economic or cultural dynamics with major adverse effect on any given sector performance and/or population wellbeing. Such impacts may result in immediate intervention by governmental bodies and stakeholders. Events may include: • Negative change in livelihood status, household income/assets or living conditions affecting a high proportion of people resulting in economic loss and protests against the project; • Reputational damage and/or drop in business revenue that threatens the future viability of the economic activity; • Increased risk to public health leading to a fatality or injury to a member of a community; and • Damage to public infrastructure (such as a sewer, regional water pipeline, etc.) leading to environmental or socio-economic impacts to other users.

Table 7 - 4: Receptor sensitivity ranking

Sensitivity	Criteria
Low	Receptor sensitivity is considered low when there is a moderate to high capacity and means to adapt to a given change and maintain / improve quality of life. Receptors of low sensitivity may include: • Individuals who are able to quickly adapt to temporary disruption in their living conditions, livelihood status or a change in the status of public infrastructure (such as a road closure); and • Businesses with a robust economic model that are able to adapt easily to any restrictions placed upon their activities, or who are able to gain economically from such changes.
Medium	Receptor sensitivity is considered medium when there is limited capacity and means to adapt to a given change and maintain / improve quality of life. Receptors of medium sensitivity may include: • Individuals who rely heavily on their livelihood to maintain their socio-economic status and have a limited ability to adapt to change; and • Businesses that have a limited ability to adapt to change and are sensitive to any reduction in economic revenue or reputation.
High	Receptor sensitivity is considered high in the case of vulnerable receptors, who have little capacity and means to adapt to a given change and maintain / improve quality of life (e.g. homeless people, Internally Displaced Persons community in temporary accommodation, people with low access to recourse (e.g. no land titles), people with no or low representation (e.g. migrants, seasonal herders with no permanent assets in the area). Receptors of high sensitivity may include: • Individuals with a marginal livelihood, low socio-economic income or poor quality living conditions;

	• Individuals who are vulnerable due to their age, disability or other reason and who may require special assistance during engagement activities; and • Businesses with a marginal economic existence which are not able to easily adapt to change.

7.4. Environmental and socioeconomic impact significance

For both environmental and socioeconomic impacts, **impact significance**, as a function of **event magnitude** and **receptor sensitivity**, is ranked as **Negligible**, **Minor**, **Moderate** or **Major** as presented in the table below.

Table 7 - 5: Impact significance

		Receptor Sensitivity		
		Low	**Medium**	**High**
Event Magnitude	**Low**	Negligible	Minor	Moderate
	Medium	Minor	Moderate	Major
	High	Moderate	Major	Major

Any impact classified as **Major** is considered to be significant and, where the impact is negative, requires additional mitigation. Impacts of **Negligible**, **Minor** or **Moderate** significance are considered as being mitigated as far as practicable and necessary, and therefore, do not require further mitigation.

8. Environmental impacts & mitigation measures

8.1. Introduction

This Chapter sets out the environmental aspects and potential environmental impacts that could arise as a result of the construction, operation, decommissioning and abandonment of the sewerage project. It also discusses the proposed environmental mitigation measures that will be applied in order to reduce or remove the potential impacts. The impacts are discussed in Phases namely: construction, operational and decommissioning Phases.

8.1.1. Identification of environmental aspects

The environmental aspects of the sewerage project have been identified for all activities associated with construction and operation of all components of the project (the WWTPs, pumping stations, and trunk sewer lines).

To identify project aspects, all proposed activities, have been considered in terms of their direct or indirect potential to:

- Breach relevant policy, legal and administrative provisions including national legislation, standards and guidelines;
- Interact with the existing natural environment including its physical and biological elements; and
- Interact with the existing socio-economic environment.

Activities assessed during site preparation, construction, reinstatement, operation and decommissioning include:

- Planned routine activities;
- Planned but non-routine activities; and
- Unplanned or accidental events.

8.1.2. Monitoring and management plans

The mitigation measures detailed in this section will be implemented during the project with the aim of minimizing the potential impacts on the environment. They will be incorporated into a number of management plans listed below:

- Construction site and Camp Management Plan;
- Biodiversity Management Plan;
- Energy Resource Management Plan;
- Air Quality management Plan;
- Noise and Vibrations Management Plan;
- Soil Resource Management Plan;
- Water Resource Management Plan;
- Traffic Management Plan;
- Occupational/Public Health and Safety Management Plan; and
- Waste Management Plan.

8.2. Impacts on local air quality

8.2.1. Construction phase impacts

Dust Generation: construction activities such as site clearance and grading, excavations/earthworks, stockpiling of materials and spoils, and vehicular movements in the project area will generate dust and affect the local air quality. Once airborne, dust will generally travel downwind before resettling. The distance travelled depends primarily on wind speed and particle size. For example, smaller particles and strong winds result in greater dilution effects but mean that the dust is deposited over a larger area.

The potential impacts are nuisance and adverse health effects on workers and people in the area, coverage of crops (possibly leading to reduced yields) and deposition on natural vegetation.

The long-term impact of nuisance dust will decline as stripped areas of land re-vegetate. Due to the temporary nature of construction, dust emissions are not anticipated to have a long-term impact on local air quality.

Exhaust Emissions: Construction vehicles and machinery are also likely to emit oxides of carbon, nitrogen, and sulphur, further compromising the local air quality.

Burning of waste: Disposal of waste (vegetation and other combustible materials) by burning will also cause local air pollution in the emission of gases and particulate matter. There is the additional risk of spread of fire to unintended areas causing damage/destruction of property and vegetation.

Due to the nature of the construction process, emissions will not be constant and will fluctuate according to the operating periods for each item of plant and the combination of machinery being used at any one time. The emissions are likely to be of low to medium significance due to the localized nature. The location of emission sources will also change as the construction spread progresses along the trunk sewer route. Potential receptors, such as residents in local villages and flora and fauna will not, therefore, be continually exposed to construction emissions for extended periods. Other mitigating aspects include a high diffusion potential from favorable meteorological conditions that enhance dispersion.

Pollution from exhaust emissions is also dependent on the maintenance conditions of the engines.

8.2.1.1. Impact significance

8.2.1.1.1. Nuisance and health effects on humans

Table 8 - 1: Nuisance and health effects on humans

Extent/Scale	Frequency	Duration	Intensity	Score	Event Magnitude
1	2	2	2	7	Medium
Human Receptors		**Receptor Sensitivity**	**Receptor Sensitivity Ranking**		**Impact Significance**
Presence	**Resilience**				
3	2	5	High		Major

8.2.1.1.2. Adverse impacts on natural vegetation

Table 8 - 2: Adverse impacts on natural vegetation

Extent/Scale	Frequency	Duration	Intensity	Score	Event Magnitude
1	2	2	1	6	Medium
Biological Receptors					

Presence	Resilience	Receptor Sensitivity	Receptor Sensitivity Ranking	Impact Significance
1	2	3	Medium	**Moderate**

8.2.1.2. Air quality management

In order to control point source and fugitive emissions that may occur during construction of the sewerage project components, the following measures should be implemented:

- Maintenance of equipment and machinery to manufacturers' specifications by regular servicing to maintain efficiency in combustion and reduce carbon emissions;
- Use environmentally friendly fuels such as low sulphur diesel;
- minimize idling of machinery;
- ensure no burning of waste on sites/non-designated areas;
- dust suppression by sprinkling of all active construction areas and roadways as and when necessary;
- Control of construction vehicle speeds by imposition of speed limits;
- Backfilling of trenches and reinstatement as soon as possible;
- Use of tarpaulins to cover trucks carting away spoil using public roads. Additionally, the trucks should maintain at least two feet of freeboard;
- Proper planning in transportation of spoil to ensure that the number of trips done or the number of vehicles used is as minimum as possible; and
- Provision of appropriate Personnel Protective Equipment such as dust masks to site workers;

8.2.2. Operation phase impacts

Various aspects of project operations have potential to affect the local air quality. These include:

Collection of grit and other solid wastes screened at the pumping stations. The screenings require to be held temporarily on drying beds before disposal as solid wastes, and their accumulation is likely to release odors affecting local air quality.

Effluent treatment processes in the anaerobic and facultative ponds have potential to result in emission of hydrogen sulphide, mercaptan (methanethiol), ammonia and other gases into the atmosphere. This is likely to be the most significant source of odor affecting ambient air quality in areas close to the facilities.

Odor is also likely to be released from wet sludge following desludging of the ponds and stockpiling on the sludge drying beds.

Along the sewer lines, septicity can occur when the residence time of sewage is long, the temperature is high and there is a lack of air exchange. The deposition of sediments in the sewers can also facilitate the formation of sulphide – a condition that frequently occurs in gentle gravity sewers in which the flow is too slow. The accumulation of hydrogen sulphide has detrimental effects such as corrosion problems in sewers and sewage treatment works, besides the toxicity hazards to humans.

The emissions from wastewater handling and treatment are also contributors to global warming since CO_2, CH_4, NH_3, Mercaptan, Nitrous Oxide etc have a high global warming potential (GWP). Although these emissions have a negative impact on the global climate, the contribution from the proposed sewerage infrastructure is likely to be minimal when viewed against regional or national emissions.

8.2.2.1. Impact significance

8.2.2.1.1. Odor nuisance on neighbouring public

Table 8 - 3: Odor nuisance on neighbouring public

Extent/Scale	Frequency	Duration	Intensity	Score	Event Magnitude
2	2	3	1	8	Medium

Human Receptors		Receptor Sensitivity	Receptor Sensitivity Ranking	Impact Significance
Presence	Resilience			
3	1	4	Medium	**Moderate**

To manage the above impacts, the following measures can be adopted:

- Storage of screenings and grit in closed containers (dumpsters) instead of on the ground and ensuring that all waste is hauled off-site on a scheduled and timely basis;
- Covering of sludge processing facilities and avoiding storage of dewatered sludge at the WWTPs;
- The adverse effects of septicity in gravity sewers can be mitigated by suitable design to shorten residence time, minimization of sediments deposition by flushing of sewers as part of maintenance to remove settled solids, and adoption of corrosion resistant construction materials; and
- Establishment of greenbelts around the WWTPs and pumping stations to serve as wind breaks

8.3. Impacts on ambient noise levels and/or vibration

8.3.1. Construction phase impacts

The construction works, carting away of spoil and the use of machinery/equipment will contribute to elevated levels of noise and vibrations within the construction sites and the immediate surroundings. Background noise in the area is generally low and is mainly from the vehicular traffic along the main roads.

Elevated noise and vibrations levels during construction of the wastewater treatment works, pumping stations and sewer lines may be of some nuisance to the neighboring public to the construction sites. The increase in traffic movements on minor roads may cause a noticeable increase in daytime noise levels through small villages. This effect will be localized and temporary, and will, for the most part, be restricted to the construction phase of the project. In addition, due to the nature of the construction process, noise levels will fluctuate in line with operating periods for each item of plant and with the combination of machinery being used at any one time. Noise levels will also vary depending on time, and distance as the construction spread progresses especially along the sewer lines. Local residents will not, therefore, be continually exposed to elevated noise levels for extended periods except those near the WWTP sites.

8.3.1.1. Impact significance

8.3.1.1.1. Vibrations and noise nuisance

Table 8 - 4: Vibrations and noise nuisance

Extent/Scale	Frequency	Duration	Intensity	Score	Event Magnitude
1	2	2	1	6	Medium

Human Receptors		Receptor Sensitivity	Receptor Sensitivity Ranking	Impact Significance
Presence	Resilience			
3	1	4	Medium	**Moderate**

8.3.1.2. Noise management

The significance of noise impacts depends on whether the construction activities will increase noise levels above the existing ambient levels by introducing new sources of noise. Noise impacts would be considered significant if the activities would result in the following:

- Exposure of persons to, or generation of, noise levels in excess of standards established in the applicable standards for noise;
- Exposure of persons to, or generation of, excessive ground-borne vibration or ground-borne noise levels;
- A substantial permanent increase in ambient noise levels (more than 3dBA) in the project vicinity above levels existing before the project; and
- A substantial temporary or periodic increase in ambient noise levels in the project vicinity above levels existing before the project.

The following noise-suppression techniques will be employed to minimize the impact of temporary construction noise at the project sites.

- Portable hoods will be installed to shield compressors and other small stationary equipment where necessary;
- Pumps, generators and other mobile equipment will be sited as far as practicable from housing and other noise sensitive locations;
- The contractor will endeavour to use equipment installed with noise abatement devices as much as practicable;

- Idling time on trucks and other noisy equipment will be limited to a minimum. Drivers will be encouraged to turn off vehicle engines when not in use, avoid unnecessary hooting or revving of engines; and
- Personal protective equipment such as ear muffs will be provided to workers at the sites as necessary.

8.3.2. Operation phase impacts

Noise and vibrations are not expected to increase considerably during operation phase of the sewerage schemes. The likely sources of noise are the installed pumps and standby generators at the pumping stations. These pumps will generate some noise in normal operations during pumping of the wastewater to the WWTPs. The standby generators will also generate noise in running of the pumps during grid power outages. The noise impact may be more pronounced during the night when the ambient noise levels are expected to be low.

The generators and pumps will be housed in appropriately designed rooms/enclosures sufficient to provide the security and air circulation required as well as an acoustic shield. The acoustic shielding is expected to reduce the noise to low levels beyond the pumping stations boundaries. Regular servicing of the pumps and the standby generators will ensure that the noise generated is within equipment design levels. The significance of this impact during operations is therefore assessed as **Minor**.

