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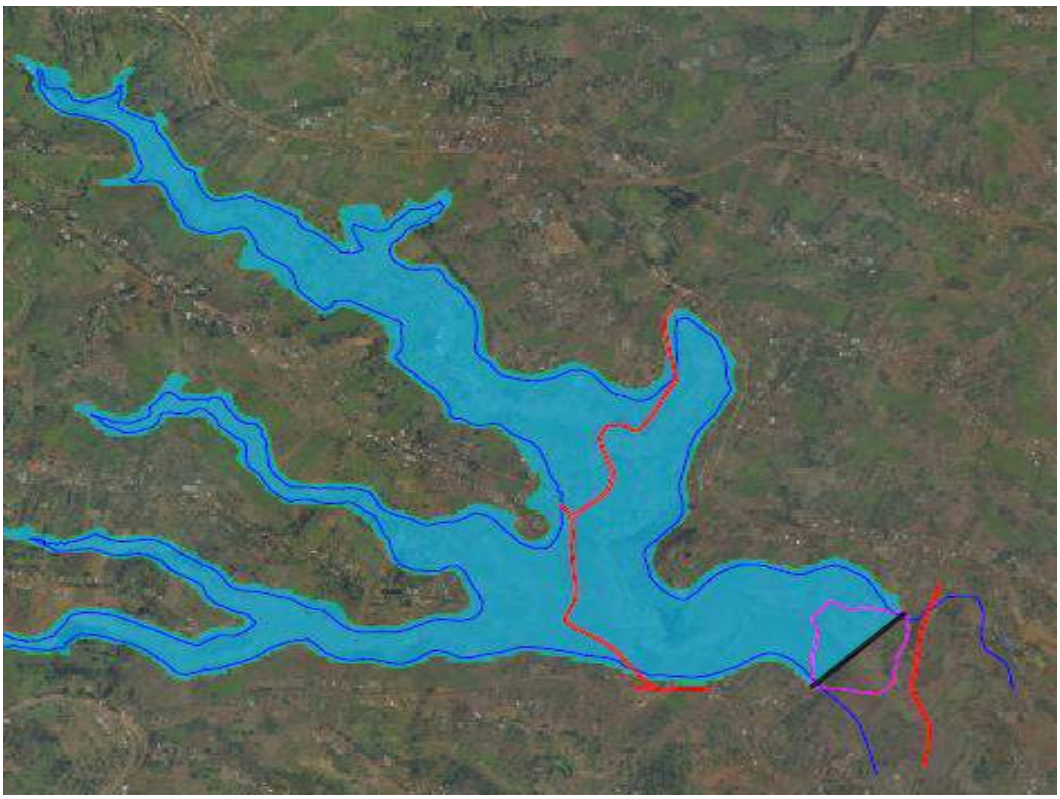
Environmental Impact Assessment (ESIA) (including Cumulative Impact Assessment) and Resettlement Action Plan (RAP) for Proposed Construction of Kariminu II Dam

Contract No.: AWSB/GoK/KR-01/2015



ENVIRONMENTAL AND SOCIAL IMPACT ASSESSMENT

STUDY REPORT

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Report Title: Environmental and Social Impact Assessment (Draft Study Report)

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NON-TECHNICAL SUMMARY

Introduction

Kariminu Dam is proposed to supplement water supply to Ruiru and Juja Satellite within the "Effective Envelope of the Nairobi Water Demand" as envisaged in the October 2011 Master Plan. The dam site is located in Gatundu North District of Kiambu County approximately 75km north of Nairobi city. It is just upstream of the main bridge linking Buchana to Kariko and Gituamba Markets about 6km from Kanyoni market on the Thika – Gituamba road. The dam will be constructed across Kariminu River downstream of its confluence with its tributaries including Gathanje, Kagundu and Githanga. Kariminu dam with an estimated yield of approximately 103,000m^3 /d in the master plan provided the most suitable source that can supply the towns of Ruiru and Juja with an initial surplus to Nairobi. This yield compares well with the confirmed mean annual flow of 100,224m^3/day.

The dam has been designed and constructed to supplement water supply for Ruiru and Juja Satellite Towns as envisaged in the Water Master Plan for Nairobi. The dam inundation area is estimated at 1,350,000m^2 such as to attain a dam height of 40m for a maximum gross storage capacity of 18.9mm^3. It is estimated maximum daily yield of 129,500m^3 (about a discharge of 1,200m^3/sec). The dam size is expected to impart socio-economic impacts such as the potential relocation of people and economic activities as well as potential disruption of the residual residents and land use features along the transmission corridor.

The ESIA Study

The ultimate goal of this ESIA study was to identify impacts resulting from the proposed project to the environment and social setting. The impacts were determined on the basis of the baseline conditions established during the field work and information obtained from the documents reviewed as well as interviews of the stakeholders and the communities within. For subjective predictions of the impacts, the site area` was subjected to environmental scoping process. This was a process of evaluating the overall magnitude of the project and the significance of the anticipated impacts and possibilities of handling the same. Detailed evaluation of the project area was undertaken such as to focus on any significant environmental and social issues as established in the scoping process.

In accordance with the Terms of Reference, the following scope has been defined for this ESIA.

(i) Clear description of the physical location and linkages of the project including the baseline conditions of the project area;
(ii) A description of the project characteristics including project objectives, project design, activities, technology, procedures and processes, materials to be used, Products, by-products and waste generated, during the project construction, operation and de-commissioning phases;
(iii) A description of the national environmental legislative and regulatory framework, baseline information and any other relevant information related to the project;
(iv) Description of the recipient environment (baseline environment and social setting of the project area and the water transmission pipeline corridor),

(v) The potential environmental effect of the project, including the social and cultural effects and the direct, indirect, cumulative, irreversible, short-term and long-term effects anticipated;
(vi) Project alternative analysis including locations, technologies or process available, analysis of alternatives, and reasons for preferring the proposed option;
(vii) An environmental management and monitoring plan outlaying the activities, associated impacts, mitigation measures, monitorable indicators, implementation timeframes, responsibilities, and cost;
(viii) An Action Plan for the prevention and management of foreseeable accidents and hazardous activities in the cause of carrying out activities or major industrial and other development projects:
(ix) Measures to prevent health hazards and to ensure security in the working environment for the employees and for the management of emergencies;
(x) Conclusions, recommendations and identification of gaps and uncertainties which were encountered in compiling the report

This scoping report was designed to provide a preliminary view of the environmental and social status. The report presents the overall project concepts, anticipated magnitude, key stakeholders and the implementation plan outline. It also involved establishment of the diversity on physical environment, climatic conditions, demographic trends as well as the hydro-geological status in the area. Relevant policy and legal requirements were also listed. The study team strived to share experiences on water resources and social issues in that part of the country and in particular with regard to water demand and utilization. The report has provided the basic considerations that could be emphasized on during the detailed and consultation sessions.

The Project Background and Justification

Following acute shortage in water in most parts of the country (Kenya being a water scarcity Country), it has become necessary that alternative mechanisms are developed to harness available sources to supplement the little available. With intensive surface runoff during heavy rains, significant volumes of storm water are lost. Dam construction has been identified as an alternative to harness the storm water for storage and use during the dry conditions. The towns around the City of Nairobi that shares water resources from the Aberdare's catchment are among the worst hit by water scarcity resulting from the increasing demand of rising population and expanding social and economic activities.

Water sources supplying the City (Sasumua dam, Thika dam, Ruiru dam and Kikuyu Springs), all outside the Nairobi area are increasingly under pressure to satisfy the city needs as well as towns local requirements, including the outlying towns of Ruiru, Juja and Thika . The production capacity is related to inadequate ability of the available sources to generate in addition to transmission losses, excessive unaccounted for abstractions along the transmission pipelines, pressure losses and illegal connections as well as other unaccounted for water.

In order to reverse this situation, Athi Water Services Board has proposed to construct additional dams to serve Juja and Ruiru towns that are presently inadequately served from inadequate water supplies from Ndarugu and Ruiru Rivers respectively. This intervention will also enable the surplus water be made available to supply the communities along the pipeline corridor for

enhanced revenue generation for the Water Services Providers and Athi Water Services Board. Kariminu II Dam was among those proposed in the Water Master Plan for Developing New Water Sources for Ruiru and Juja Towns that also covered the analysis of water needs and infrastructure development.

Proposed Project Coverage

Catchment Area

Kariminu River originating from Aberdares will be the main river feeding the proposed dam. Other tributaries include Githanga River, Kiangundu, river and Gathanji River. The Kariminu River sub-catchment forms the western edge of the Tana River drainage basin discharging into Chania River before its confluence with Thika River further downstream in Thiak town. It is bordered on the west by Ndarugu River sub-catchment which is also one of the sub-catchments to the Athi River drainage basin. The site is at an approximate altitude of 1,873 a.s.l. with the catchment area upstream of the proposed dam axis being 105 km^2.