8.4. Visual and landscape impacts

8.4.1. Construction phase impacts

The aspects of the project that will impact on the landscape and visual integrity of the area are the temporary use of land for construction (the sewer line ROW, construction camps and materials storage yards) and the permanent adoption of land for the WWTPs, pumping stations, access roads and sewer line manholes and inspection chambers.

During construction, the visual integrity of the landscape will be reduced since the WWTPs sites, pumping stations, sewer line ROW and the temporary facilities will be visible from the time of vegetation and topsoil removal until (for the sewer line and the temporary facilities) reinstatement is complete and vegetation has re-established fully.

Existing woody and herbaceous vegetation on the proposed sites for the WWTPs and pumping stations will be removed thus opening up views and changing the land cover permanently. Reinstatement and landscaping of these sites will be limited to the periphery/site boundaries where trees and berms will be established to provide visual shields to the facilities.

In all areas of construction activities, items such as large machinery/equipment, earthworks, pipe sections and other vehicles will be visible throughout construction. This is a temporary impact, the duration of which will be minimized by the prompt removal of vehicles, plant and materials on completion of the works.

8.4.1.1. Impact significance

8.4.1.1.1. Visual disturbance effects on humans

Table 8 - 5: Visual disturbance effects on humans

Extent/Scale	Frequency	Duration	Intensity	Score	Event Magnitude
2	3	2	2	9	High

Human Receptors		Receptor Sensitivity	Receptor Sensitivity Ranking	Impact Significance
Presence	Resilience			
3	2	5	High	Major

8.4.1.1.2. Adverse impacts on natural vegetation

Table 8 - 6: Adverse impacts on natural vegetation

Extent/Scale	Frequency	Duration	Intensity	Score	Event Magnitude
1	2	2	1	6	Medium

Biological Receptors		Receptor Sensitivity	Receptor Sensitivity Ranking	Impact Significance
Presence	Resilience			
1	2	3	Medium	**Moderate**

8.4.1.2. Visual and landscape impact management

All disturbed areas should be reinstated in accordance with the project's reinstatement specification. The Contractor should prepare a Reinstatement Plan for the project based on the specifications. The main objective of reinstatement of the sites should be to return the visual integrity of the landscape as closely as possible to its previous condition.

Wherever possible, the removal of existing mature trees which form important visual focal points should be avoided. Provided that the integrity of the sewer line is not jeopardized, any removed trees should be

replaced during the reinstatement phase using indigenous species, preferably of local provenance. It will be necessary to protect newly planted trees from browsing animals. However, the following standard conditions governing planting and landscaping in the vicinity of sewers are required to facilitate inspection and maintenance of the sewerage systems:

- In general, no trees shall be planted within 3m from both sides of the constructed sewers;
- Turf, plants and minor flowering shrubs may be accepted over sewerage provided they do not have profuse or penetrating roots;
- Planting within the space of 1.5m around the cover of any chambers should be avoided; and
- There should be free access to all sewerage installations at all times even when the turf, plants and shrubs are mature

8.4.2. Operation phase impacts

Once the temporary working areas have been reinstated, the majority of the landscape will return to its former condition. The only persistent visual impacts will take the form of manholes and inspection chambers along the sewer lines required for maintenance. The buried sewer line will therefore have **Minor** visual impacts during its operational life.

The WWTPs and pumping stations will be permanent and visible features of the project. Although landscaping plans such as establishment of berms and planting of trees around the site boundaries are proposed, these facilities may not be entirely out of sight for the public (the pumping stations will be near the Eldoret – Kitale Road while the ponds at the WWTPs will occupy swathes of land representing a different land use from the surrounding). Elaborate landscaping of these sites can limit the viewpoints to the facilities and thus reduce their visual impact. The significance of the visual impact during operation phase was therefore assessed as **Moderate**.

8.5. Impacts on the ecology of the project area

8.5.1. Construction phase impacts

The aspects of the project that have the potential to impact on local flora and fauna in general are land take (both permanent and temporary), disturbance to the land surface, removal and storage of topsoil, spillages of hazardous chemicals and inappropriate disposal of hazardous and non-hazardous waste. In addition, dust emission and soil compaction will primarily affect flora, while noise emissions will only have the potential to affect fauna.

The project area is an agricultural zone where maize and beans are the major crop cultivated on most farmlands. The proposed sites for WWTPs and pumping stations in Moi's Bridge and Matunda are on farmlands with homesteads where the dominant vegetation cover is food crops (mainly maize and beans). On these farms also, some trees such as *Grevillea robusta* (planted as agroforestry trees with the crops or to mark plot boundaries), *Croton macrostachys* and *Persea americana* are found. On the other hand, the proposed sewer lines will mainly be along road reserves through developed residential and commercial areas where the main vegetation cover is herbaceous (grass and other weeds) with occasional encounters of trees such as *Croton sp* and other shrubs.

The figures below show the approximate locations and existing land uses for the WWTPs and pumping stations at Moi's Bridge and Matunda.

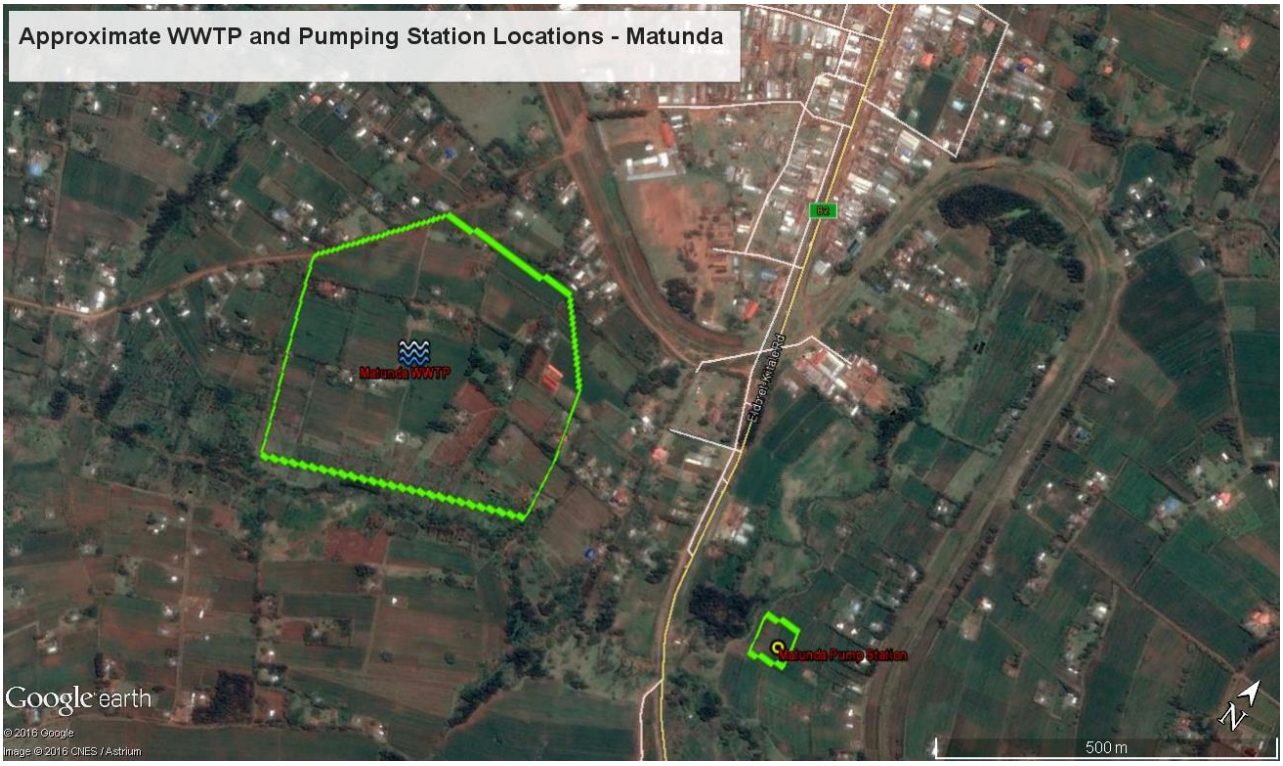


Figure 8 - 1: Approximate locations for the Matunda WWTP and pumping station

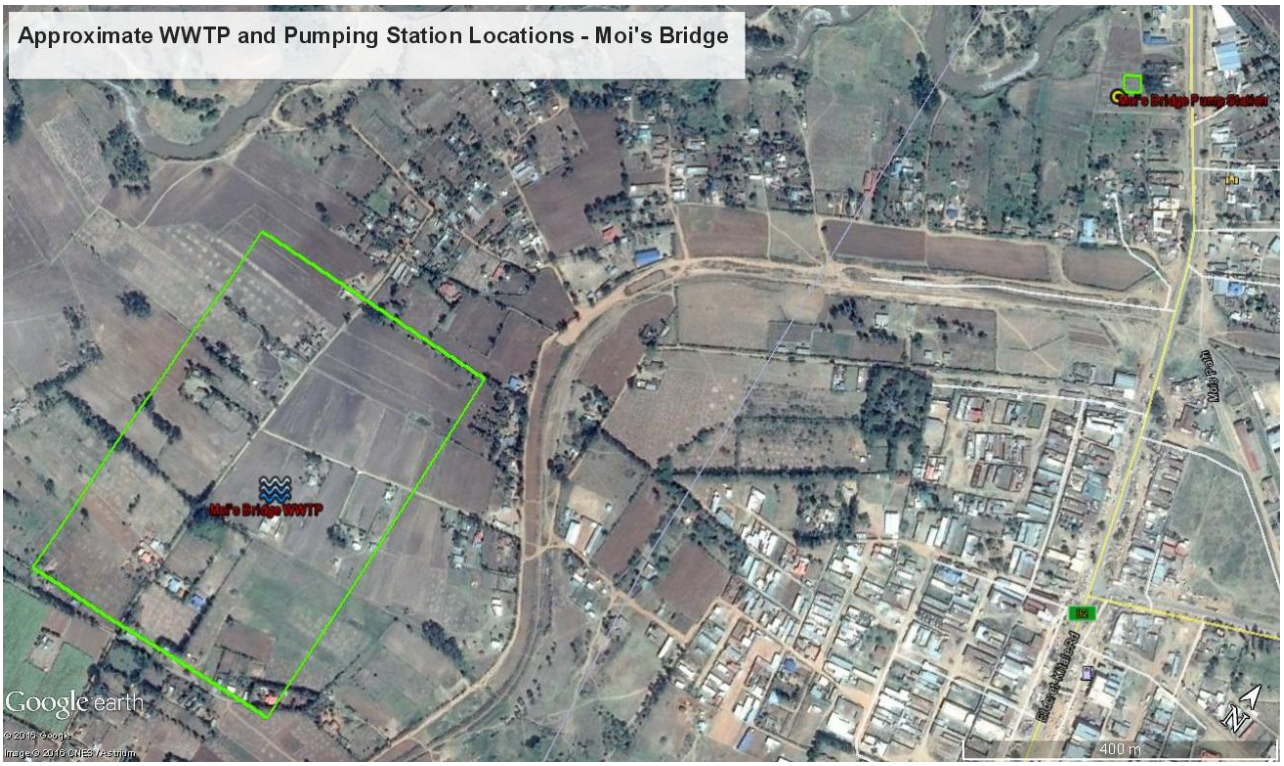


Figure 8 - 2: Approximate locations for the Moi's Bridge WWTP and pumping station

Site clearing, removal of top soil and excavation in the construction of the treatment works, pumping stations and sewer lines will therefore result in little loss of natural vegetation. Existing vegetation cover which is heavily modified and comprised of food crops is seasonal, and construction activities can be programmed to commence after the crop harvesting season. The risk of loss of natural vegetation in construction of the sewerage schemes is therefore assessed as **Minor.**

Pollution events due to fuel, oil and/or chemical spills especially at construction camp(s) could lead to the smothering and mortality of surrounding vegetation and to the contamination of soils, which may prevent future regeneration of vegetation. The pollution risk is assessed as **Moderate** and therefore, a pollution prevention and an emergency response plan will be required to ensure the protection of vegetation and the underlying soil.

Due to extensive agricultural activities in the project area, wild animals are non-existent. However, domestic animals such as cattle, sheep and goats are kept by some farmers. Various birds' species also forage on the existing vegetation in farmlands and around homesteads. Construction works are unlikely to significantly impact on the existing domestic animals and avifauna in the project area as the animals mainly confined within farms/homesteads while the birds are free ranging and can avoid construction sites. The significance of the potential impact to fauna/avifauna is therefore assessed as **Negligible**.

8.5.1.1. Management of flora and fauna

Most of the ecological impacts resulting from project development will be temporary provided that all disturbed areas are reinstated quickly and effectively after construction in accordance with approved plans. A critical element in management of ecological impacts therefore is the development and implementation of a Reinstatement Plan.

It shall be the responsibility of the contractor to prepare and implement the Restoration Plan. Since agricultural land represents the majority of the habitats affected, elaborate reinstatement programmes will be limited in their extent.

Vegetation and soil contamination by hydrocarbon/chemical pollution events should be curtailed by development and implementation of pollution prevention plans and emergency response plans. These plans should contain spill containment and cleanup procedures.

8.5.2. Operation phase impacts

During the schemes' operational lifetime, the general value of the WWTP sites as a birds habitat is likely to be improved as a result of the plants' construction. Polishing ponds often are used as loafing habitat by waterfowl, and the potential establishment of aquatic biota in the polishing ponds may provide foraging opportunities for various wetland bird species.

8.6. Impacts on soil resources

8.6.1. Construction phase impacts

Project construction will require earthworks involving site clearance, grading, topsoil removal, excavation of the anaerobic, facultative and maturation ponds, foundations for auxiliary buildings, and trenching for the sewer lines. Since access to the proposed treatment works and pumping stations is either poor or non-existent, new accesses will be created, graded and surfaced with suitable material. There will therefore be significant earthworks with the need to stockpile excavated soil at these locations, either for reuse on site or eventual disposal. Erosive action on these stockpiles and disturbed areas due to heavy precipitation and winds can result in the loss of soil resource, runoff to surface watercourses, and potential impacts to aquatic resources

The establishment of permanent facilities such as the treatment works and access roads has potential to result in the permanent loss of soil from these sites. Along the sewer lines, excavated soil from trenching will be stockpiled and re-used in backfilling and reinstatement after laying of pipes. Some of the excavated soil from the treatment ponds will also be used in establishment of berms around the ponds.

Compaction of soils during construction may occur where the bearing strength is exceeded by the weight of construction vehicles. This is most likely to occur on the unsurfaced access roads and along sewer line ROW, which will be subject to repeated vehicle movements. Soil compaction alters drainage characteristics and decreases the ability of vegetation to re-establish.

Any spillage of hazardous materials particularly at the construction camp(s) is likely to cause soil contamination and/or eventual surface/groundwater contamination. The hazardous materials include oils, fuel, grease, paints, solvents, curing compounds, adhesives, acids, soil stabilizers and binders etc. These materials require careful handling and storage to prevent spillage. Vehicle, plant and machinery maintenance on site can also lead to soil pollution in the event of spillage of hydrocarbons (such as oil and fuel).

8.6.1.1. Impact Significance

8.6.1.1.1. Soil loss resulting from erosion and carting to spoil

Table 8 - 7: Soil loss resulting from erosion and carting to spoil

Extent/Scale	Frequency	Duration	Intensity	Score	Event Magnitude
1	2	2	2	7	Medium

Physical Receptors		Receptor Sensitivity	Receptor Sensitivity Ranking	Impact Significance
Presence	Resilience			
2	3	5	High	Major

8.6.1.1.2. Soil contamination from pollution incidences

Table 8 - 8: Soil contamination from pollution incidences

Extent/Scale	Frequency	Duration	Intensity	Score	Event Magnitude
1	2	2	2	7	Medium

Physical Receptors		Receptor Sensitivity	Receptor Sensitivity Ranking	Impact Significance
Presence	Resilience			
2	3	5	High	Major

8.6.1.2. Soil resources management

During reinstatement, the trench back-fill material will be compacted to a similar value to the original surrounding soils to avoid subsidence as a consequence of rain water channeling. In order to avoid compaction impacts outside the sewer line ROW during construction work, deviation from the ROW or access roads will be restricted.

As much as possible, soil excavated from the ponds and other areas should be used in establishment of berms around the ponds to avoid offsite disposal of spoil. The berms should also be grassed immediately to reduce the erosion potential from these structures.

Adequate reinstatement following construction will help the subsequent re-establishment of vegetation and thereby reduce the risk of soil erosion. A project specific Reinstatement Plan will be prepared and will include mitigation for impacts to soils based on the following:

- Recreation of a stable landform that mirrors the pre-disturbed condition (e.g. contours, shape, level of compaction) as this will minimize the risk of preferential erosion and therefore facilitate natural revegetation;
- Ensuring protection of topsoil through separation from subsoil and storage in a manner that, as far as possible, retains the soil structure and seed bank and minimizes the risk of topsoil loss. The trench will be subsequently backfilled with subsoil, followed by topsoil;
- Establishment of appropriate mechanisms to stabilize the working width if temporary demobilization of the pipeline spread is necessary; and
- Development of a bio-restoration methodology that enables the re-establishment of the pre-construction vegetation cover particularly the variety and distribution pattern of plant species, and establishment of sufficient vegetation cover to minimize erosion of the sewer line ROW.

Effort will be made to ensure that for both temporary and permanent reinstatement, the sewer line ROW exhibits no more than a moderate level of erosion potential. The reinstatement works will be undertaken in a manner that achieves the following minimum standards:

- Very low risk of the depth of cover above the pipeline being reduced;
- Very low risk of off-site pollution and sedimentation;
- Low risk of damage to bio-restoration by washing-out of seeds and plants

To facilitate natural revegetation of the sewer line ROW, the separately stockpiled topsoil and vegetation debris will be spread over the surface of the ROW following completion of grading. Once the topsoil has been replaced it will be stone picked to remove large stones, which are not in keeping with the surrounding soil texture. It will then be tined and cultivated as necessary to ensure effective re-vegetation.

To prevent soil contamination and possible surface/ground water contamination, spillage prevention and control measures will be instituted where hazardous materials are stored in pallets and where possible under cover in secondary containment. Ample supplies of clean-up materials will be kept and be readily accessible.

The Contractor will review spill response requirements at all applicable work sites and train workers on spill prevention and clean-up. Clean-up requirements will include the following:

- Immediately clean up leaks and spills;
- Use absorbent materials for large spills;
- Avoid hosing down or burying dry material spills; and
- Properly dispose of materials used to clean up hazardous materials.

Vehicle and equipment maintenance activities will be done as much as possible away from construction sites while a designated area away from drainage courses will be identified to carry out necessary repair or maintenance activities. Drip pans and absorbent materials will be availed at these designated areas to manage spillages;

8.6.2. Operation phase impacts

Once the project is in operation, there will be minimal additional impact on the soils of the area except where compaction is caused by off-track vehicle movements. Vehicle movements especially along the sewer line ROW are expected to be limited to times when repair is necessary. There may also be risks of soil erosion especially following unplanned events such as sewer line blockage and overflow. In summary, impact significance on soils during operations is assessed as **Minor**.

8.7. Impacts on energy resources

8.7.1. Construction phase impacts

Fossil fuels (mainly diesel) will be used in the running of engines at the construction sites. Fossil energy is non-renewable and its excessive use may lead to depletion of the resource. However, at the local scale, these impacts are of little significance and are best analyzed/quantified at a national/global scale.

8.7.1.1. Impact significance

8.7.1.1.1. Depletion of fossil fuel resources

Table 8 - 9: Depletion of fossil fuel resources

Extent/Scale	Frequency	Duration	Intensity	Score	Event Magnitude
1	1	1	1	4	Low

Physical Receptors		Receptor Sensitivity	Receptor Sensitivity Ranking	Impact Significance
Presence	Resilience			
1	2	3	medium	**Minor**

8.7.1.2. Energy resource management

Despite the low impact on energy resources, it is prudent to institute measures to conserve fossil fuel since these also impact on local air and noise pollution levels. Proposed measures include:

- Minimize idling of machinery;
- Avoid overloading of trucks and machinery; and
- Regularly service vehicles, plant and machinery.

8.7.2. Operation phase impacts

The proposed WWTPs do not require electricity in operations. However, electricity will be required in the offices and staff housing, and at the pumping stations to run the pumps and provide lighting. Although there will be an increase in energy demand for these uses, the demand is not expected to be significant. The significance of this impact is therefore assessed as **Minor**.

8.7.2.1. Energy management

To ensure efficient energy consumption by the schemes' auxiliary facilities, energy saving technologies (mainly applied in the choice of electrical appliances) and management strategies should be applied. Staff at the WWTPs and staff housing should be encouraged to adopt energy conservation measures such as the use of energy efficient appliances, and switching off lights when not in use.

Energy use should be monitored during the project lifetime. Energy consumption meters should be installed with the involvement of the power distribution company, Kenya Power. Alternative sources of energy such as solar lighting should also be sought and exploited.

8.8. Impacts on water resources

8.8.1. Construction phase impacts

The key concerns on water resources during construction is the discharge of sediments into watercourses. The main surface water resources that could be impacted are the Nzoia and Little Nzoia Rivers.

The major sediment-generating activities identified during construction include the construction of treated effluent outfalls into Nzoia and Little Nzoia Rivers. The elevated risk of these activities are due to the proximity of the outfall structures to the water courses. Soil disturbance at the river banks during trenching and establishment of working areas followed by erosion may deliver fine sediments from these disturbed areas into the nearby waterways. Trenching and earthworks in establishment of ponds and access roads also have potential to impact on surface water resources if erosion following heavy precipitation occurs on these sites which are also proximal to the water courses.

Sediment pollutes the water because it subdues light levels within the water column and at the channel boundary thereby impacting freshwater ecosystems. The presence of high levels of suspended sediment concentration can also render potable water supplies unpalatable thereby affecting consumers, who depend directly on the river for their water needs.

Spillage of hazardous materials has potential to cause soil contamination and eventual surface/groundwater contamination. The spilled hazardous materials such as oils, fuel, grease, paints, solvents, curing compounds, adhesives, acids, soil stabilizers and binders can be transported by runoff into the rivers causing pollution of the water resources.

Construction of the project components will also increase the demand for portable and construction water. It is expected that these construction water requirements will be met by abstraction of water from Nzoia (either directly or through the Water Company) and Little Nzoia Rivers. The water will be required in mortar and concrete works, and for laying of dust at construction sites.

Flushing, cleaning and testing of the sewer line will be carried out prior to commissioning, and this will require significant volumes of water depending on the length of pipe being tested at a time. The principal hazard introduced by hydro-testing is the unlikely event of a failure of the line under test, resulting in the unplanned discharge of water. This could result in local erosion, particularly in poorly consolidated soils.

8.8.1.1. Impact significance

8.8.1.1.1. Pollution of water resources from sediments and other contaminants

Table 8 - 10: Pollution of water resources from sediments and other contaminants

Extent/Scale	Frequency	Duration	Intensity	Score	Event Magnitude
2	2	2	2	8	Medium

Physical Receptors		Receptor Sensitivity	Receptor Sensitivity Ranking	Impact Significance
Presence	Resilience			
2	2	4	medium	**Moderate**

8.8.1.1.2. Increased water demand

Table 8 - 11: Increased water demand

Extent/Scale	Frequency	Duration	Intensity	Score	Event Magnitude
1	2	2	1	6	Medium

Physical Receptors		Receptor Sensitivity	Receptor Sensitivity Ranking	Impact Significance
Presence	Resilience			
2	2	4	medium	**Moderate**

8.8.1.2. Water resources management

Where appropriate and advantageous, seasonal constraints on construction activities may be imposed to ensure that earthworks are completed during the short dry season between January and February.

Measures for spill prevention and control applied for soil pollution prevention shall also aid in water pollution prevention by hazardous substances in use during construction.

To prevent pollution of the river by silt-laden runoff from the construction sites, stockpiles will not be located next to waterways. Silt fence(s) shall be erected down-slope of exposed soil areas, temporary stockpiles or along storm water channels leading to the rivers from the sites as necessary. The silt fences shall intercept the flow of sediment laden runoff trapping the sediments. Sediment traps which are temporary runoff containment areas that promote sedimentation prior to discharge of the runoff through a stabilized spillway can also be established as alternatives to silt fences.

8.8.2. Operation phase impacts

Various aspects of operation of the WWTPs, sewer lines and pumping stations have potential to impact the quality of water in Nzoia and Little Nzoia Rivers. Although plant designs envisage that the treated effluent discharged into the rivers will be of a high quality meeting the regulatory standards, unplanned circumstances such as plant or equipment failure or overloading of the treatment works may result in discharge of untreated or partially treated effluent into the rivers. Failure of sewer lines (blocked or burst sewers), or overflow of the holding ponds at the pumping stations following pumping failure may result in overflow of raw sewage that would eventually find its way into the rivers. This can cause contamination negatively affecting aquatic lifeforms in the rivers and the downstream uses of the rivers such as domestic water sources or irrigation.

The water table in Moi's Bridge and Matunda is high and the potential for ground water contamination exists where WWTP designs are insufficient to address ground water protection. However, for the proposed WWTPs, HDPE dam liners are included in designs to prevent percolation of effluent from the ponds and minimize the risk of ground water pollution.

8.8.2.1. Impact significance

8.8.2.1.1. Nuisance and health effects on humans

Table 8 - 12: Nuisance and health effects on humans

Extent/Scale	Frequency	Duration	Intensity	Score	Event Magnitude
3	1	1	3	8	Medium

Human Receptors		Receptor Sensitivity	Receptor Sensitivity Ranking	Impact Significance
Presence	Resilience			
3	3	6	High	Major

8.8.2.1.2. Adverse impacts on aquatic lifeforms

Table 8 - 13: Adverse impacts on aquatic lifeforms

Extent/Scale	Frequency	Duration	Intensity	Score	Event Magnitude
3	1	1	1	8	Medium

Biological Receptors		Receptor Sensitivity	Receptor Sensitivity Ranking	Impact Significance
Presence	Resilience			
2	3	5	High	Major

8.8.2.2. Water resource management

Designs of the sewerage schemes have factored – to the extent foreseeable, possibilities of stresses on the system or equipment failure. The counter measures include:

- Provision of standby generators, duty and standby pumps and holding ponds capable of holding up to 6hrs of sewerage flow at pumping stations in the event of grid power outage or breakdown of the pump;
- Appropriate spacing of sewer manholes to enable easy cleaning or unblocking;
- Large sized and deeper ponds to allow greater retention time for effluent and breakdown of organic loads

However, a rigorous monitoring programme is proposed in order to ensure that the new WWTPs operate in a consistent and environmentally sound fashion. The Operator, in cooperation with the County Government Kakamega will initiate and maintain the programme. A testing programme will be established to monitor the treatment performance and efficiencies within the treatment plants. Raw influent and treated effluent parameters to be monitored on a daily basis will likely include biochemical oxygen demand (BOD), total suspended solids (TSS), COD (as an indicator of BOD), ammonia nitrogen (NH3-N), trace ammonia as an indicator of nitrification, dissolved oxygen and pH. In addition, suspended solids measurements of primary effluent, and total dissolved solids (TDS) and faecal coliform counts will be regularly measured in the plant effluent. Sampling for heavy metals will be performed on a monthly basis and the sampling frequency increased if a significant concentration of heavy metals is detected.