Dam Site and Buffer Areas

The proposed dam site is characterized with ridges and hill with relatively steep cliffs. The project area is primarily under plantations of Tea, Coffee and Pineapples and to a lesser extent subsistence farming of vegetables and tubers like arrowroots along the river banks. The rural residential settlement pattern in the area is in clusters of related family homesteads which are widely scattered and confined within the elevated zones away from the flood plains. According to the water rules, the allowed buffer zone from to a water body is 30 meters which in this case will be under tree cover to restrict encroachment by the residents.

The dam has been designed to a height of 40m high such as to inundate flood plains upstream of Kariminu River and the adjoining tributaries. The flood plains are currently highly cultivated though limited settlements in the lower areas. Due to the steep slopes of the area, a 30m buffer has been allowed to ensure safety of the water as well as the riparian landowners. The setting of the dam allows land acquisition that will cover the highest water mark and the buffer areas. Downstream the dam embankment, it is also proposed that a safety buffer is created. This will involved clearing settlements and other land use activities on a defined area presumed faced with safety risks. This area is also staked out for acquisition.

Service Areas

The area to be served by the proposed Kariminu Dam is mainly to Juja and Ruiru Sub-Counties, specifically Juja and Ruiru towns and the immediate surroundings currently served from Ndarugu and Ruiru rivers respectively through local water treatment facilities. The local community currently water supply to the community neighbouring the project area is from Kariminu River to the resident's access directly or through the existing community water schemes. At the moment, there are no provisions in the design to supply the adjacent areas and the transmission pipeline. However, there are recommendations to provide easy access to the dam water for basic domestic water for the immediate landowners.

Downstream of the Dam

Areas downstream of the proposed Kariminu Dam wall are characterized by riverine farming of tubers and vegetables for subsistence purposes with mixed coffee, tea and food crops (maize, pineapples, vegetables, fruits and fodder) in the general river corridor outside the flood plain.

The flood plain next to the bridge extending downstream is utilized for farming during the dry weather, but flooded during the rainy season. Like the dam area, the residents depend on the river as their main source of water for domestic, livestock and irrigation. The extents to which normal flood flow will be retained at the dam, therefore, have a direct link to the livelihoods downstream.

Water Transmission Pipelines

The area traversed by the treated water transmission pipeline is generally settled and extensively cultivated. Major land use is settlement in rural setting with scattered institutions (schools, churches and colleges). The zone is a transition from the tea growing areas to the coffee growing with notable food crop production (mainly maize and fruit trees). The transmission pipeline is divided into three sections as described below;

(i) A 5.5km stretch linking the water treatment works to the Northern Collector corridor near Kamwangi Market. The pipeline on a 6m wide way leave will run generally along the river basin but away from river banks for safety of the pipeline. It is expected that the water will flow by gravity to the corridor and to Bennett's Ridge Tank. The wayleave will be acquired,

(ii) The current corridor is 18m wide transmitting water from Ngethu to Gigiri and it has been indicated that it cannot accommodate an additional pipeline. The proposed treated water main from Kariminu II Dam will run along the right hand side of the Northern on a 6m way leave upto the junction with the Ruiru – Githunguri Road. The preliminary characteristic of the proposed corridor is defined by the control points presented in the table below;

(iii) There is a ~20km long stretch of the Northern Collector from near Kamwangi Market to Ngewa Junction (on the Ruiru – Githunguri Road crossing) and the link to Bennett's Ridge where the consumer water reservoir will be located. While the stretch along the Northern Collector will require an acquisition of an additional 6m, the pipeline from Ngewa Junction to Bennett's Ridge will run along the road reserves and no additional land will be required. This also applies to the pipelines to Ruiru and Juja that will also run along Nairobi – Thika Highway reserve.

Project Activities

The following activities are envisaged through the project implementation;

(i) Planning and Feasibility Studies
(ii) Design Work
(iii) Construction Phase
- ✓ Resettlement Activities
- ✓ Site Clearing
- ✓ Sanitation Management
- ✓ Public Amenities
- ✓ Material Sourcing and Haulage
- ✓ Restoration Activities

(iv) Dam Commissioning
(v) Dam Operations

Study Findings

During the site visit the following key findings were identified:

(i) The terrain of the proposed site has several ridges and very steep terrain.
(ii) The prevalent vegetation on the ground is mostly plantations of pineapples, tea and coffee though traces of trees and shrubs were noted.
(iii) There are several graves, pit latrines and cattle pens around the dam area and the transmission pipeline routes which should be relocated. Reason for possible relocation will include clearing the highest water mark line and pipeline way leave as well as ensuring reduced risks to water quality from infiltration of pollutants from pit latrines and cattle pens. Graves will be relocated while for the pit latrines and cattle pens will decommissioned and emptied and dumped far from the site avoid any cases of contamination in the future,
(iv) There are power lines traversing the project area serving the settlements and markets. These service lines will require to be relocated accordingly,
(v) The access road branching off at Buchana Catholic church to the left will be closed leading to possible inconveniences to residents leaving beyond that point and and accessibility to Gituamba market, The other road linking Buchana Coffee Factory and Kiriko Market will be relocated to run over the dam embankment wall
(vi) Though the project area is not prone to landslides despite the steep terrain, during construction which would entail mechanical dredging and excavations might to some level trigger sudden movements of the earth,
(vii) The current area next to the Buchana Coffee drying beds will be the location for the water treatment works. The ~4ha. Parcel of land will require to be acquired,
(viii) The water will be transmitted through a pipeline running from the water treatment works and then along the Northern Collector. The Northern Collector corridor measuring 18m may not accommodate another pipeline and hence an additional 6m corridor may need to be acquired,
(ix) Land acquisition will be immense affecting both sides of Kariminu River.
(x) There will be loss of livelihood for farmers who are entirely dependent of cash crop farming.
(xi) The use of agrochemicals in a large scale in the project area in the plantations might lower the quality of the river water due to contamination through percolation and surface runoff of the fertilizers, herbicides and pesticides used.

Potential Impacts and Corrective Measures

Positive outcomes that can be derived from the construction of the dam are as follows;

(i) Once constructed, Kariminu dam will supply water to Juja, Ruiru and parts of Nairobi meeting to some extent a percentage of the merging in the demand for the crucial resource.
(ii) There will be a bigger pool for economic activity through a well established fishing organization which will be fishing in the dam.
(iii) During the dry season the residents will still be able to carry on with farming since water for irrigation will be readily available to utilize.

(iv) To some extent security will be enhanced in the area since several security officers will be deployed in the area to protect the dam and in the long run the security concerns for the residents will be looked into.
(v) During the construction as well as post construction phase a number of the youth will be employed.

Damages to environmental features, human life and properties could arise from the following scenarios;

(i) The dam breaking,
(ii) Accidental drowning of residents and livestock
(iii) Possible contamination in case an impurity is deposited into the dam which can be catastrophic.
(iv) The spillways breaking,
(v) Collapsing of the raised storage tanks,

Environmental Management Plan

Management Plan Principles

The project is geared towards enhancing social and economic benefits through sustainable water supply. Development of the Kariminu dam project would be expected to comply with the environmental conservation requirements in accordance with the established Kenyan laws and regulations. To realize these goals, acceptability by a majority of the stakeholders and minimal effects to the physical environment will require to be ensured through participation in the project and continuous consultations, evaluations and review of the design aspects throughout project implementation cycles. It is also recommended that the environmental management guiding principles specific to this project improvement and water resources management be established to allow integration of environmental management considerations during construction and operations.

Management Responsibilities

In order to implement the management plan, it is recommended that an expert be identified to oversee the environmental and social management aspects including the dam conservation, soil erosion control, re-vegetation whenever appropriate, water conservation and equity in distribution, enhanced sanitation and hygiene measures throughout project area. The expert would also be required to coordinate and monitor environmental management activities during construction and post monitoring audits. Other recommended participants include;

(i) Athi Water Service Board will be responsible for coordination of all the activities and liaisons, particularly in regard to the quality control of the works and social issues.
(ii) Water Service providers, in this case Gatundu Water and Sewerage Company) who have the responsibility to enforce water quality monitoring and efficient maintenance systems, procedures to minimize interruptions to water supply and ensure accessibility by all consumers,
(iii) National Environmental Management authority (NEMA) through the county directors office shall be responsible of surveillance of environmental and social aspects of the project implementation,
(iv) Kariminu Water Community Association Committee

Environmental Management Guidelines

The guidelines will include among other areas environmental management programmes, standard operation procedures, compliance monitoring schedules and environmental audit schedules as required by the law. Social harmony of the dam and associated component will be achieved through the collaborations with the stakeholders or community management committees introduced at various water consumption points

Institutional Framework Management

The National Policy on Water Resources Management and Development and the Water Act 2002 are the guiding tools on water resources management. The policy goal is to facilitate the provision of water in sufficient quantity and quality and within a reasonable distance to meet all competing uses in a sustainable, rational and economical way. It also separates policy formulation, regulation and services provision and defines clear roles for sector actors within a decentralized institutional framework and includes private sector participation and increased community development. The Ministry in-charge of Water is responsible for policy development, sector co-ordination, monitoring and supervision to ensure effective Water and Sewerage Services in the Country, sustainability of Water Resources and development of Water resources for irrigation, commercial, industrial, power generation and other uses.

Institutional integration encourages provision of sustainable development and a healthy environment to all Kenyans. The key functions of NEMA through the NEC include policy direction, setting national goals and objectives and determining policies and priorities for the protection of the environment, promotion of cooperation among public departments, local authorities, private sector, non-governmental organizations and such other organizations engaged in environmental protection programmes and performing such other functions as contained in the act. Other stakeholders include Kiambu County Government, Ministry of Environment, Water and Natural Resources, Ministry of Agriculture and Livestock and Fisheries, The Local Community and Kariminu Cam Committee.

Conclusions and Recommendations

Conclusion	Recommendation
Kariminu dam is generally acceptable by a majority of the local community, most of whom appreciate the value of the dam locally and the target beneficiary towns where a majority also have interests. However part of the community will be affected through displacement of settlements, agricultural land and public amenities.	Concerns of the community, and especially those directly affected should be addressed effectively during the planning and construction as well as operations of the dam facility. Continuous engagement and involvement should be integrated in the project implementation and dam operations,
✓ Commissioning of Kariminu dam will significantly reduce the deficit in water demand for Ruiru and Juja Towns. ✓ Market centers and communities along the water transmission corridors are potential beneficiaries of the water project.	✓ Appropriate management of the new facility will require keen attention from AWSB and Gatundu Water and Sewerage Company ✓ Athi Water Services Board to provide a parallel service water pipeline to provide the communities along the water transmission pipeline,

Conclusion	Recommendation
✓ Land acquisition for the project will be guided by a comprehensive Resettlement Action Plan (RAP) to be developed under the project. The Plan will also provide a clear complaints redress mechanism to ensure fairness and value to the affected landowners. ✓ A majority of the PAPs might be at risk of losing their compensation earnings from lack of knowledge and skills.	✓ A comprehensive Resettlement Action Plan (RAP) should be commissioned. The process should be all inclusive and within the law. Effective complaint redress systems should be integrated. ✓ Compensation for loss of land, settlements and restoration of livelihoods should be realized before the project implementation commences. ✓ Consider training and awareness raising of the PAPs on investment skills for enhanced beneficiates from compensations.
The catchment areas for the dam are increasingly on threat of inappropriate use with vegetation clearing, wrong agricultural practices and increased settlements. This is a potential future risks to the dam storage capacity (siltation) and the quality of the water (pollutant loading).	✓ Initiate intervention measures for sustainable catchment management strategies (if non-exists) in collaboration with the communities and other relevant agencies. ✓ Influence sustainable agricultural practices to reduce discharge of agrochemical residues into the dam, ✓ Integrate a buffer zone around the dam to prevent direct discharge surface runoff and hence pollution control, ✓ Encourage riparian communities to observe appropriate sanitation technologies for the safety of the dam.
The project will also spur socio-economic activities within the project area such as fishing, tourism, controlled irrigation and also boost water supply to the local markets and institutions through appropriate collaborations with AWSB and the Services provider. These activities will consequentially lead to increased employment and other economic opportunities,	✓ Communities are advised to form Water Resources Users Associations (WRUAs) and obtain water abstraction permits from WRMA to draw water and supply for their members and other potential economic opportunities, ✓ The local community should also participate in water resource management planning, this will empower the local people so that they regard the development project as their own and learn ways to protect the water resource,
The dam development will present certain ecological and social challenges by vegetation cover removal (especially the riverine species) and replacement with new species (plants and animals) in the long run,	✓ Prepare Construction Environment Management Plans (CEMP) based on this report to ensure specific ecological issues are address during the construction period. ✓ Ensure well formulated environmental management plans that will support sustainable biodiversity of the dam for future value addition to the communities.

Conclusion	Recommendation
The project will disrupt public amenities include access roads and power lines as well as water pumps and pipelines. It is, however, noted that the project will provide alternative routes for access roads and collaborate with relevant agencies in the relocation of services where required,	Development of alternative access roads and relocation of service lines including power and water shall be integrated into the project implementation.
As a result of the dam construction the downstream impacts will include species migration to upstream areas, dam safety risk and land use changes due to fluctuation in the water regimes along the river basin,	Full dam risk assessment study should be undertaken after the project completion to identify the precautionary measures to be undertaken for the safety of the affected areas,
The dam will also provide a flow balancing effect downstream such that high storm water will not cause excessive flooding of the flood plain during the heavy rains. Effectively, the productivity of the cultivation on the flood plain will not be significantly affected,	Sensitize riparian communities to utilize the opportunity wisely to avoid destruction of Kariminu River flood plain.
It is also noted that the dam will control the level of siltation of Kariminu River and other points downstream through retention of the same. The intermittent release of silt during the scouring flush-out may be less damaging to the river downstream,	Monitor the silt build-up of the dam and develop a scouring schedule in line with the land regimes downstream.
The Treated water rising main will is planned to link to the Northern Collector and onward run along the western edge to Ngewa Junction. From Ngewa Junction, the pipeline is to run along the road reserve to the Bennett's Ridge Reserve Tank Location	The additional pipeline will need to be delineated and necessary land acquisition process undertaken for compensation purposes. The associated RAP studies were undertaken along this ESIA Study.

1.1 Background

The current access to clean water in Kenya is estimated at about 90% in urban areas and approximately 45% in the rural areas while the national average stands at about 60%. At the same time, provision for safe sanitation stands at a national average of 80% (with an estimated 95% in the urban areas and about 77% in the rural). This situation illustrates Kenya as a "chronic water scarce" country created by the limited endowment of water with less than 650m^3 per capita per year. This is projected to further reduce to under 245m^3 per capita per year by the year 2025, far below the internationally recommended minimum of 1,000m^3 per capita/year unless drastic measures are taken. Water resources in the country are increasingly getting degraded from catchment destruction, pollution discharge, over-abstraction and wastage among other challenges. Kenya's Water resources are also highly vulnerable to climate variability often resulting into conditions of floods and severe droughts in equal measures. Inadequate storage capacity in the country limits the ability to buffer the nation against such water shortage shocks.

The main existing infrastructure serving Nairobi City and its Satellites towns were built between 1900 and 1994 and are undersized to insure the actual and future water demand of Nairobi including among others;

(i) Kikuyu Springs
(ii) Ruiru Dam
(iii) Sasumua Dam
(iv) Thika Dam – Mwagu Intake System

Water from the above sources is treated at 3No. Water Treatment Plants namely:

(i) Ngethu Treatment Works with a capacity of 460,000m^3/day (5.3m^3/s)
(ii) Sasumua Treatment Works with a capacity of 63,700m^3/day (0.74m^3/s)
(iii) Kabete Treatment Works with and a capacity of 20,000m^3/day (0.23m^3/s)

The Water Master Plan Study commissioned by Athi Water Services Board in 2011 identified a priority strategy to meet the 2017 water demand for Nairobi and also prepare a master plan for the year 2035 water needs for Nairobi and Satellite towns. The Master Plan identifies the towns of Thika, Kikuyu, Ruiru – Juja, Kiambu, Karuri, Mavoko, Ngong Township and Ongata Rongai as "the Effective Envelope" of Nairobi Water Demand. From this envelope, Thika, Ruiru-Juja, Kiambu and Karuri are some of the towns that the proposed dams in this study are targeting. The findings of the Water Master Plan, therefore, are the main guiding baseline information during the establishment and development of the water supplies to these towns.