In this case, sampling of industrial waste streams will be pursued to identify the source and to initiate a corrective programme to halt the discharge.

A well-equipped wastewater quality testing laboratory will be constructed as part of the administration complex at the new WWTPs. These lab facilities will be operated as integral units of the plants themselves.

Sampling stations will be established on River Nzoia and Little Nzoia in the vicinity of the outfalls to monitor water quality in the receiving waters and to help assess the impact of the treated effluent on water quality. Sampling will be carried out twice weekly, for BOD, NH3-N, TDS and faecal coliforms. Dissolved oxygen levels and coliform bacteria will also be monitored. These data will be available, and occasionally tested in parallel by other national laboratories responsible for water quality issues and human health issues.

An Effluent Discharge Control Plan that is binding to the Operator is attached as **Appendix D** of this Report

8.9. Impacts of generated waste

8.9.1. Construction phase impacts

Construction activities will generate inert, non-hazardous and hazardous wastes over the construction period. Wastes likely to be generated during construction include spoils (from excavations), vegetation (felled trees, shrubs, stumps and their root systems) packaging materials used for packing cement, plastics, reject materials including damaged bricks/blocks, and leftovers/excesses, wastewater (concrete washout and hydraulic test water) etc.

Construction camp(s) will need to dispose of ordinary waste (from kitchens, offices and other areas) sanitary waste (sewerage and wash water), and maintenance wastes (from maintenance of plant and machinery at the camps).

There are currently no waste disposal facilities in the project area such as landfill sites or sewerage treatment and disposal sites. Improper waste management at construction sites and camps will interfere with the aesthetic status of the surrounding while creating health and safety hazards. Improper disposal of the wastes off-site could also cause nuisance, health and safety hazards, and create breeding grounds for vermin.

8.9.1.1. Impact significance

8.9.1.1.1. Environmental pollution and creation of health and safety hazards from poor management of wastes

Table 8 - 14: Environmental pollution and creation of health and safety hazards from poor management of wastes

Extent/Scale	Frequency	Duration	Intensity	Score	Event Magnitude
1	3	2	2	8	Medium

Human Receptors		Receptor Sensitivity	Receptor Sensitivity Ranking	Impact Significance
Presence	Resilience			
3	2	5	High	Major

8.9.1.2. Construction phase waste management

The following measures are proposed to manage wastes generated at the sites:

- Land-fill spoils as much as possible within the sites or identified fill areas. As much as possible, spoils generated from excavation of ponds should be used on site as landscaped berms;
- Felled trees, shrubs and stumps can be isolated for collection by locals as firewood;
- Organic wastes can be composted on site;
- Provide pit latrines at the camp(s) and construction sites for use by workers. The pit latrines should be backfilled upon project completion;
- Vehicle maintenance should as much as possible be done off-site (at the construction camp's garage/workshop or commercial garage) and wastes (used oil, oily rugs, cans and used parts) disposed in a designated area. Where maintenance must be carried out on site, wastes generated should be carried away from site for disposal in designated area(s). Disposal in this case should be by burying in a deep pit;
- The Contractor should ensure that construction materials left over at the end of construction are used elsewhere rather than their disposal; and
- The Contractor should put in place measures to ensure that construction material requirements are carefully budgeted and to ensure that the amount of construction materials left on site after construction is kept minimal. Additional measures for minimization of solid waste during construction of the proposed

Project could include the use of durable, long-lasting materials that will not need to be replaced often, thereby reducing the amount of construction waste generated over the project lifetime.

8.9.1.2.1. Concrete waste management

- The Contractor should avoid mixing of excess concrete if possible, and should discard excess concrete in a designated area away from water courses;
- Washing of concrete coated vehicles or equipment should be done off-site or in a designated wash area a minimum of 50 feet away from drainage channels. The runoff from the on-site concrete wash area should be contained in a temporary pit where the concrete can set; and
- The temporary pit should be lined with plastic or clay to prevent seepage of the wash water into the ground. The wash water should be allowed to evaporate or collected along with all concrete debris in a concrete washout system bin.

8.9.1.2.2. Hydraulic test water disposal

To the extent possible, hydraulic test water (water used to check the tightness of the sewer line) should be discharged into the next section of the pipeline to be tested. If necessary, additional water can be added to make-up any losses or differences in lengths of test section. If less is required, the surplus water should be discharged in a manner that prevents erosion e.g. by discharge on vegetated ground.

8.9.2. Operation phase impacts

Operation of the WWTPs will generate solid and liquid wastes requiring proper handling and disposal to prevent environmental pollution and creation of health hazards. Impacts of effluent generation and discharge are discussed in Section 8.8.2 of this Report.

8.9.2.1. Grit and other solid wastes

The pre-treatment process of screening at the pumping stations and WWTPs will generate solids such as grit and other coarse screenings (such as polythene, sanitary towels etc) which will require regular removal and disposal. These will be hand raked and collected for disposal at a landfill site. Although the wastes are not expected to be in significant quantities, inappropriate handling, storage and disposal is likely to cause environmental pollution and health hazards to both workers and the neighboring public.

8.9.2.2. Sludge

Based on the wastewater treatment system using waste stabilization ponds, the proposed WWTPs will generate biological sludge. It is expected that the ponds will be de-sludged every 2 -5 years and that desludging will be done once the pond is half full. Estimated sludge volumes are shown below:

Table 8 - 15: Sludge production from the WWTPs

	Moi's Bridge WWTP	Matunda WWTP
Population sewered	60,414	40804
No of pond Streams	6	6
Population served by each anaerobic pond	10,069	6,801
Sludge production rate	0.04m^3/h/yr	0.04m^3/h/yr
Annual sludge produced	402.76m^3	272.03 m^3
Total sludge produced at the time of desludging	900m^3	650m^3

Poor handling and disposal of wet and dried sludge may result in health hazards to both site workers and the neighboring public. Dried sludge is however a good soil improver due to its content of phosphorus and nitrogen and, in particular, due to the amendment of organic matter. In addition, due to absence of

connected polluting industries in the project area, the heavy metals levels are expected to be well under the acceptable limits.

8.9.2.3. Impact significance

8.9.2.3.1. Environmental pollution and creation of health hazards from poor management of wastes

Table 8 - 16: Environmental pollution and creation of health hazards from poor management of wastes

Extent/Scale	Frequency	Duration	Intensity	Score	Event Magnitude
1	3	3	1	8	Medium

Human Receptors		Receptor Sensitivity	Receptor Sensitivity Ranking	Impact Significance
Presence	Resilience			
2	2	4	Medium	**Moderate**

8.9.2.4. Management of generated wastes

8.9.2.4.1. Management of solid wastes

There are no sanitary landfills within the locality of Moi's Bridge and Matunda, nor within larger towns proximal to the sites such as Kitale or Eldoret. These two towns currently experience serious problems with solid waste management – including the lack of adequate space for landfilling, and adding solid wastes from the WWTPs will only compound the problems. It is therefore proposed that a suitable landfill site be identified near Matunda and Moi's Bridge which will serve the two towns and other neighboring urban areas.

The sludge from each pond will be temporarily held in sludge drying beds for about 45 days – a period in which sludge digestion is expected to have taken place completely and that the dry cake left is safe for disposal. The dry cake can then be sold off/collected for disposal as organic fertilizer for use in local farms. Alternatively, in the event that uptake by local farmers is low, the dried sludge can be landfilled at an appropriate location.

Sludge quality will need to be monitored to ensure that human health is protected. The expected absence of significant quantities of heavy metals or toxic compounds in the wastewater indicates that pathogens and nematodes will likely be the major health concern. The health impact is likely to be slight to non-existent if proper sludge stockpiling, handling and soil conditioning procedures are followed.

8.10. Natural hazard Vulnerability

8.10.1. Construction and operation phase impacts

The WWTP site in Moi's Bridge is exposed some natural hazards that affect Nzoia river basin such as flooding. The location and topography of the proposed project site potentially makes it susceptible to seasonal riverine flooding associated with high intensity rainfall in the catchment areas. The potential sources of flooding are from over bank flow of the Nzoia River, and inundation by storm water flowing from elevated areas.

8.10.1.1. Impact significance

8.10.1.1.1. Flooding

Table 8 - 17: flooding

Extent/Scale	Frequency	Duration	Intensity	Score	Event Magnitude
1	2	2	3	8	Medium

Physical Receptors		Receptor Sensitivity	Receptor Sensitivity Ranking	Impact Significance
Presence	Resilience			
1	3	4	Medium	**Moderate**

8.10.1.2. Management of natural hazards

To mitigate this hazard, a dyke can be constructed on the bank to contain overtopping the bank from flood flows. Inundation by storm water can be contained by construction of appropriate storm water drainage systems which will effectively divert overland storm water flow around the facility and into the River.

Appropriately sized berms around the WWTP lagoons will also prevent flooding of the facility by river flow.

Every effort has been made during pipeline routing to avoid areas prone to landslides and debris flows, thereby minimizing the potential impact.

8.11. Impacts on cultural heritage and archaeology

8.11.1. Construction phase impacts

Aspects of the project which could impact on archaeological resources and cultural property include the removal of topsoil and subsoil during earthworks for the ponds, trenching and opening up of new accesses. Construction activities may damage/destroy any existing archaeological monument(s) or cultural property whether marked/recorded or new discoveries. There are no known archaeological/cultural assets in the project area. However, there exists the possibility of encountering marked or unmarked graves within the farmlands proposed as sites for the WWTPs. Although the overall risk is assessed as **Minor**, an unmarked grave is at a higher risk of damage during earthworks.

8.11.1.1. Management of impacts on archaeology and cultural heritage

If areas of archaeological and/or cultural significance are revealed at any of the project sites, an appropriate response should be decided upon in consultation with the land owner and/or National Museums of Kenya.

For any encounters along the sewer line route, considerations should be made to alter the alignment of the pipeline to avoid damage to the feature. Where the sewer line cannot be sensibly moved, significant sites may need to be excavated and recorded prior to construction activities continuing in the area.

Where graves are identified, consultations with the land owners should be carried out to relocate the graves to suitable locations.

8.11.2. Operation phase impacts

Once the project is operational, there will be no further impact on archaeology or cultural heritage of the project area.

8.12. Impacts on occupational/public health and safety

8.12.1. Construction phase impacts

The construction works inevitably expose workers and/or the general public to health and safety risks. Some of the likely hazards include accidents on site (involving workers and machinery, or the public and construction works such as sewer line trenches and manholes) or along accesses to the sites (involving construction vehicles and the public), or exposure to dust leading to pneumatic illnesses.

The lack of provision of potable water for sanitation during construction can also lead to health hazards affecting construction workers at the compounds.

8.12.1.1. Impact significance

8.12.1.1.1. Exposure to health and safety hazards

Table 8 - 18: Exposure to health and safety hazards

Extent/Scale	Frequency	Duration	Intensity	Score	Event Magnitude
1	3	2	2	8	Medium

Human Receptors		Receptor Sensitivity	Receptor Sensitivity Ranking	Impact Significance
Presence	Resilience			
3	2	5	High	Major

8.12.1.2. Occupational/public health and safety management

To reduce accidents and hazards involving/ posed to workers, the contractor(s) should develop and implement Site Health and Safety rules and regulations. Other health and safety measures can include:

- Provision of all workers on site with the necessary Personal Protective Equipment, and ensuring a safe and healthy environment for the construction workers;
- Workers accidents during construction can be mitigated by enforcing adherence to safety procedures and preparing contingency plans for accident response. In addition, safety education and training should be emphasized;
- The Contractor should have qualified first aid personnel among the workers and maintain fully stocked first aid kits at active construction sites;
- Hazards and accidents involving the public should be minimized by controlling access to the construction sites. This should be done by cordoning off the construction sites (especially trenches and manhole excavations) and posting warning signs in hazard prone areas;
- To reduce hazards exposure to the public such as open trenches, the Contractor should endeavour to lay pipes and backfill as soon as possible;
- The Contractor should provide health and safety briefing of visitors at construction sites; and
- The Contractor should ensure that workers have access to sanitary facilities at active construction sites and provide potable water.

8.12.2. Operation phase impacts

Once the project is operational, health and safety impacts will mainly be limited to activities within the WWTPs and pumping stations. Safety and health concerns include the danger of falling into the treatment ponds, creation of breeding grounds for vermin such as mosquitos and rodents, and potential discharge of untreated/ partially treated effluent into the rivers causing health hazards to downstream consumers of water.

8.12.2.1. Impact significance

8.12.2.1.1. Exposure of Treatment Works staff to health and safety hazards

Table 8 - 19: Exposure of Treatment Works staff to health and safety hazards

Extent/Scale	Frequency	Duration	Intensity	Score	Event Magnitude
1	3	3	1	8	Medium

Human Receptors		Receptor Sensitivity	Receptor Sensitivity Ranking	Impact Significance
Presence	Resilience			
3	1	4	Medium	**Moderate**

8.12.2.2. Management of operation phase health and safety impacts

These health and safety hazards can be mitigated though formulation and implementation of a health and safety policy and operation procedures that address the health and safety aspects of activities at the WWTPs. Workers should be properly trained, and issued with appropriate protective clothing and PPE for work at these sites.