Development Strategy for Water Supply to Satellite Towns identified three options to serve the Satellite Towns to meet their water demands up to Year 2035. Three Options were developed as possible strategies for augmenting water supply to the Satellite Towns. These included;

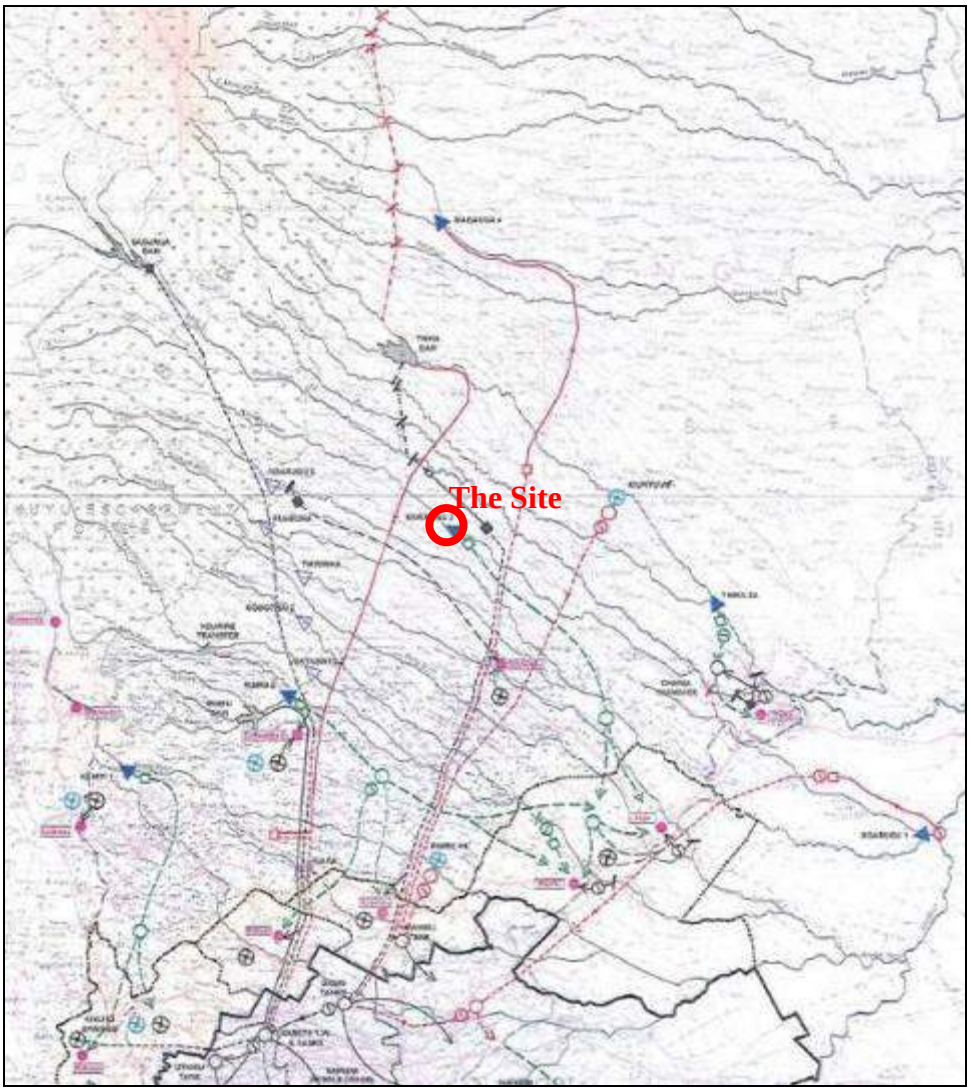
(i) Independent Water Supply Option: Each Satellite Town will have its own independent water supply system. The current status quo will remain for operation and management of the Water Supply Systems for the Satellite Towns.

(ii) Strategic Bulk Water Supply Option: The focus of Water Supply is Nairobi City with off takes for en-route Satellite Towns. Satellite Towns downstream of Nairobi City Water Supply will be supplied through extensions from the Nairobi Water Supply System. A Bulk Water Provider can be appointed under this Option thereby reducing the operation and management costs.

(iii) Mixed Water Supply Option: This is a hybrid of the Independent and Strategic Bulk Supply Option. The Satellite Towns will be supplied from a combination of Independent Water Sources and from the Nairobi City Bulk Water Supply. This Option will be managed partially by a Bulk Water Provider and Independent Service Providers.

Overall the results of the least cost analysis clearly shows that the Mixed supply option is the most favourable. See figure below. The Kariminu II Dam is part of this option.

Figure 1: The Nairobi Water Master Plan



1.2 Justification for Proposed Kariminu Dam

The capacity of water resources in the Aberdare slopes has been declining with time due to a number of factors including catchment degradation from competition of land use requirements and reduced rainfall to recharge the sources as well as increasing water demand for domestic, commercial and also irrigation purposes for the urban and rural users. This situation is overstretching the available water for domestic supply in urban areas including to the City of Nairobi (which is the major consumer of water from the Aberdare catchment) and now being felt in Ruiru, Juja and Thika Towns. The resources require progressive augmentation to meet the present and future water demand.

The towns around the City of Nairobi that shares water resources from the Aberdare's catchment are among the worst hit by water scarcity resulting from the increasing demand of rising population and expanding social and economic activities. Water sources supplying the City (Sasumua dam, Thika dam, Ruiru dam and Kikuyu Springs), all outside the Nairobi area are increasingly under pressure to satisfy the city needs as well as towns local requirements, including the outlying towns of Ruiru, Juja and Thika . The production capacity is related to inadequate ability of the available sources to generate in addition to transmission losses, excessive abstraction along the transmission pipelines, pressure losses and illegal connections as well as other unaccounted for water.

In order to reverse this situation, Athi Water Services Board has proposed to construct additional dams to serve Juja and Ruiru towns that are presently inadequately served from inadequate water supplies from Ndarugu and Ruiru Rivers respectively. This intervention will also enable the surplus water be made available to supply the communities along the pipeline corridor for enhanced revenue generation for the Water Services Providers and Athi Water Services Board. Kariminu II Dam was among those proposed in the Water Master Plan for Developing New Water Sources for Ruiru and Juja Towns that also covered the analysis of water needs and infrastructure development.

1.3 The Project

The project site is located in Gatundu North District of Kiambu County approximately 75km north of Nairobi city. The dam reservoir area is bound by latitudes 9898000 to 9900000 and longitudes 260000 to 263000. The dam location is just upstream of the main bridge linking Buchana to Kariko and Gituamba Markets about 6 km from Kanyoni market on the Thika – Gituamba road. The proposed Kariminu Dam will be constructed across Kariminu River downstream of its confluence with its tributaries including Gathanje, Kagundu and Githanga. Kariminu dam with an estimated yield of approximately 103,000m^3 /d in the master plan provided the most suitable source that can supply the towns of Ruiru and Juja with an initial surplus to Nairobi. This yield compares well with the confirmed mean annual flow of 100,224m^3/day.

The dam is being designed and constructed to supplement water supply for Ruiru and Juja Satellite Towns as envisaged in the Water Master Plan for Nairobi. The dam inundation area is estimated at 1,350,000m^2 such as to attain a dam height of 40m for a maximum gross storage capacity of 18.9mm^3. It is estimated maximum daily yield of 129,500m^3 (about a discharge of 1,200m^3/sec). The dam size is expected to impart socio-economic impacts such as the potential

relocation of people and economic activities as well as potential disruption of the residual residents and land use features along the transmission corridor.

The Water Treatment Facilities are expected to cater for raw water flow of 70,000m3/d (0.81m3/s) with the construction of Kariminu II Dam. It is not possible that the yield of the source will be increased in future, say by raising the dam or diverting other rivers into Kariminu 2 Dam and therefore it might not be necessary to construct the treatment facilities while taking care of future additional capacity. However, adequate space should be provided for the treatment works units and the ancillary facilities required.

The treated water transmission main will convey water from the treatment works site to Gigiri Reservoirs in Nairobi City and to Ruiru-Juja towns. The treated water main will leave the treatment works along a new way leave, south of Kariminu River, to its intersection with the Ngethu way leave close to Kamwangi approximately 5.5km from the new water treatment works.

A new Service Reservoir site will be required to serve Ruiru and Juja towns. The reservoir will play the role of a Break Pressure Tank and will also serve as a Balancing Tank to Ruiru and Juja towns. The Reservoir will need provide at least half-day storage of the total daily treated water inflows. Enroute demands are expected to be served along the pipeline route from the reservoir due to the mushrooming developments within the coffee estates and Thika Highway. The capacity of the pipeline from the reservoir to Ruiru and Juja towns has been increased by 1.5 times to cater for peak demands.

1.4 The ESIA Study

1.4.1 ESIA Terms of Reference

In accordance with the Terms of Reference, the following scope has been defined for this ESIA.