The WWTPs and pumping stations will manned and secured with chain-link perimeter fencing to prevent unauthorized entry by humans and animals.

Management of public health impacts related to air quality around the sites, water quality downstream of the outfall from the WWTPs, and solid wastes generated, are addressed in Sections 8.2.2.1, 8.8.2.2 and 8.9.2.4 of this Report.

8.13. Impacts on traffic

8.13.1. Construction phase impacts

Construction works and construction traffic are likely interrupt or inconvenience both vehicular and pedestrian traffic flow along access roads to the WWTPs, sewer line routes, and at road crossings. These impacts are expected to last for the duration of the infrastructure construction period.

The impacts and associated mitigation measures of vehicle emissions to air quality are discussed in Section 8.2.1 of this Report.

Likely impacts of increased construction traffic include nuisance from obstruction and slow movement of construction vehicles, and increased safety hazards for other motorists and pedestrians.

Road crossings will involve open trenching of the road requiring closure of one half of the road at a time. This will constrict traffic flow, creating inconvenience and potential safety hazards.

Heavy Goods Vehicles using the access roads to deliver construction materials or cart away wastes may also damage public roads.

8.13.1.1. Impact significance

8.13.1.1.1. Nuisance and increased safety hazards to other road users

Table 8 - 20: Nuisance and increased safety hazards to other road users

Extent/Scale	Frequency	Duration	Intensity	Score	Event Magnitude
2	2	2	1	7	Medium

Human Receptors		Receptor Sensitivity	Receptor Sensitivity Ranking	Impact Significance
Presence	Resilience			
2	2	4	Medium	**Moderate**

8.13.1.1.2. Damage to public roads

Table 8 - 21: Damage to public roads

Extent/Scale	Frequency	Duration	Intensity	Score	Event Magnitude
2	1	3	2	8	Medium

Physical Receptors		Receptor Sensitivity	Receptor Sensitivity Ranking	Impact Significance
Presence	Resilience			
2	2	4	Medium	**Moderate**

8.13.1.2. Traffic management

Traffic Management principles should be fully utilized and implemented by the Contractor(s) to ensure safety, and prevention of nuisance to the general public. A traffic management plan that minimizes the interface whenever possible between the public and construction traffic, reduces the number of Heavy Goods Vehicles (HGV) movements where practicable, and controlling vehicular movements on the project sites should be developed and implemented. The traffic management plan should cover:

- Planning and managing both vehicles and pedestrian routes;
- The elimination of reversing where possible;
- Safe driving and working practices;
- Protection of the public;

- Adequate vision and lines of sight;
- The provision of signs and barriers; and
- Adequate parking and offloading areas.

Appropriate signs, barricades, and other traffic management measures, should be used to minimize road user inconvenience and promote safety during temporary closure of roads.

Other details of the Traffic management plan should include:

- Dates and duration of stages and closures; and
- Contractor's contact person(s) with 24 hour telephone number

8.13.2. Operation phase impacts

Once the project is in operation, impacts on traffic are expected to be insignificant (**Negligible**). Staff/project vehicle movements along public roads on project activities are likely to be few and irregular and will be mainly as a result of maintenance works on project components.

8.14. Impacts on other natural resources

8.14.1. Construction phase impacts

Construction materials that will be used include masonry stones/bricks, aggregate, sand, cement, iron bars, precast concrete pipes etc. These materials (or raw materials for precast elements) will be obtained from quarries, hardware shops and sand harvesters who extract such materials from natural resource banks such as river banks and land. Unsustainable extraction of these resources can cause serious environmental degradation in the source areas.

8.14.1.1. Impact significance

8.14.1.1.1. Environmental degradation at materials sites

Table 8 - 22: Environmental degradation at materials sites

Extent/Scale	Frequency	Duration	Intensity	Score	Event Magnitude
3	1	3	1	8	Medium

Physical Receptors		Receptor Sensitivity	Receptor Sensitivity Ranking	Impact Significance
Presence	Resilience			
2	2	4	Medium	**Moderate**

8.14.1.2. Raw materials management

The Contractor(s) should source construction materials such as sand, aggregate and masonry stones from approved quarries and mining sites which have undergone satisfactory environmental impact assessment and are licensed according to the regulations. Since the approved quarries/mining sites are expected to apply acceptable environmental performance standards, the negative impacts of their activities at the extraction sites are considerably well mitigated.

The Contractor(s) should implement stringent inventory management mechanisms and only order for materials after a fairly accurate estimation of actual construction requirements.

Where possible, building elements should be manufactured off-site and delivered to site, to maximize benefits of off-site manufacture including minimizing waste, maximizing recycling (because manufacture is in one location), high quality elements, better occupational health and safety management, less noise and dust.

8.14.1.2.1. Material delivery, storage, and use

The Contractor(s) should provide appropriate training of workers on proper material delivery and storage practices and procedures. He/they should designate on-site materials delivery and storage areas and these should be located near construction entrances and away from watercourses. Earth berms or other containment measures should surround storage areas.

The Contractor should maintain accurate and up to date records of materials delivered and stored on site. He should at all instances endeavor to minimize site inventory.

Materials safety data sheets (MSDS) should be maintained for all chemicals and other hazardous substances in use at sites. Hazardous chemicals should be well labelled and stored in their original containers. The Contractor should however minimize the handling of hazardous materials on site. Workers with emergency spill clean-up training should be present during unloading of dangerous materials or liquid chemicals.

Materials should be stored under cover during the rainy season, while chemicals, drum and bagged materials should be stored on pallets and where possible, under cover in secondary containment.

Stockpiles should be located a minimum of 50 feet away from concentrated runoff. If necessary, physical diversions should be provided to protect the stockpiles from concentrated runoff. These measures will reduce the potential of storm water pollution originating from stockpiles of construction materials.

Any significant residual materials remaining on the ground after the completion of construction works should be removed and properly disposed. If the residual materials contaminate the soil, then the contaminated soil should also be removed and properly disposed.

8.15. Cumulative impacts

8.15.1. Overview

Cumulative impacts can occur either when different impacts from one development interact to exacerbate effects on sensitive receptors, or when the magnitude of an impact of a development is augmented or exacerbated by impacts from other existing or future neighboring developments, thus creating a more significant impact on a receptor.

This assessment considers the cumulative effects that are likely to result from the proposed Moi's Bridge and Matunda Sewerage schemes and other existing or future infrastructure projects.

8.15.2. Existing and proposed construction projects

There are no known existing construction projects in Moi's Bridge or Matunda that may generate cumulative impacts on aspects such as traffic, air quality, noise levels etc. However, a water supply scheme is planned for these two towns and the concurrent implementation of the water supply and sewerage schemes may generate cumulative impacts on the aspects aforementioned, especially around the townships. These include an exacerbation of the traffic nuisance, air pollution and noise levels from construction activities.

On the other hand, concurrent implementation of the two projects can allow the laying of sewer lines and water lines in a common trench (with the water line above the sewer line). This would result in a positive impact to the community as disruptions and construction work would only occur once for both projects

8.15.3. Water quality of Nzoia River,

There are other towns within the Nzoia river watershed with existing or planned sewerage schemes all draining (eventually) into Nzoia river. The proposed Matunda and Moi's Bridge sewerage schemes are within the upper reaches of the Nzoia River and are likely to be among the early point sources of effluent into the river. The cumulative effect of the additional wastewater (from existing and planned schemes) entering rivers within the Nzoia catchment, in the event of ineffective treatment, is the decreased water quality of Nzoia River. This is likely to result in a major negative impact to the river water quality.

8.15.4. Mitigation of cumulative impacts

To mitigate cumulative impacts from construction activities of different projects within the same locality, the following measures should be considered:

- Communication between water supply and sewerage contractors to determine how the projects will impact each other;
- Synchronising of construction phasing (of the water supply and sewerage schemes) such that one project either bypasses an area until the other project is complete, or the two are implemented concurrently to minimise duration of disturbance;
- Ensuring that design parameters for sewerage schemes within the catchment are maintained, and that operational effectiveness of each scheme is maintained.

8.16. Decommissioning phase Impacts

The decommissioning process is part of a facility or other infrastructure disposition. Disposition starts when the development's mission ends and may include dismantlement and release for reuse, or demolition and environmental restoration. During the decommissioning phase, all buildings, utility systems, infrastructure systems and related facilities are dismantled and/or demolished safely and efficiently using appropriate procedures and work controls.

Decommissioning in the case of the proposed sewerage schemes refers to abandonment and/or demolition of all structures including excavation/abandonment of the sewer collection system, backfilling of treatment ponds, disposal of wastes, and environmental restoration. Demolition poses potential hazards, and also generates wastes which ought to be dealt with appropriately.

Decommissioning impacts are closely related to the reason for the decommissioning and include but are not limited to:

- Decommissioning activities result in a creation of employment opportunities for workers involved in demolition and restoration activities;
- Decommissioning, and especially demolition activities, involve use of light and heavy machinery or tools that generate noise and vibrations;
- Demolition activities generate rubble that requires proper disposal and can create health and safety hazards if inadequately managed;
- Demolition activities create occupational and public health and safety hazards with the likely occurrence of accidents involving workers/general public and machinery or rubble; and
- Demolition activities generate dust which if improperly managed can create health risks to workers and the general public, and cause stunted vegetation growth.

8.16.1. Mitigation of decommissioning impacts

LVNWSB in conjunction with a Health, Safety, and Environment expert should develop environmental, health, and safety procedures for decommissioning, in keeping with the formulated Decommissioning Environmental Management Plan (DEMP) as discussed in Section 2.2.5.8 of this Report. These procedures should, among other issues, address the following:

- A Health and safety plan;
- The extent of decommissioning;
- Pollution prevention plans including air, water, and soil pollution prevention plans;
- Waste management plans; and
- Restoration plans.

At the end of decommissioning works, LVNWSB should obtain certificates of completion from all the necessary authorities including NEMA.

9. Socioeconomic impacts & mitigation measures

9.1. Introduction

This Chapter identifies the potential socio-economic impacts of the proposed sewerage schemes and mitigation measures for the adverse impacts identified. The impacts have been identified and assessed based on professional judgment, previous project experience and discussions with various stakeholders in the project area.

9.2. Access to improved sanitation

One of the greatest challenges facing emerging urban settlements such as Matunda and Moi's Bridge towns are poor wastewater disposal methods, and inadequate sanitation facilities including public toilets, waste receptors, and waste disposal sites. In addition, with the planned increase in water supply to these towns, the need to appropriately dispose generated wastewater will only become greater.

The operation phase of the schemes, when fully constructed, will have a major positive impact on the project area through a resolution of the existing poor sanitation conditions, and reduction in ground water contamination by untreated effluent. This will be a long term, continuous impact that will improve the quality of life of Matunda and Moi's Bridge residents.

9.2.1.1. Impact significance

9.2.1.1.1. Improved sanitation in the locality

Table 9 - 1: Improved sanitation in the locality

Magnitude	Receptor Sensitivity	Impact Significance

9.3. Local employment and procurement opportunities

A number of new direct employment opportunities will be created during the construction period. The detailed labor requirements for the schemes will not be known until the appointment of the construction contractor(s). It is however expected that construction activities will require engineers, project managers/foremen, workers, and specific equipment operators, among others.

The schemes will provide direct business opportunities for companies and individuals supplying goods and services such as construction materials, consumables, cleaning services etc. There will also be indirect employment opportunities on the supply side as the suppliers increase their resource capacity to meet project demands. With the creation of employment and business opportunities, taxes shall be remitted to the exchequer in the purchase of materials and other consumables, and payment for services offered by various parties in the construction process.

9.3.1.1. Impact significance

9.3.1.1.1. Increased employment and business opportunities

Table 9 - 2: Increased employment and business opportunities

Magnitude	Receptor Sensitivity	Impact Significance

Medium	Medium	**Moderate**

Unemployment rates in the project area are high, and the schemes will have short-term impacts on the workers (including their families) employed during construction. There may arise complaints and dissatisfaction among the communities affected by the projects if recruitment of workers is perceived to be biased and without local representation.

To mitigate the local representation concerns, the Contractor(s) should establish local employment targets in order to maximize local employment. Unemployed and able workers among the affected communities in each locality should be given first priority in recruitment of casual laborers. The Contractor(s) should have a credible procedure to identify and verify the areas in which the potential workers live, as well as information on experience and skills. It may be necessary to enlist the help of the local administration (chiefs, sub-chiefs and headmen) in vetting the workers.

9.4. Land acquisition and land-based livelihoods

9.4.1. Introduction

Project land acquisition and associated livelihood impacts will be addressed in accordance with the Land Act 2012 and international good practice as embodied in the policies and guidelines of the IFC/World Bank Group (OP 4.12 on Involuntary Resettlement).

9.4.2. Project land requirements

The proposed project will require the following land areas:

- 41 acres for the proposed Matunda Town WWTP and 1.0 acre for the pumping station, and 5 acres for sewer wayleaves;
- 60 acres for the proposed Moi's Bridge Town WWTP and 1.0 acre for the pumping station, and 6 acres for sewer wayleaves;
- A 6m by 26.8Km (10.95km for Matunda and 15.81km for Moi's Bridge) construction corridor for the sewer line ROW (this is temporary and only for the construction period. Affected land owners may be able to use the land with some restrictions)
- Land for the construction camp(s), materials and equipment storage

9.4.3. Potential land and livelihood impacts

The project-affected families are mostly rural, and depend on agriculture for their livelihood. Sixty (60) in Moi's Bridge and seventy one (71) families in Matunda will either be physically and/or economically displaced by project components including the WWTPs and pumping stations. The schemes will also impact on other cultivated lands causing economic displacement of ninety one (91) families in Moi's Bridge, and seventy six (76) families in Matunda mainly along the sewer line ROW. The economic displacement is however temporary and will be for the duration of the construction activities. Cultivation on top of the sewer line and the ROW will be possible and is allowed. However, no structures can be established on this corridor as these may interfere with sewer maintenance activities.

Mitigation of potential environmental and social impacts is an integral part of project development, from conceptual design through to construction and operation. A key mitigation already implemented has been routing of the sewer lines to mainly follow the road reserve avoiding as much as possible, private property and the need to physically relocate households.

The project will involve impacts on land, productive assets, and livelihood through:

- Temporary use of land for construction purposes;
- Permanent acquisition of land for the WWTPs and pumping stations;
- Imposition of rights to construct and operate a sewer line under existing ownership for the sewer line alignment; and
- Imposition of restrictions on land use adjoining the sewer line.

Land and related livelihood impacts of the sewerage schemes will include the following:

- Temporary loss of use of cultivated land, with resultant loss of income for owners/users for the construction period;
- Permanent loss of land and the related income to the WWTPs, pumping stations and access roads;
- Impairment of livelihood in areas adjacent to the sewer lines that are affected by restrictions on use;
- Loss of trees/perennial crops in the 5m metre construction corridor; and
- Loss of annual / seasonal crops in-ground at the time land is occupied for construction.

9.4.3.1. Impact significance

9.4.3.1.1. Loss of land and livelihoods for affected people

Table 9 - 3: Loss of land and livelihoods for affected people

Magnitude	Receptor Sensitivity	Impact Significance
Medium	Medium	**Moderate**

9.4.4. Land acquisition and compensation

As part of the social impact assessment, a team comprised of a Sociologist, a Registered Valuer, and a Local Administrator informed the affected people about the nature of the projects, the need for land acquisition, and their rights and obligations with respect to the acquisition process. The Valuer undertook a valuation of land, crops and assets that will be lost to the relevant project components and prepared a recommendation on the compensation payable to affected land owners and users. The recommendation will be used as a starting point in the negotiation of a final settlement with affected land owners and users. All compensation rates and entitlements will be publicly disclosed and adjusted if necessary to take into account any feedback received.

A standalone Resettlement Action Plan document has been prepared for project affected persons that will be displaced both physically and economically by project components.

The table below summaries the potential impacts and mitigation/management measures proposed for land acquisition and livelihoods impacts.

Table 9 - 4: Summary of potential impacts and mitigation measures for land acquisition and livelihood impacts

Issue/impact	Mitigation/management measures
Construction phase	
Permanent expropriation of land and related income	Cash compensation based on market value of land or provide with option of replacement land within the village if available of equivalent size and quality.
Interruption of land use along the sewer line ROW by the construction process for the duration of the construction period	▪ Cash compensation should be provided for lost agricultural productivity during the construction period.

	▪ Reinstatement of land to a least the condition it was in prior to construction.
Loss/damage to crops, trees fences along the pipeline construction corridor	▪ Compensation for property damage and loss of amenities within the designated construction corridor; and ▪ Adequate notice to be given to farmers before commencement of construction so that the farmers do not unnecessarily lose crops.
Potential damage to property outside the sewer line ROW and approved construction areas through activities such as: clearing land beyond the project working areas for which compensation has been paid; vehicles or people straying outside working areas and causing damage to land and crops; adverse effects of dust on crops	▪ Construction activities to be carried out in predetermined working areas. Any damage by construction works outside the boundaries to be appropriately compensated by the contractor; ▪ Requirement to keep within the working area to be enforced and emphasized to the workers during induction and toolbox talks; and ▪ Working areas to be determined prior to construction and demarcated as necessary using fencing, marker posts or signs.
Operation phase	
Following completion of construction, there will be restrictions on land use especially along the pipeline ROW precluding building or the planting of trees	Compensation for restrictions to land use be provided to land owners as set out in the Resettlement Action Plan (RAP).

9.4.5. Accidents involving community members

Accidents involving community members could occur from the safety hazards posed by construction sites or construction activities. Such could include traffic-related accidents, accidents involving open trenches or other accidents. Any incident that harms a person has potential to diminish the quality of life for that person, negatively impacting them or their household livelihood, and potentially creating tension between the local community and project teams.

9.4.5.1. Impact significance

9.4.5.1.1. Diminished quality of life for affected persons

Table 9 - 5: Diminished quality of life for affected persons

Magnitude	Receptor Sensitivity	Impact Significance
Medium	Medium	**Moderate**

Safety training, traffic management and driver training, and a high priority placement of safety by the Contractor(s) throughout their work, will ensure that the risk of serious accidents is low. The Contractor(s) should also appoint a community liaison team to work with communities to manage issues or anxiety surrounding accidents and to advice on the risks and dangers associated with the schemes.

10. Environmental management & monitoring plan (EMMP)

10.1. Overview

The measures presented here summarize the key impacts identified, the remedial measures to be taken, the responsible person(s) for execution, and the monitoring activities to be undertaken. An indication of the timing for implementation and the cost involved is also provided.

The EMMP tables can be further expanded with documented procedures and guidelines for work practices in order to be responsive to the situations that various Contract Parties will encounter. Implementation of the EMMP shall be done within the provisions of the law and for the ultimate benefit of the stakeholders in the area. The effectiveness of the EMMP should be monitored and assessed regularly through inspections and reporting throughout construction and during operations.

10.2. Construction environmental management and monitoring plans

A Construction Environmental Management and Monitoring Plan (CEMMP) is a practical and achievable plan of management to ensure that any environmental impacts during the design, planning and construction phase are minimized. CEMMP's have been proposed to deal with the following issues during construction of the sewerage schemes:

- General site management;
- Air quality;
- Noise and vibrations;
- Aesthetics (visual and landscape);
- Biodiversity (flora and fauna);
- Soil resources;
- Energy resources;
- Water resources;
- Waste management;
- Traffic Management;
- Occupational/public health and safety; and
- Displacement and disruption of livelihoods

10.2.1. Contractor environmental management plan

The contractor(s) who shall be appointed for the construction of the schemes must develop their own EMPs to ensure actions and mitigation necessary to protect the environment are incorporated into all site procedures. At a minimum, the contractor's EMP must address the following:

- Policy
- Planning
- Implementation and Operation

10.2.1.1. Policy

Each contractor should develop an environmental policy that includes, as a minimum, the following:

- A commitment to comply with applicable regulations and other requirements that the construction company subscribes to;
- A commitment to provide a safe work environment;
- A commitment to provide the training and equipment necessary to for employees to conduct their work safely;

- A commitment to continuously improve performance and to pollution prevention; and
- A commitment to communicate the policy to all persons working for and on behalf of the company.

10.2.1.2. Planning

Environmental issues and the legal and other requirements in construction of the sewerage schemes have been identified in this ESIA. Each contractor must demonstrate within his plan that he has read and understood the ESIA Report and its provisions for environmental management and monitoring.

10.2.1.3. Implementation and Operation

Roles, responsibilities and authorities should be defined, documented and communicated to ensure effective environmental and social management. A specific management representative should be assigned that is responsible for ensuring that the EMP is established, implemented and maintained and is responsible for reporting performance, reviewing the Plan and making recommendations for improvement. Documented confirmation is required that the training needs of all persons working for or on the company's behalf whose work pose significant hazards to their health and safety and / or may create a significant impact on the environment has been identified. Records of all training must be maintained.

Management, supervisory, and employee responsibilities must be communicated to all employees through training, formal job descriptions, work experience, hiring practices, etc. Awareness training should be provided that include the importance of conforming to the policy and procedures, the significant environmental issues, and the roles and responsibilities of management and staff.

Records should be legible, identifiable and traceable to the activity. Records should be stored and maintained in such a way that they are retrievable and protected against damage, deterioration or loss.

Each Contractor should establish, implement and maintain procedures to identify potential emergency situations and potential accidents that can have an impact on the environment, surrounding communities, the employees, and / or the public.

The contractor should be prepared to respond to actual emergency situations and accidents and prevent or mitigate associated adverse environmental or social impacts. The EMP must also address how the contractor will receive, document and respond to external interested parties.

10.2.2. Environmental monitor

An independent Environmental Monitor should be identified and contracted to perform the following:

- Verify that all project approvals and permits are in place prior to the start of construction;
- Evaluate contractor plans (e.g., EMP, Spill Response and Waste Management Plans) and monitor implementation;
- Develop inspection checklists to ensure site inspections are focused and useful;
- Conduct environmental monitoring of construction works; the environmental monitor should ensure the protection of the environment, that mitigation measures are appropriately implemented and to facilitate communication between the Contractor(s), the Project Team and NEMA; and
- Prepare regular written reports to the Project Team, Contractor(s) and, where need be, NEMA on an agreed to schedule.

Detailed CEMMP's are presented below.

Table 10 - 1: CEMMP - Site management

Objective	**To apply best management practices in site management during construction**			
Management strategy	**To control potential pollutants at their source through the use of good housekeeping practices**			
	Activities	**Responsibility**	**Timing**	**Estimated Costs (Kshs)**
Actions	▪ Provide training to workers to ensure that they understand the requirements of the environmental management plan as applicable to their responsibilities; ▪ Conduct drills to check on preparedness and response time to emergencies; ▪ Implement practices and procedures that promote proper handling and storage of construction materials and other stockpiles to prevent or reduce storm water pollution, injury to workers or visitors, ground water pollution, and soil contamination; ▪ Minimize or eliminate the discharge of pollutants into storm water drainage systems/natural water channels, surface water bodies or aquifer by reducing hazardous material use on site, using alternative products, and training employees in proper handling and use of construction materials ▪ Ensure protection of stockpiles to reduce the potential for air and storm water pollution originating from stockpiles of construction materials, topsoil and subsoil; ▪ Ensure measures to prevent the discharge of wastes(solid waste, sanitary/effluent waste, hazardous waste, concrete waste) into the ground or the area's surface water courses /water bodies; ▪ Institute practices and procedures to reduce or prevent leaks or spills which may be discharged into the environment; and ▪ Develop a plan that addresses the sequence of construction activities as it relates to local climate in order to minimise soil erosion from exposure to wind, rain, runoff and vehicle tracking.	Contractor	During construction	▪ 100,000 for worker's training ▪ 50,000 for drills ▪ 150,000 for housekeeping measures ▪ 200,000 for pollution prevention ▪ 90,000 for protection of stock piles ▪ 300,000 for waste management ▪ 150,000 for management and containment of materials to prevent spillages/leakages

Objective	**To apply best management practices in site management during construction**			
Management strategy	**To control potential pollutants at their source through the use of good housekeeping practices**			
	Activities	**Responsibility**	**Timing**	**Estimated Costs (Kshs)**
Performance indicators	Housekeeping practices vis a vis EMP requirements; environmental pollution and H&S concerns arising during construction			
Monitoring requirements	Periodic audits	Environmental Monitor	Construction Phase	
Reporting	Monthly progress reports during construction			
Interface	Environmental Management and Coordination Act, 1999 and subsidiary legislation			

Table 10 - 2: CEMMP - Biodiversity

Objective	**Conserve/protect the existing biodiversity in the Project area**			
Management strategy	**Institute measures to protect and conserve existing biodiversity**			
	Activities	**Responsibility**	**Timing**	**Estimated Costs (Kshs)**
Actions	▪ Avoid unnecessary removal/destruction of vegetation in site clearance; ▪ Development and implementation of a Reinstatement Plan; ▪ Re-vegetation of disturbed grounds with indigenous species; ▪ Incorporate existing vegetation into landscaping plans where possible and ensure that proper care is taken for this vegetation before and after construction; ▪ Ensure the protection of existing vegetation using any of the following methods: mark, flag or fence areas of vegetation to be preserved; designate limits of root systems (tree drip line); limit grading to within one foot of the tree drip lines if grading under the tree is necessary; and locate construction traffic routes, spoil piles etc away from existing vegetation; ▪ Ensure the prevention of vegetation and soil contamination by hydrocarbon/chemical pollution events through development and implementation of pollution prevention plans and emergency response plans.	Contractor	During construction	▪ 100,000 for protection of existing vegetation ▪ 300,000 for re-vegetation and landscaping
Performance indicators	Extent of vegetation clearance			
Monitoring requirements	Periodical inspection	Contractor/ Environmental Monitor	Construction Phase	
Reporting	Site log book			
Interface	Compliance with the EMMP and with the EMCA, 1999			

Table 10 - 3: CEMMP - Energy resource management

Objective	**Minimize impact on energy resources due to the construction works**			
Management strategy	**Conserve fossil fuel energy resources** **Reduce CO_2 emissions at the construction sites**			
	Activities	**Responsibility**	**Timing**	**Estimated Costs (Kshs)**
Actions	▪ Maintain equipment and machinery to manufacturers' specifications by regular servicing to maintain efficiency in combustion and reduce carbon emissions; ▪ Use environmentally friendly fuels such as low sulphur diesel; ▪ Minimise the period for machinery idling to save on fuel; and ▪ Specify and procure the most energy efficient plant options fit for purpose and avoid use of plant with unnecessary and excess capacity.	Contractor	Construction phase	▪ No additional costs (NAC)
Performance indicators	Evidence of energy conservation measures instituted and functional at the site.			
Monitoring requirements	Physical inspection	Environmental Monitor	Construction phase	
Reporting	Site activities log book.			
Interface	Comply with international best practices			

Table 10 - 4: CEMMP - Air quality

Objective	**Maintain the air quality by avoiding air pollution**			
Management strategy	**Abate pollution of the atmosphere by reducing emissions**			
	Activities	**Responsibility**	**Timing**	**Estimated Costs (Kshs)**
Actions	▪ Minimize exposed areas through the schedule of construction activities to enable dust control; ▪ Maintain equipment and machinery to manufacturers' specifications by regular servicing to maintain efficiency in combustion and reduce carbon emissions; ▪ Use environmentally friendly fuels such as low sulphur diesel; ▪ Minimise the period for machinery idling; ▪ Control of speed limit for construction vehicles along dusty roads; ▪ Rehabilitation of disturbed areas once completed; ▪ Use of tarpaulins to cover trucks carting away spoil using public roads. Additionally, the trucks should maintain at least two feet of freeboard; ▪ Proper planning in transportation of spoil to ensure that the number of trips done or the number of vehicles used is as minimum as possible; and ▪ Provision of appropriate Personnel Protective Equipment such as dust masks to site workers.	Contractor	Construction phase	▪ NAC ▪ Equipment operation costs yet to be determined ▪ NAC ▪ NAC ▪ 30,000 for signage & other speed controls ▪ 300,000 for re-vegetation and landscaping ▪ 30,000 for tarpaulins ▪ NAC ▪ 100,000 for worker PPE
Performance indicators	▪ Lack of complaints / Complaints; ▪ Deposition of dust on neighbouring vegetation; and ▪ Reports / Log book entries.			
Monitoring requirements	▪ Physical inspection; ▪ Air quality measurements if necessary; and ▪ Site Log books.	Environmental Monitor	Construction phase	
Reporting	Site logs of inspections and corrective actions.			
Interface	Review and comply with relevant laws and regulations on air quality control.			