(i) Clear description of the physical location and linkages of the project including the baseline conditions of the project area;
(ii) A description of the project characteristics including project objectives, project design, activities, technology, procedures and processes, materials to be used, Products, by-products and waste generated, during the project construction, operation and de-commissioning phases;
(iii) A description of the national environmental legislative and regulatory framework, baseline information and any other relevant information related to the project;
(iv) Description of the recipient environment (baseline environment and social setting of the project area and the water transmission pipeline corridor),
(v) The potential environmental effect of the project, including the social and cultural effects and the direct, indirect, cumulative, irreversible, short-term and long-term effects anticipated;
(vi) Project alternative analysis including locations, technologies or process available, analysis of alternatives, and reasons for preferring the proposed option;
(vii) An environmental management and monitoring plan outlaying the activities, associated impacts, mitigation measures, monitorable indicators, implementation timeframes, responsibilities, and cost;

(viii) An Action Plan for the prevention and management of foreseeable accidents and hazardous activities in the cause of carrying out activities or major industrial and other development projects:
(ix) Measures to prevent health hazards and to ensure security in the working environment for the employees and for the management of emergencies;
(x) Conclusions, recommendations and identification of gaps and uncertainties which were encountered in compiling the report

1.4.2 ESIA Objectives and Scope of Work

The ESIA report should be in line with the Environmental Impact Assessment and Audit Regulations of June 2003 established under Environmental and Management and Coordination Act (EMCA), 1999. The objective of the study is to carry out an environmental and Social Impact Assessment for Kariminu Dam. This dam should be able to provide the maximum yield in order to supply water to Juja and Ruiru and possibly a section of the local communities and those along the transmission corridor and at the same time be the most economically viable dam at the cited location. In accordance to the ESIA regulations, therefore, the objectives of the study should include the following key issues;

(i) A clear description of the proposed project including its objectives, design concepts, proposed water uses and anticipated environmental and social impacts,
(ii) Description of the baseline conditions in the project areas such as to cover the physical location, environmental setting, social and economic issues,
(iii) A description of the legal, policy and institutional framework within which the proposed dam project will be implemented,
(iv) Description of the project alternatives and selection criteria,
(v) Details of the anticipated impacts to the environment, social and economic aspects of the area covered by the project. This include cumulative impacts associated with other projects in the areas associated with water supplies or abstractions of water from the same sources,
(vi) Appropriate mitigation and/or corrective measures,
(vii) Develop an environmental management plan (EMP) presenting the project activities, potential impacts, mitigation actions, targets and responsibilities, associated costs and monitoring indicators

The scope of the Environmental and Social Impact Assessment (ESIA) was to develop suitable recommendations to be integrated in the project design and implementation for mitigation of anticipated adverse impacts to the environment and social setting the project and service areas. An evaluation of public opinions and stakeholders attitude towards the project was captured through interviews and consultative forums conducted throughout the project area variously during the study period.

1.5 ESIA Approach

This approach was defined to identify impacts resulting from the proposed project to be determined on the basis of the baseline conditions established during the field work and information obtained from the documents reviewed. Detailed evaluation of the project area was undertaken to focus on any significant environmental issues. The communities living within the

proposed dam coverage area were interviewed during consultation and participation process during the detailed study process. Among the tools used included questionnaires, self writing forms, photographs, focus Group Discussions, etc. Overall, the study was undertaken through the stages below;

1.5.1 Scoping Process

This process was designed to provide a preliminary view of the environmental and social status. It involved establishment of the diversity on physical environment, climatic conditions, demographic trends as well as the hydro-geological status in the area. Relevant policy and legal requirements were listed. This enabled determination of project elements that would be emphasized on. Among the aspects identified and that have been discussed in detail under this report included;

Environmental aspects

(i) Submergence of the tributaries including the related ecosystems (vegetation species and habitats for organisms and breeding areas),
(ii) Potential sediment transportation and storage in the dam and immediately upstream,
(iii) Excavation of biomass accumulated over hundreds of years before inundation,
(iv) Water quality effects from pollution point sources on the project inundation area including among others pit latrines, grave sites, livestock pens, settlement and market centres,
(v) Emergence of new species in the area such as to include vectors, wild animals and plant species,
(vi) Effects on micro climatic conditions in the neighbouring areas,

Social and Economic

(i) Land issues with respect to land ownership, land acquisitions, compensations and resettlement of the landowners,
(ii) Social linkages of the dam such as to include public health (HIV/AIDS, Malaria, typhoid, bilharzias, etc.), income generation (employment, business, farming, etc.) and access to water and other social facilities and amenities,
(iii) Cultural linkages including relocation of graves and interference with other cultural sites,
(iv) Economic values of existing natural resources (biomass, sand, soils, stones, etc.),

Hydrology

Hydrology is the main factor considered for a sustainable dam and in this regard, there is a notable emphasis in this regard. The hydrological analysis sought to establish the available water resources in the Kariminu River sub-basin system and evaluated the stream flow trends, rainfall analysis, flow duration curves to ascertain whether the flows are adequate for storage thereof with analysis of the following data;

(i) Daily rainfall data;
(ii) Daily Evaporation data;
(iii) Wind speed and direction;
(iv) Other climatic parameters (humidity, temperature), etc.

The presence of sediments in rivers has its origin in soil erosion, where the erosion is a result of series of complex and interrelated natural processes which would loosen and move away the soil and rock materials under the action of water, wind and other geological factors. The most important factors which influence the erosion from any area are rainfall regime, vegetal cover, soil type, land slope and land use.

Sediment generated in the uplands of the catchment reaches the streams and rivers wherein sediment transport takes place with the flowing water as the carrier. Sediment is transported downstream either as suspended load or as bed load. Gross sediment production is the amount of sediment eroded and removed from the catchment area. The production is generally measured in terms of weight of sediment per unit drainage area per unit time (e.g. tons/km^2/year). With the establishment of a reservoir, sediment deposition occurs due to reduced velocities and turbulence of moving water. The sediment deposition in reservoirs is of considerable economic and practical interest since it reduces the storage capacity of the reservoir. The study has estimated the sediment deposition into the proposed dam development in order to propose the required reservoir storage capacity enough to store all the accumulated sediment deposits without compromising on the useful storage volume.

Ecological Aspects

Ecological setting is also an important factor in dam development and operations in an area. In this connection, a comprehensive review, field analysis, documentation and collation of existing and relevant literature or reports was done to help gain a clear and detailed understanding of the ecological (e.g. climatic conditions etc.) and biological characteristics of the project sites and their environs. The biodiversity endowment (flora and fauna) of the project sites was assessed to document the baseline information of the flora and fauna species that are found in the project sites and their conservation status based on the IUCN Red List. This focused on characterization of the woody species (trees and shrubs), wildlife species, reptiles, amphibians and avian biodiversity assemblages in the proposed project sites.

Other Issues

Additional emphasis was on the following key areas;

(i) Updating the environmental and social baseline conditions in and around Kiambu County and the dam location, water transmission corridor and the user areas,
(ii) Evaluating the land use patterns within the project areas and the larger Kiambu County in general with respect to influence from the dam construction and use thereafter,
(iii) Reviewing the environmental impacts with particular focus on physical environment, social and economic issues as well as natural resources aspects within the project areas,
(iv) Reviewing the social implications of the project to be gathered through structured public participation and interviews of the public officials, community groups, farmers, land owners, public institutions, opinion leaders, etc.,
(v) Reviewing the mitigation measures and an environmental management plan outline,

An Environmental and Social Impact Study Report on the dam project and associated accessories will be developed on the basis of available information and a report will be prepared for submission to the National Environmental Management Authority (NEMA) in accordance to

the legislation. In addition to the physical environmental assessment, the communities (Farmers, business people, landowners, institutional heads, residents, etc.) within the project area will be involved through interviews and consultation forums to give their views and opinions as beneficiaries. Liaison with the local leadership and the administration is expected to facilitate this process while the presence of the Client's representative at this stage would be necessary in order to clarify certain policy issues that may arise during the meetings.

The ultimate goal will be to identify the anticipated impacts resulting from the proposed project that is determined on the basis of the baseline conditions established during the field work and information obtained from the documents reviewed.

1.5.2 Documentary Review

Various relevant documents were reviewed for a clear understanding of the terms of reference, environmental status of the project area and the target river systems, data on demographic trends (for the project area, the beneficiary areas and the adjoining districts), land use practices in the affected areas (either as catchments, dam location or the beneficiary areas), development strategies and plans (local and national) as well as the policy, legal and institutional documents.

1.5.3 Field Assessment

Field assessment was designed to address the physical, social, economic and biological environment as well as the project affected persons (PAPs). Determination of the affected environmental and socio-economic features would not only be felt within the dam area but also in the neighbouring districts (upstream, around the dammed area and downstream). The field work session was, therefore, focused on establishing the anticipated positive and negative impacts in terms of physical and biological environment i.e. (hydrology, climatic patterns and water resources related aspects), social and economic trends, (population trends, settlement trends, economic patterns, cultural setting and linkages, land ownership issues, etc). Other specific objectives of the field study included;

(i) Evaluate the environmental setting around the proposed site. General observations were focused on the topography, land use trends, ground and surface water sources, public amenities, wetlands, settlements, forests, soils, etc. Also to identify climatic and land cover variations along the affected areas,
(ii) Obtain any available information and data from the local public offices including environment, water, lands, education, health and agriculture. Public consultations were also conducted with the stakeholders.
(iii) Evaluate social, economic and cultural settings in the entire project areas
(iv) Undertake comprehensive consultative public participation exercise such as to reach a large section of the project affected persons as well as other stakeholders.

1.5.4 Detailed ESIA Study Activities

This assignment involved a series of activities carried out in liaison with the Client, relevant government departments, local authorities, community groups and other organizations in the area with a view to sharing their experiences and information with respect to environmental resources and social aspects. Effective evaluation of the social baseline status achieved through

interviews (consultative meetings and discussions) and physical inspection of the entire project area. The baseline conditions provided the starting point for the impacts predictions and benchmark for the mitigation measures. Details of the activities have been listed under the terms of reference, but the expected outputs for each activity are outlined in the sub-sections below;

(i) Review of the proposed dam project details to understand project magnitude and the overall implementation plan by the client.
(ii) Establishment of the current baseline conditions to provide a documented foundation for the impact predictions and a benchmark for the development of mitigation measures
(iii) Update of the legislative and regulatory requirements as a basis for drawing a compliance monitoring protocol for the construction and commissioning phases.
(iv) Environmental and social impacts assessments significant impacts to the environment and the nearby communities. Types and levels of impacts as well as criteria for developing suitable mitigation measures and an environmental management plan.
(v) Environmental management plan on mitigation measures, responsibilities, timeframes, environmental costs and an environmental management plan.

1.6 RAP Study Approach

1.6.1 Principle

Resettlement Action Plan (RAP) is gradually being introduced in projects in Kenya to ensure appropriate due diligence in the relocation of people and economic features from project target areas. It involves overlaying the project layout on the target land to confirm the social and economic features affected by the project. A census of the affected person and an inventory of their assets and livelihoods are compiled and the related costs quantified for appropriate compensation through established policies. Any project with the potential to displace up to 200 PAPs undergoes an Abbreviated RAP while where over 200 PAPs are to be involved. A full RAP will be undertaken for Kariminu II Dam Project.

Involuntary resettlement is an integral part of the overall project formulation and needs to be dealt with from the earliest stages of the project. This would help to explore alternatives and minimize the un-necessary displacement of population. In principle, development partners emphasizes that where displacement is unavoidable, the project should assist with all means to improve the former living standards, income generating capacities, production levels or at least maintain the previous standards of living of those displaced. This requires a thorough understanding of social, economic and cultural conditions of the area and its people and the factors, which influence the lives of those affected. This can only be achieved through detailed socio-economic survey among the project affected persons (PAPs). Such a survey becomes the basis for propositions of measures to mitigate the impacts on the PAPs which would be included in a Resettlement Action Plan (RAP).

1.6.2 RAP Objective

The basic objective of the entire exercise is to carry out a Socio-Economic Survey (SES) among PAPs falling within the project area so as to collect information and generate data which are

necessary for preparation of an appropriate RAP report. The activities below will be undertaken,

(i) PAPs identification and asset inventory to establish all affected parcel owners and quantifiable developments on the land,
(ii) Rapid PAPs Census will be an enumeration of the nature and status of affected people in regard to households compositions, leadership, livelihoods, health aspects, housing and other socio-economic factors,
(iii) Consultations with PAPs to explain the project and seek their opinions and suggestions on how the resettlements should be undertaken,
(iv) Compensation Assessments will be undertaken to estimate values and entitlements to the land owners as the preliminary stages of the compensation process,
(v) RAP Implementation schedules will be a tool to ensure order and known timeframes desired for the compensation of the PAPs,
(vi) Complaints redress mechanism will be a tool to moderate extreme differences in terms of valuation, compensation factors and impacts generated by the project.

1.6.3 RAP Scope

Resettlement Action Resettlement report will detail the existing land ownership, household setting, livelihoods and physical developments as they will be at the cut-off date. The report will present a detailed inventory of the project affected persons (PAPs) and a schedule of land acquisition and displacements alongside appropriate compensation factors including relocation destinations. Opinions and views of the PAPs will be presented from consultation forums held during the RAP process such as to inform key concerns for consideration in the implementation process. Other issues to be covered will include RAP implementation plan and monitoring guidelines for adoption. Specifically, the report will address the following;

(i) RAP guiding principles
(ii) RAP activities
(iii) Cost estimates
(iv) Institutional arrangements for the RAP implementation
(v) Project impact on human settlements including historical and cultural sites
(vi) RAP Implementation schedule
(vii) Internal and external monitoring and evaluation mechanisms
(viii) Development of Grievance Redress Mechanism

At this stage, the affected community seems to be agitating for land-for-land form of compensation despite the potential challenges involved including land availability. An intensive discussion including intervention by the Client in this particular regard will be considered. A resettlement statement would also be prepared to provide an outline of necessary indications towards land acquisition and compensation as a basis for a detailed resettlement action plan.

1.7 Public Consultations

Stakeholders, Public and PAPs Consultations were undertaken simultaneously such as to comprehensively address all social, economic and cultural aspects of the project including the land acquisition and compensation aspects. The process of these public consultations involved identification of the affected communities, informing the provincial administration from the

Assistant County Commissioner and the area Chief and Assistant Chiefs as well as the Community Welfare awareness creation and mobilization of communities. Public consultation meetings, chaired by the provincial administrations, were then held at the dam site and target beneficiary sites.

1.8 Reporting

The reports (inception, draft ESIA Study Report and final ESIA Study Report) were done at pre-agreed timeframes such as to cover the requirements of the National Environmental Management Authority (NEMA) guidelines. Besides continuous briefings to the Client and local NEMA office also undertaken.

RAP studies and reporting was undertaken as a standalone exercise but alongside this ESIA study. However, a comprehensive chapter has been integrated into the ESIA report to address the associated social impacts and mitigation measures.

1.9 Study Experts

This study was carried out by the following experts;

(i) Lead EIA Expert and Team Leader
(ii) Sociologist
(iii) Support Environmentalists
(iv) Ecologist
(v) Hydrologist
(vi) Dam Engineer
(vii) Water Engineer
(viii) RAP Expert
(ix) Surveyor
(x) Field Data Collection Support staff

2.1 Project History

A Water Master Plan study was commissioned by Athi Water Services Board in 2011 to assess and identify a priority strategy to meet the 2017 water demand for Nairobi and also prepare a master plan for the year 2035 water needs for Nairobi and Satellite towns including Juja and Ruiru urban areas. Juja and Ruiru (supplied from Ndarugu and Ruiru Rivers respectively) have the demand rising. To augment the supply and the two towns, Kariminu II dam has been proposed for development.

Kariminu Dam is located in Gatundu North Sub-County, Kiambu County across Kanyoni and Gathaiti locations of Mang'u and Chania Divisions. The selected Kariminu Dam site is located near Kiriko Township stretching upto slightly beyond Gituamba Market in Gatundu North district in the Central region of Kenya and 75km North of Nairobi. The dam reservoir area is bound by latitudes 9898000 to 9900000 and longitudes 260000 to 263000. Other components of the dam including the Water Treatment Works, the treated water transmission pipeline, the treated water storage tank and the water distribution pipelines are briefly described in the following sections.

2.2 Project Components Location

2.2.1 The Dam

The proposed Kariminu Dam is located in Kiambu County (Gitwamba ward, Gatundu North Sub-County, Mangu Division Gathaite Location). Among the villages in the neighbourhood include Buchana, Kiriko, Gathanji and Kanyoni. The dam locally referred to as Buchana Dam, will be constructed across Kariminu River downstream of the confluence with Gathanje, Kiangundu and Gitanga Rivers and traverses two administration areas namely Gituamba Sub-location, Kiriko Sub-location each overseen by a Chief. The dam is proposed to supplement water supply to Ruiru-Juja Satellite within the "Effective Envelope of the Nairobi Water Demand" as envisaged in the October 2011 Master Plan prepared by Mangat, I. B. Patel in association with Egis BCEOM Consortium.