Table 10 - 5: CEMMP - Noise and vibrations

Objective	**Maintain low noise levels and reduce vibrations emanating from construction activities**			
Management strategy	**Prevention of noise pollution and vibrations**			
	Activities	**Responsibility**	**Timing**	**Estimated Costs (Kshs)**
Actions	▪ Install portable hoods to shield compressors and other small stationary equipment where necessary; ▪ Endeavour to use equipment installed with noise abatement devices as much as practicable; ▪ Reduce idling time on trucks and other noisy equipment; ▪ Encourage drivers to turn off vehicle engines when not in use; ▪ Provide personal protective equipment such as ear muffs to workers at the site as necessary; and ▪ Carry out construction work during the day only.	Contractor	Construction phase	▪ 150,000 for noise abatement measures ▪ NAC ▪ NAC ▪ NAC ▪ 100,000 for PPE ▪ NAC
Performance indicators	▪ Complaints; and ▪ Reports / Log book entries.			
Monitoring requirements	▪ Physical inspection; and ▪ Site Log books.	Environmental Monitor	Construction phase	
Reporting	Site logs of inspections and corrective actions.			
Interface	Review and comply with relevant laws and regulations on Noise pollution and vibrations.			

Table 10 - 6: CEMMP - Soil resource management

Objective	**Protection of soil resources at the site**			
Management strategy	**Prevention of depletion of the soil resource at the site**			
	Activities	**Responsibility**	**Timing**	**Estimated Costs (Kshs)**
Actions	▪ Salvage, stockpile and ensure re-use of native topsoil during re-vegetation activities in disturbed areas; ▪ Use excavated soil from treatment ponds in establishment of berms within the WWTP; ▪ Develop and implement a reinstatement plan; ▪ Reinstatement to ensure that trench backfill material is compacted to a similar value to the surrounding soils; ▪ Ensure that clearance of vegetation is limited to the plinth of proposed structures and trench line to prevent soil erosion that would ensue after loss of vegetation; ▪ Ensure that construction vehicles use predetermined tracks at the site to reduce ground compaction; ▪ Stabilize and maintain access roads created to access project sites to minimize erosion and dust from vehicular traffic; ▪ Stabilize construction sites and camp(s) entrances/exits to reduce the amount of sediment tracked off-site by construction vehicles; ▪ Oils, fuels, paints and any hazardous materials to be stored in accordance with their respective MSDS's, and in such a manner to avoid spillages or leakages; and ▪ Seeding and planting of trees, shrubs and ground cover for temporary or permanent stabilization of soil in areas such as: cleared areas without on-going construction activity; open space and fill areas; spoil piles or temporary stockpile of fill material.	Contractor	Construction phase	▪ NAC ▪ NAC ▪ 100,000 for protection of existing vegetation ▪ NAC ▪ 300,000 for maintenance of accesses ▪ 150,000 for stabilization of entrances/exits ▪ 150,000 for management and containment of materials to prevent spillages/leakages ▪ 300,000 for re-vegetation and landscaping
Performance indicators	▪ Level of soil erosion observed at the site; and			

Objective	**Protection of soil resources at the site**			
Management strategy	**Prevention of depletion of the soil resource at the site**			
	Activities	**Responsibility**	**Timing**	**Estimated Costs (Kshs)**
	▪ Quantity of excavated soil carted away/re-used at the site.			
Monitoring requirements	▪ Physical inspection; and ▪ Site Log books.	Environmental Monitor	Construction phase	
Reporting	Site logs of inspections and corrective actions.			
Interface	Review and comply with relevant laws and regulations on protection of soil resources.			

Table 10 - 7: CEMMP - Water resource management

Objective	**Protection of water resources in the area**			
Management strategy	**Conservative use of water at the site and prevention of water pollution by construction activities**			
	Activities	**Responsibility**	**Timing**	**Estimated Costs (Kshs)**
Actions	▪ Institute measures to prevent/minimise pollution of Nzoia and Little Nzoia Rivers by sediments; ▪ Measures for protection of soil erosion shall also apply; ▪ Endeavour to complete earthworks during the dry season; ▪ Ensure that water is used efficiently by avoiding extravagant water use and wastage in construction or hydraulic testing of the sewer line;	Contractor	Construction phase	▪ NAC
Performance indicators	▪ Water consumption levels , water pollution incidences or practices that could cause water pollution			
Monitoring requirements	▪ Physical inspection ▪ Site Log books	Environmental Monitor	Construction phase	
Reporting	Site logs of inspections and corrective actions.			
Interface	Review and comply with relevant laws and regulations on protection of soil and water resources			

Table 10 - 8: CEMMP - Traffic management

Objective	**Prevention of traffic nuisance by construction vehicles**			
Management strategy	**Develop and observe traffic management plans**			
	Activities	**Responsibility**	**Timing**	**Estimated Costs (Kshs)**
Actions	▪ Contractor shall ensure that construction vehicles do not cause nuisance to the general public through obstructions, and that speed limits are observed; ▪ Develop a traffic management plan to ensure that site vehicles do not interfere with the regular traffic along the main roads, or pose safety hazards to site workers or the general public; ▪ Set up traffic control/warning signs near construction sites and road crossings informing other motorists of potential hazards; and ▪ Recruit traffic marshals to control traffic especially at road crossings where parts of the road may be closed while trenching.	Contractor	Construction phase	▪ 30,000 for signage & other speed controls
Performance indicators	▪ Complaints/ number of accidents/incidences			
Monitoring requirements	▪ Physical inspection ▪ Site Log books	Environmental Monitor	Construction phase	
Reporting	Site logs of inspections and corrective actions.			
Interface	Review and comply with the relevant laws and regulations regarding traffic management.			

Table 10 - 9: CEMMP – Occupational/public Health and safety

Objective	**Ensure a safe and healthy working environment at the site for workers and safety &health for the public**			
Management strategy	**Provide proper safety equipment, facilities and conditions that will eliminate or reduce the risk to the workers and the public.**			
	Activities	**Responsibility**	**Timing**	**Estimated Costs (Kshs)**
Actions	▪ Comply with the OSHA, 2007 and all other relevant regulations governing health and safety at workplaces; ▪ Access to the construction sites shall be controlled to prevent access by unauthorised personnel; ▪ Endeavour to lay pipes and backfill trenches at the earliest opportunity; ▪ Provide for appropriate signage and warnings in work areas; ▪ Provide appropriate personnel protective equipment (PPE) to site workers; ▪ Provide for First Aid facilities, and ensure that workers are trained on emergency response such as first aid skills; ▪ Provide and clearly display emergency contacts on site; ▪ Provide for adequate sanitary facilities (latrines and wash water); and ▪ Develop and implement detailed and site specific Health and Safety and Emergency Response Plans.	Contractor	Construction phase	▪ NAC ▪ 300,000 for hoarding of construction sites ▪ 30,000 for signage ▪ 100,000 for PPE ▪ 100,000 for First Aid facilities & Training of First Aiders ▪ 60,000 for establishment of sanitary facilities
Performance indicators	▪ Health and safety awareness among workers; and ▪ Frequency of incidents/accidents and fatalities.			
Monitoring requirements	▪ Daily inspection of work areas; and ▪ Tool box meetings.	Health and Safety Advisor	Construction phase	
Reporting	Log incidents/accidents and fatalities; and Tool box minutes.			
Interface	Compliance with regulations on health and safety at the workplace			

Table 10 - 10: CEMMP - Solid and effluent waste management

Objective	**Prevention of pollution from wastes generated at the site**			
Management strategy	**Ensure wastes generated are adequately disposed off**			
	Activities	**Responsibility**	**Timing**	**Estimated Costs (Kshs)**
Actions	▪ Isolate woody vegetation cleared and facilitate collection by neighbouring residents; ▪ Ensure excavated soil is used as much as possible in landscaping at the WWTPs or disposed appropriately in landfills to prevent nuisance; ▪ Avoid mixing excess concrete if possible. Discard excess concrete in a designated area; ▪ Concrete-coated vehicles/equipment should be washed off-site or in a designated area. The concrete wash area should be at least 50m away from natural storm drainage channel. ▪ Runoff from onsite concrete wash areas should be contained in temporary pits where concrete can set; ▪ Ensure hydraulic test water is disposed in a manner not to cause erosion or is reused where the sewer line is to be tested in sections; ▪ Segregate wastes generated into inert fill materials, recyclable/reusable materials and hazardous wastes for appropriate disposal; and ▪ Ensure sanitary facilities are provided at construction sites and that they are located at convenient places away from drainage facilities.	Contractor	Construction phase	▪ NAC ▪ NAC ▪ NAC ▪ 150,000 for establishment and maintenance of concrete washout areas ▪ 60,000 for waste segregation facilities ▪ 60,000 for maintenance of existing sanitary facilities
Performance indicators	▪ Waste management plans at the site; and ▪ Site status.		Construction phase	
Monitoring requirements	Periodical inspection of the site to establish adequacy of waste management plans in place.	Environmental Monitor	Construction phase	
Reporting	Periodical audit reports			
Interface	Compliance with the provisions of the Waste Management Regulations on waste management.			

Table 10 - 11: CEMP for displacement and livelihoods disruption

Objective	**Mitigate as much as possible, adverse impacts of the schemes on livelihoods**			
Management strategy	**Adequate compensation of affected people**			
	Activities	**Responsibility**	**Timing**	**Estimated Costs (Kshs)**
Actions	▪ Cash compensation based on market value of land or provide with option of replacement land within the village if available of equivalent size and quality; ▪ Cash compensation to be provided for lost agricultural productivity during the construction period. ▪ Reinstatement of land to a least the condition it was in prior to construction ▪ Compensation for property damage and loss of amenities within the designated construction corridor; ▪ Adequate notice to be given to farmers before commencement of construction so that the farmers do not unnecessarily lose crops; ▪ Construction activities to be carried out in predetermined working areas. Any damage by construction works outside the boundaries to be appropriately compensated by the contractor; ▪ Requirement to keep within the working area to be enforced and emphasized to the workers during induction and toolbox talks; ▪ Working areas to be determined prior to construction and demarcated as necessary using fencing, marker posts or signs; ▪ Compensation for restrictions to land use be provided to land owners as set out in the Resettlement Action Plan (RAP).	LVNWSB	Operations	Costs of compensation provided in the Resettlement Action Plan
Performance indicators	Grievances from the affected individuals/households		Operations	
Monitoring requirements	▪ RAP implementation against plans	LVNWSB	Operations	
Reporting	▪ Periodic report on RAP implementation		Operations	
Interface	Land Act 2012, WB procedures on Involuntary Resettlement			

10.3. Operations phase environmental management and monitoring plans

The Operational Environmental Management and Monitoring Plans (OEMMPs) focus on sound environmental management practices that will be undertaken to minimize adverse impacts on the environment through normal operation of the sewerage schemes.

Measures are proposed for the foreseeable impacts and cover the following aspects:

- Air quality management;
- Noise and vibrations management;
- Visual and landscape impacts management;
- Energy resources Management;
- Water resources Management
- Waste Management; and
- Health and Safety Management;

Detailed OEMMP's are presented below.