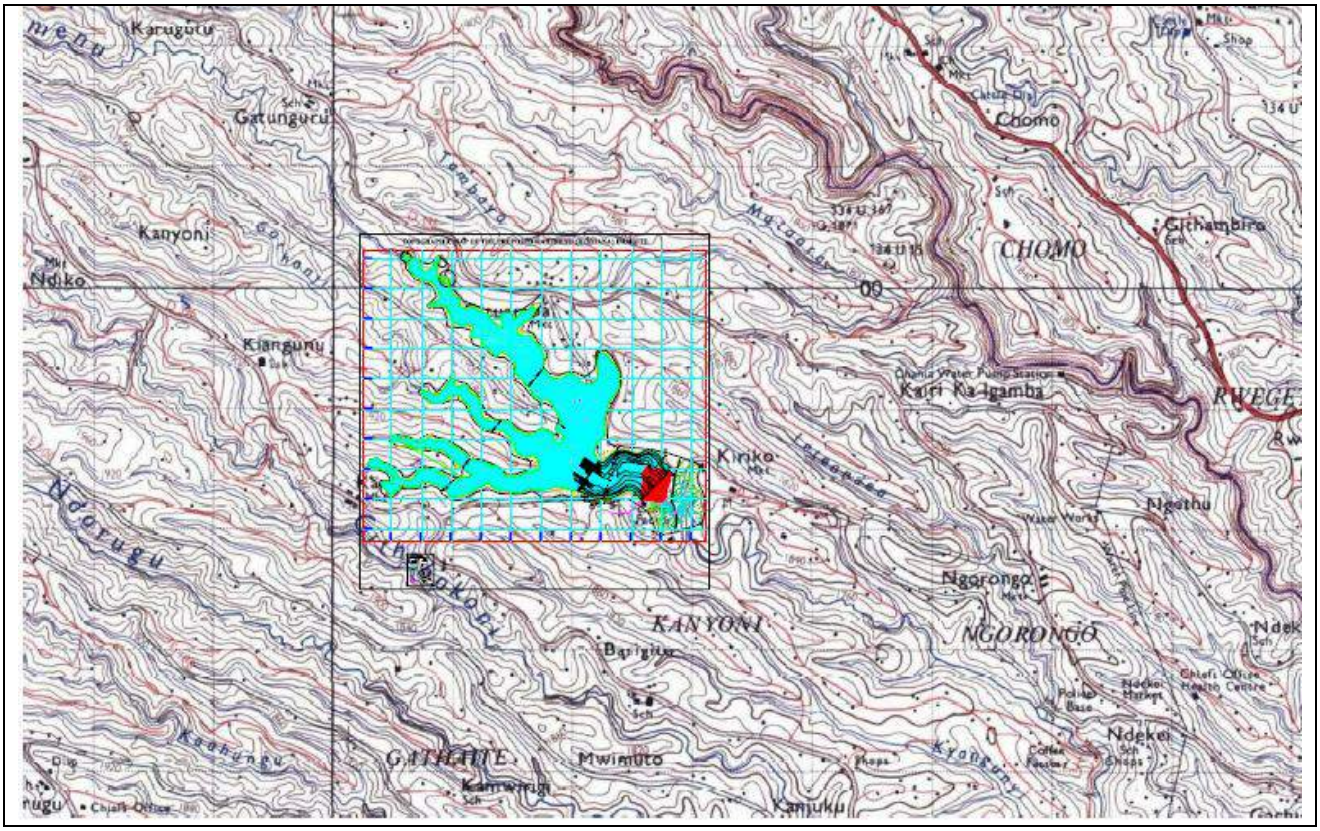
The proposed Kariminu dam site in the Master Plan is the subject of this Feasibility Study Report. The dam options to be considered range within the parameters of 36 to 46m height, highest gross storage of 10 – 19Mm^3, estimated maximum daily yield of 103,680m^3 and the topographic survey results confirm these preliminary expectations. The nominal impoundment has been determined to be 8.5Mm^3 with optimum guaranteed yield of 46,000m^3 per day, to justify the investments and meet the demand of the of target areas as determined in the Master Plan to year 2035.

The following are the preliminary parameters for the proposed dam reservoir envisaged to be 40m high (actual land requirement being reported through the RAP process);

(i) The maximum area to be submerged is135×10^{4}m^2, equivalent to ~135ha.
(ii) The maximum storage above the lowest river bed level is 18.9×10^{6}m^3 (~19Mm^3)
(iii) The useful storage above the lowest outlet level is 14 ×10^{6}m^3 (14Mm^3)
(iv) The dead storage – 1.0×10^{6}m^3 (at elevation 1,825m a.s.l.)

(v) The length of the reservoir of 3.5km (distance to the tail end)
(vi) The catchment area contributing runoff to Kariminu reservoir is 105km^2
(vii) The longest distant point of the catchment from the dam site is 40km
(viii) The average fall of the main watercourse is 2%

Figure 2: Kariminu Dam General Location Map



2.2.2 Water Treatment Works

The Treatment works has been located approximately 700m downstream of the dam wall along Kariminu river basin to the South of dam at approximately geo-reference 0° 55' 27.93"S and 36° 52' 13.01"E. It is on the lower side of the river to avoid a river crossing. The raw water main has been kept short to minimize operational problems caused by suspended solids or internal sliming. In addition, the location of the treatment works represents a break in pressure along the pipeline and therefore it has been located as close as possible to the dam site. The works are anticipated to occupy a total surface area of 2ha. though 4ha. will be allowed to accommodate support services including an office, caretaker and operators houses, security, back-up generators, sludge drying beds, waste handling facilities, sanitation facilities and other accessories necessary for operations as well as future expansion. The facility will also be provided with access road and power supply without compromising on the quality.

2.2.3 Water Transmission Pipeline

Transmission of the water will pass through 3 main stages namely;

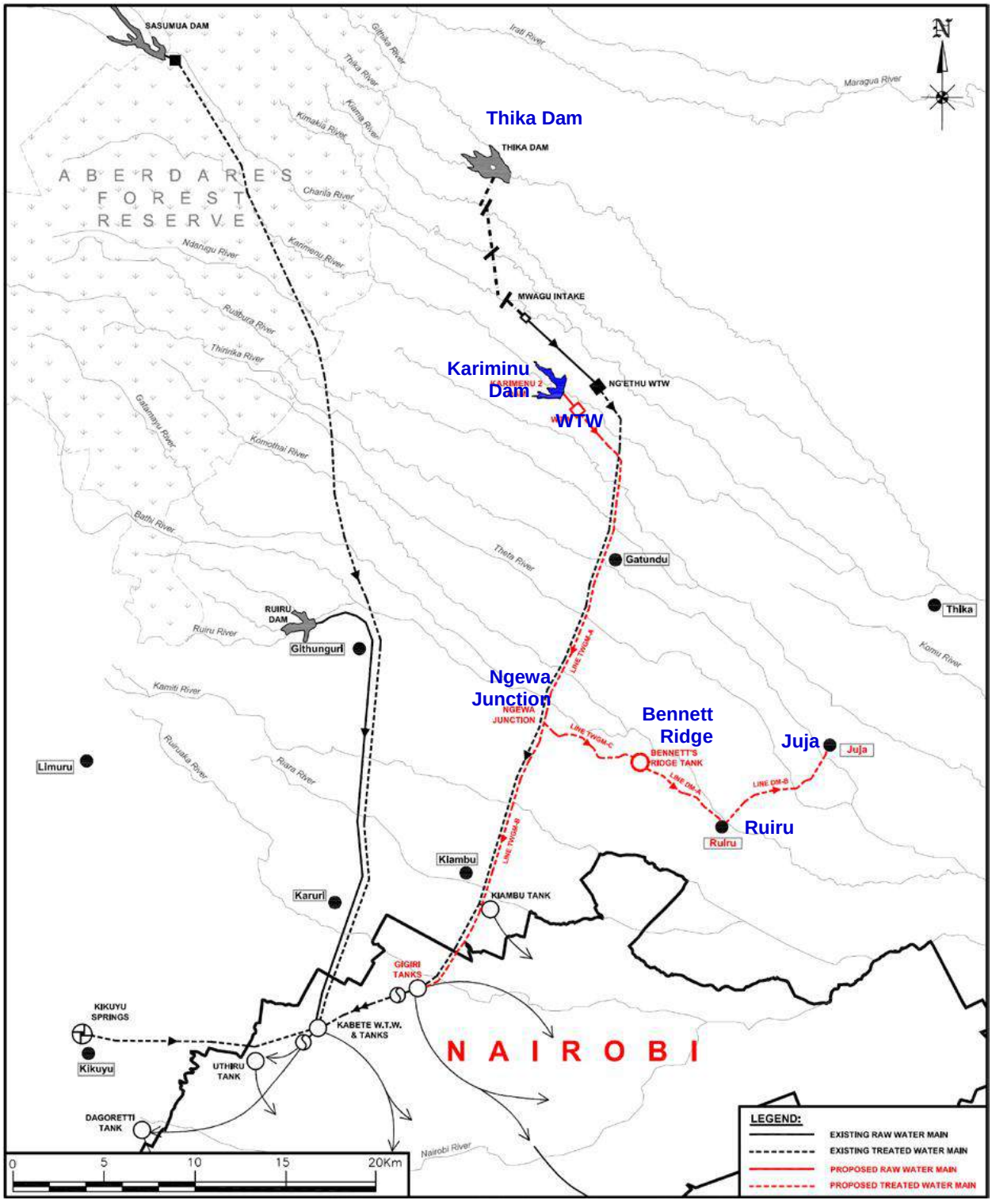
(i) A 700m long raw water main from the dam to the water treatment works
(ii) A 5.5km long link pipeline between the water treatment works and the main Nairobi Line (also referred to as the Northern Collector).
(iii) The section running on the western edge parallel to the Northern Collector upto Ruiru – Githunguri road junction near Ngewa market
(iv) Link to the location of the treated water reservoir
(v) Delivery pipelines sections to Ruiru and Juja towns where the water is intended to benefit.