Table 10 - 12: OEMMP for air quality management

Objective	**Ensure that the WWTPs do not result in a deterioration of the local air quality**			
Management strategy	**Adopt practices that minimise odour's from works and wastes generated**			
	Activities	**Responsibility**	**Timing**	**Estimated Costs (Kshs)**
Actions	▪ Ensure storage of screenings and grit in closed containers (dumpsters) instead of on the ground; ▪ Ensure that all waste is hauled off-site on a scheduled and timely basis; ▪ Ensure the covering of sludge processing facilities; ▪ Avoid prolonged storage of dewatered sludge at the WWTPs; ▪ Mitigate the adverse effects of septicity in gravity sewers by suitable design to shorten residence time, minimization of sediments deposition and adoption of corrosion resistant construction materials; and ▪ Establishment and maintenance of greenbelts around the WWTPs and pumping stations to serve as wind breaks	LVWSB	Operations	▪ Maintenance costs to be determined once project is operational
Performance indicators	▪ Ambient air quality around the WWTPs		Operations	
Monitoring requirements	▪ Periodical inspection	LVWSB	Operations	
Reporting	▪ Environmental Audits and other Statutory and non-statutory reports		Operations	
Interface	▪ Comply with NEMA regulations on air quality			

Table 10 - 13: OEMP for noise and vibrations

Objective	**Manage activities to reduce impacts of noise on surrounding properties and comply with the laws of Kenya**			
Management strategy	**Ensure implementation of noise prevention mechanisms**			
	Activities	**Responsibility**	**Timing**	**Estimated Costs (Kshs)**
Actions	▪ Regular maintenance of pumps according to manufacturer's specifications; and ▪ Acoustic shielding if necessary following measurements and/or complaints.	LVNWSB	Operations	Nil
Performance indicators	▪ Noise levels at the pumping stations from identified point sources		Operations	
Monitoring requirements	▪ Complains; and ▪ Periodic measurements.	LVNWSB	Operations	
Reporting	▪ Complaints / incidents should be recorded in a log book on location.		Operations	
Interface	Comply to the laws and regulations of Kenya on noise and vibrations			

Table 10 - 14: OEMP for visual and landscape impact management

Objective	**Minimise the visual intrusion of works**			
Management strategy	**Implementation of elaborate landscaping plans around facilities**			
	Activities	**Responsibility**	**Timing**	**Estimated Costs (Kshs)**
Actions	▪ Ensure landscaping around facilities (WWTPs and pumping stations) by planting and maintenance of vegetation around them to limit view points to the facilities	LVNWSB	Operations	▪ Landscaping costs are part of construction costs. Vegetation maintenance costs to be determined during operations
Performance indicators	Visibility of facilities from public places		Operations	
Monitoring requirements	▪ Periodic inspections	LVNWSB	Operations	
Reporting	▪ Annual audit report		Operations	
Interface	Best management practices (BMPs)			

Table 10 - 15: OEMMP for energy resource management

Objective	**Minimize impact on energy within the Project area due to the operation of the WWTPs and pumping stations**			
Management strategy	**Conserve energy resources through lowering the consumption levels**			
	Activities	**Responsibility**	**Timing**	**Estimated Costs (Kshs)**
Actions	▪ Encourage staff at the WWTPs staff housing to conserve energy through awareness programs; ▪ Install and maintain energy efficient appliances e.g. indoor lights and outdoor security lights; and ▪ Explore use of solar energy for lighting at the WWTPs and pumping stations.	LVNWSB	Operations	▪ 200,000 for energy efficient lighting
Performance indicators	▪ Changes in energy consumption levels		Operations	
Monitoring requirements	▪ Develop a monitoring and evaluation schedule.	LVNWSB	Operations	
Reporting	▪ Logs of inspections and corrective actions.		Operations	
Interface	▪ Compliance with existing laws/regulations on energy conservation, and international best practices			

Table 10 - 16: OEMMP for water resource management

Objective	**Minimize impact on water resources within the Project area due to the operation of the sewerage schemes**			
Management strategy	**Protect the water quality of the receiving water bodies by ensuring that effluent discharged is treated appropriately**			
	Activities	**Responsibility**	**Timing**	**Estimated Costs (Kshs)**
Actions	▪ Implement a rigorous monitoring programme in order to ensure that the new WWTPs operate effectively and as designed ▪ A testing programme to be established to monitor the treatment performance and efficiencies within the treatment plants; ▪ Raw influent and treated effluent parameters to be monitored on a daily basis to include biochemical oxygen demand (BOD), total suspended solids (TSS), COD (as an indicator of BOD), ammonia nitrogen (NH3-N), trace ammonia as an indicator of nitrification, dissolved oxygen and pH; ▪ Suspended solids measurements of primary effluent, and total dissolved solids (TDS) and faecal coliform counts to be regularly measured in the plant effluent; ▪ Sampling for heavy metals to be performed on a monthly basis and the sampling frequency increased if a significant concentration of heavy metals is detected. ▪ Sampling of industrial waste streams to be pursued to identify the source and to initiate a corrective programme to halt the discharge; ▪ Sampling stations to be established on River Nzoia and Little Nzoia in the vicinity of the outfalls to monitor water quality in the receiving waters and to help assess the impact of the treated effluent on water quality;	LVNWSB	Operations	▪ Costs of water quality monitoring to be established during project operations
Performance indicators	▪ Quality of water in Nzoia and Little Nzoia Rivers downstream of outfalls		Operations	
Monitoring requirements	▪ Daily, weekly and monthly monitoring schedule of identified parameters.	LVNWSB	Operations	
Reporting	▪ Water sampling reports.		Operations	
Interface	▪ Compliance with existing laws/regulations on water resource management, and international best practices			

Table 10 - 17: OEMMP for waste management

Objective	**Eliminate impact on public health due to poor waste management at the WWTPs**			
Management strategy	**Removal of agents of environmental pollution and proper disposal of wastes while complying with the laws of Kenya.**			
	Activities	**Responsibility**	**Timing**	**Estimated Costs (Kshs)**
Actions	▪ To appropriately dispose solid wastes from the WWTPs, identify a suitable landfill site near Matunda and Moi's Bridge which will serve the two towns and other neighbouring urban areas. ▪ Dried sludge/cake to be sold off/collected for disposal as organic fertilizer for use in local farms. Alternatively, in the event that uptake by local farmers is low, the dried sludge can be landfilled at an appropriate location. ▪ Monitor sludge quality to ensure that human health is protected. Ensure that pathogens and nematodes which are likely be the major health concern are eliminated from dried sludge; ▪ Ensure that proper sludge stockpiling, handling and soil conditioning procedures are followed.	LVWSB	Operations	▪ Cost of a suitable land fill site to be determined during project operations
Performance indicators	▪ Appropriateness and adequacy of solid waste management practices at the WWTPs		Operations	
Monitoring requirements	▪ Periodical inspection	LVWSB	Operations	
Reporting	▪ Environmental Audits and other Statutory and non-statutory reports		Operations	
Interface	▪ Comply with NEMA regulations on Waste management			

Table 10 - 18: OEMP for occupational/public safety and health management

Objective	**Prevent the occurrence of accidents from conditions and activities at the WWTPs and pumping stations**			
Management strategy	**Establishment and implementation of health and safety plans**			
	Activities	**Responsibility**	**Timing**	**Estimated Costs (Kshs)**
Actions	▪ Develop and implement operating procedures cognisant of the health and safety hazards at the WWTPs and pumping stations ▪ Provide training to staff at the facilities and ensure they have appropriate PPE for work at the sites ▪ Secure the WWTPs and pumping stations with chain-link perimeter fencing and a guard to prevent unauthorised entry	LVNWSB	Operations	Nil costs for implementation of procedures Cost of securing the facilities are part of construction costs
Performance indicators	Health and safety measures in place at the WWTPs and pumping stations		Operations	
Monitoring requirements	▪ Records of incidents and accidents; and ▪ Annual health and safety audits.	LVNWSB	Operations	
Reporting	▪ Occupational Health and Safety Audit Report		Operations	
Interface	Occupational Safety and Health Act, 2007			

10.4. Decommissioning environmental management plan (DEMP)

10.4.1. Overview

Once LVNWSB has decided to proceed with decommissioning –of the entire or some components of the sewerage schemes, a Project Decommissioning Plan shall be prepared and submitted to NEMA for approval. Only after NEMA's approval and after LVNWSB has completed any precursor activities, and decommissioning schedule shall the decommissioning process begin.

The following steps shall be followed in the decommissioning process.

10.4.1.1. Scoping

This is a consultative process to discuss the scope of the decommissioning action for all project components, including the schedule, budget, risks and approach for performing the work.

10.4.1.2. Facility walk-down

Site personnel shall perform a facility walk down to obtain the information necessary to prepare the hazard assessment and the Reconnaissance Level Characterization Report (RLCR). Safety and physical hazards at the sites shall be identified as part of the initial project reconnaissance. The safety and physical hazard assessment will help site personnel determine the possible risks to workers, the public and the environment during decommissioning.

To identify and control hazards, an Integrated Safety Management (ISM) process description and implementation plan shall be followed. The ISM integrates the identification, analysis and control of hazards and provides feedback for improvement. The ISM will consist of five core safety management functions which include:

- Definition of the scope of work;
- Identification and analysis of hazards associated with the work;
- Development and implementation of hazard controls;
- Performance of the work within such controls; and
- Provision of feedback on the adequacy of the controls.

10.4.1.3. Reconnaissance level characterization

The Reconnaissance Level Characterization produces an overall assessment of the hazards, and other conditions associated with each structure/facility to be decommissioned. The physical condition of the structures/facilities shall be assessed in order to identify hazards, as well as physical obstacles or other conditions that could affect decommissioning activities. The Reconnaissance Level Characterization shall include a detailed review of hazards that require special work controls to complete decommissioning safely. In all cases, the team performing the RLC shall check the historic information against current observed conditions.

10.4.1.4. Prepare reconnaissance level characterization report (RLCR)

Based on the Reconnaissance Level Characterization, LVNWSB shall prepare a report for review and approval by NEMA. The report summarizes the results of the Reconnaissance Level Characterization and provides an analysis of the risks presented by the project. The RLCR shall also contain sufficient detail including analysis of analytic information to establish the basis for decommissioning activities.

The project points of contact and staff shall use the RLCR to provide input to the preparation of the health and safety analysis, the determination of the engineering support requirements, and the determination of appropriate milestones.

10.4.1.5. Perform physical work of disposition operations

These activities include, for example, excavation, dismantling, demolition and removal of components. After demonstration that the structure/facility meets the established criteria, it shall be demolished or excavated.

The requirements and procedures set out in the ISM plans shall be followed by workers performing decommissioning.

10.4.1.6. Perform and validate final characterization

At the end of the decommissioning, site personnel shall confirm that their activities have achieved the standard required in the completion of disposition for structures/facilities that are demolished such that only environmental restoration activities remain.

After the structure/facility is demolished, the final characterization shall occur. The demolition survey shall be conducted in accordance with the Site's characterization protocols, and shall provide sufficient data to demonstrate that the Site has successfully completed decommissioning in conformance with the set regulation requirements.

The post-demolition survey may result in a loop of activity for Site decommissioning personnel, because if the survey reveals insufficient decommissioning to meet the requirements of the regulations, additional action will have to be taken. Only at such time as the Site project point of contact is satisfied that the post-demolition survey shows that decommissioning is complete, shall the survey be deemed final.

10.4.1.7. Environmental restoration

Environmental Restoration constitutes those activities necessary to characterize, assess and remediate contamination in soils, sediments, surface and ground water from past activities at the site. It may also entail reinstatement and re-vegetation of the site(s) through planting of indigenous trees and shrubs. Re-vegetation shall be carried out to the extent determined by the proposed future use of the sites.

11. Conclusions and recommendations

An environmental and social impact assessment (ESIA) has been carried out for the proposed Matunda and Moi's Bridge Towns' sewerage schemes, and an ESIA Study Report prepared outlining the potential positive and adverse impacts of the proposed schemes.

The sewerage schemes are a positive and necessary intervention because, while the towns have experienced rapid population growth, solid and wastewater management problems have also grown. The study has identified both positive and adverse impacts of the sewerage schemes, and assessed their significance, and presented mitigation measures for the anticipated adverse environmental impacts of the schemes.

Beneficial impacts identified in the assessment included: creation of employment and business opportunities during construction of the schemes, access to improved sanitation through better wastewater handling and disposal, reduction in ground and surface water resource contamination with additional benefits of a reduction in water-borne illnesses, and increase wetland birds diversity around the treatment ponds.

Adverse impacts identified include displacement and/or disturbance of members of the community with potential loss of livelihoods, the potential increase in noise pollution, air pollution, soil and water resources pollution, and increased health and safety hazards during construction phase of the project. The risk of surface water pollution from untreated effluent discharge into the receiving rivers will exist during operations of the schemes, with potential to adversely affect aquatic ecology, and the health of downstream users.

Mitigation measures proposed during construction include implementation of a resettlement action plan for the expected displacement/disturbance to communities, institution of noise management mechanisms on machinery at the site, dust control around construction areas and stockpiles, soil and water pollution prevention through proper management of construction wastewater, storage and use of hazardous chemicals, and implementation of health and safety and traffic management plans.

During project operation, monitoring of treated effluent quality is proposed to ensure that the discharge into Nzoia and Little Nzoia Rivers meets regulatory standards. Other measures include proper handling and disposal of solid wastes and sludge generated from the treatment process, and management of visual impacts of the works (mainly the treatment ponds) through landscaping of sites.

From the foregoing, no adverse environmental impacts are anticipated that cannot be mitigated. An environmental audit is recommended upon the completion of construction works to corroborate the implementation of the proposed mitigation measures. Any unforeseen project impacts shall be identified and addressed through annual environmental audits.

In conclusion, the Consultant proposes that project approval and an Environmental Impact Assessment license be issued by NEMA based on the environmental management measures contained in this ESIA Study Report.

12. References

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Appendix A. Registration Certificates for the EIA Expert and Firm of Experts

Appendix B. Project layout drawings

Appendix C. Public consultation records

Appendix D. Effluent discharge control plan

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