Treated water will be dispatched from the treatment works through a 5.5km long treated water rising main pipeline on a 6m wide way leave to link with the Northern Collector corridor near Kamwangi Market . It will then run for ~15km alongside the Northern Collector to the Ngewa Junction on Ruiru – Githunguri Road at 1° 5' 48.78"S and 36° 52' 8.97"E near Ngewa Market. The pipeline will branch close to Ngewa Market just before crossing the road to Bennett Place where the storage tank will be constructed. The pipeline branching at Ngewa will gravitate water to a new reservoir next to Bennett's Ridge Road (Jacaranda) located at 1° 6' 42.23"S and 36° 54' 43.07"E approximately 6.5km from the Ngewa junction. From the reservoir the pipeline will run along the road to Ruiru town and then proceeding to Juja town along the Nairobi – Thika Highways reserve subject to topographical challenges.

2.2.4 Treated Water Storage Tanks

A new Service Reservoir site will be required to serve Ruiru and Juja towns. The reservoir will play the role of a Break Pressure Tank and will also serve as a Balancing Tank to Ruiru and Juja towns. The Reservoir will need provide at least half-day storage of the total daily treated water inflows. Pipeline transit demands are expected to be served along the pipeline route from the reservoir due to the mushrooming social and economic developments within the coffee estates and Thika Highway. The capacity of the pipeline from the reservoir to Ruiru and Juja towns has been increased by 1.5 times to cater for peak demands.

Figure 3: The Proposed Water Transmission Corridor Outline



2.3 The Proponent and Key Stakeholders

The proposed Kariminu II Dam development project will be constructed by Athi Water Services Board through World Bank frequency. Other stakeholders who will have a role to play during the construction and post constructions stages through the various obligations they have in enhancing sustainable development include the following

(i) Water Resources Management Authority,
(ii) Kenya Forest Service,
(iii) Ministry of Agriculture, Livestock and Fisheries,
(iv) Ministry of Water and Irrigation,
(v) Gatundu Water and Sewerage Company (Dam under their jurisdiction),
(vi) Ruiru – Juja Water and Sewerage Company (RUJWASCO),
(vii) Nairobi City Water and Sewerage Company,
(viii) Ministry of Health,
(ix) County Government of Kiambu
(x) Affected Communities incl. institutions

2.4 Project Area Description

2.4.1 Catchment Area Upstream of the Dam

Kariminu River originating from Aberdares will be the main river feeding the proposed dam. Other tributaries include Githanga River, Kiangundu, river and Gathanji River. The Kariminu River sub-catchment forms the western edge of the Tana River drainage basin discharging into Chania River before its confluence with Thika River further downstream in Thiak town. It is bordered on the west by Ndarugu River sub-catchment which is also one of the sub-catchments to the Athi River drainage basin. The site is at an approximate altitude of 1,873m a.s.l. with the catchment area upstream of the proposed dam axis being 105 km^2.

2.4.2 Dam Site and Buffer Areas

The proposed dam site is characterized with ridges and hill with relatively steep cliffs. The project area is primarily under plantations of Tea, Coffee and Pineapples and to a lesser extent subsistence farming of vegetables and tubers like arrowroots along the river banks. The rural residential settlement pattern in the area is in clusters of related family homesteads which are widely scattered and confined within the elevated zones away from the flood plains. According to the water rules, the allowed buffer zone from to a water body is 30 meters which in this case will be under tree cover to restrict encroachment by the residents.

The dam has been designed to a height of 40m high such as to inundate flood plains upstream of Kariminu River and the adjoining tributaries. The flood plains are currently highly cultivated though limited settlements in the lower areas. Due to the steep slopes of the area, a 30m buffer has been allowed to ensure safety of the water as well as the riparian landowners. The setting of the dam allows land acquisition that will cover the highest water mark and the buffer areas.

Downstream the dam embankment, it is also proposed that a safety buffer is created. This will involved clearing settlements and other land use activities on a defined area presumed faced with safety risks. This area is also staked out for acquisition.

Figure 4: Views of the Dam Coverage Area

Part of the valley Bottom

The Escarpment Horizons

Typical Settlements

Figure 5: General Impression of the Dam Coverage

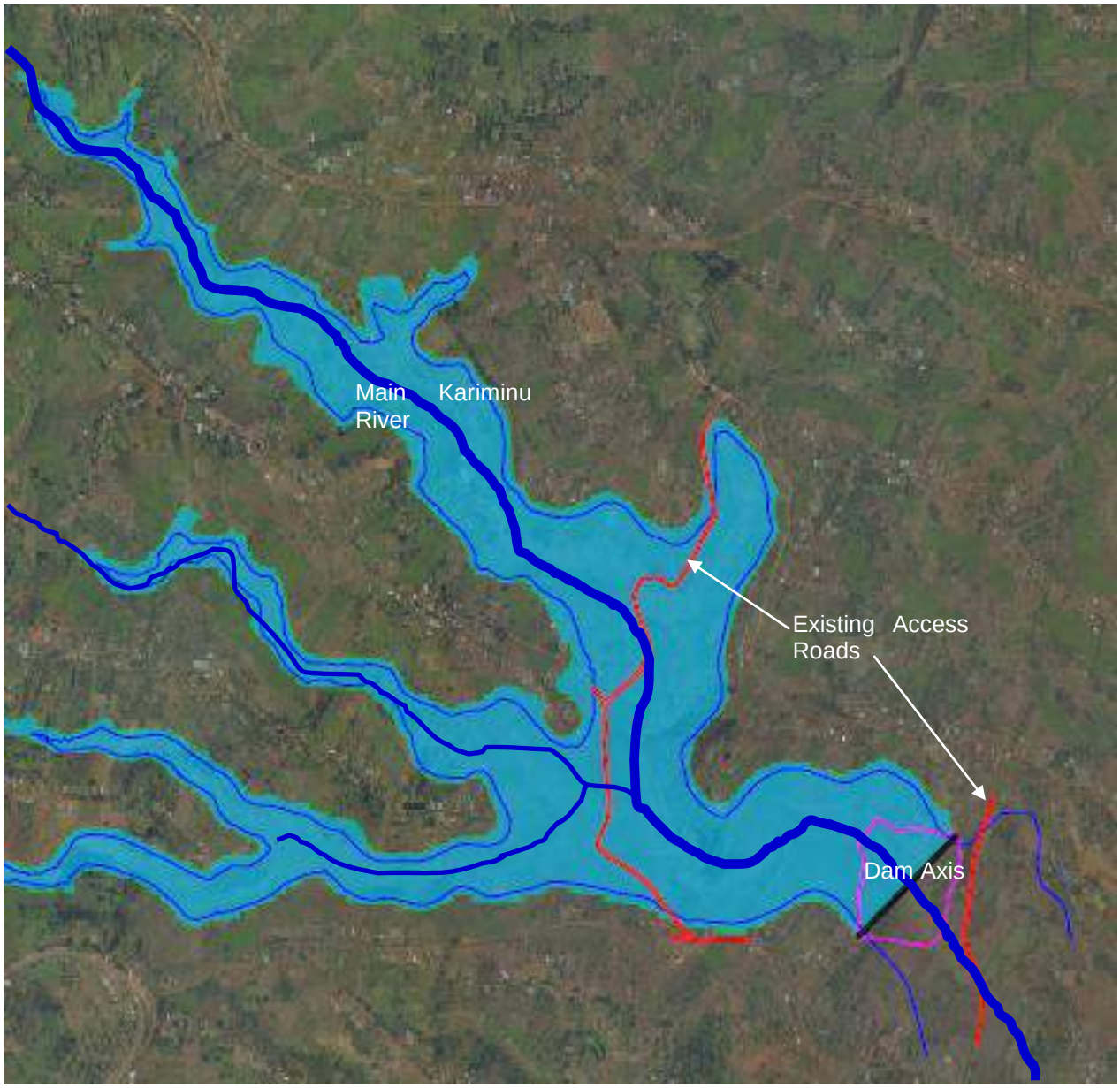
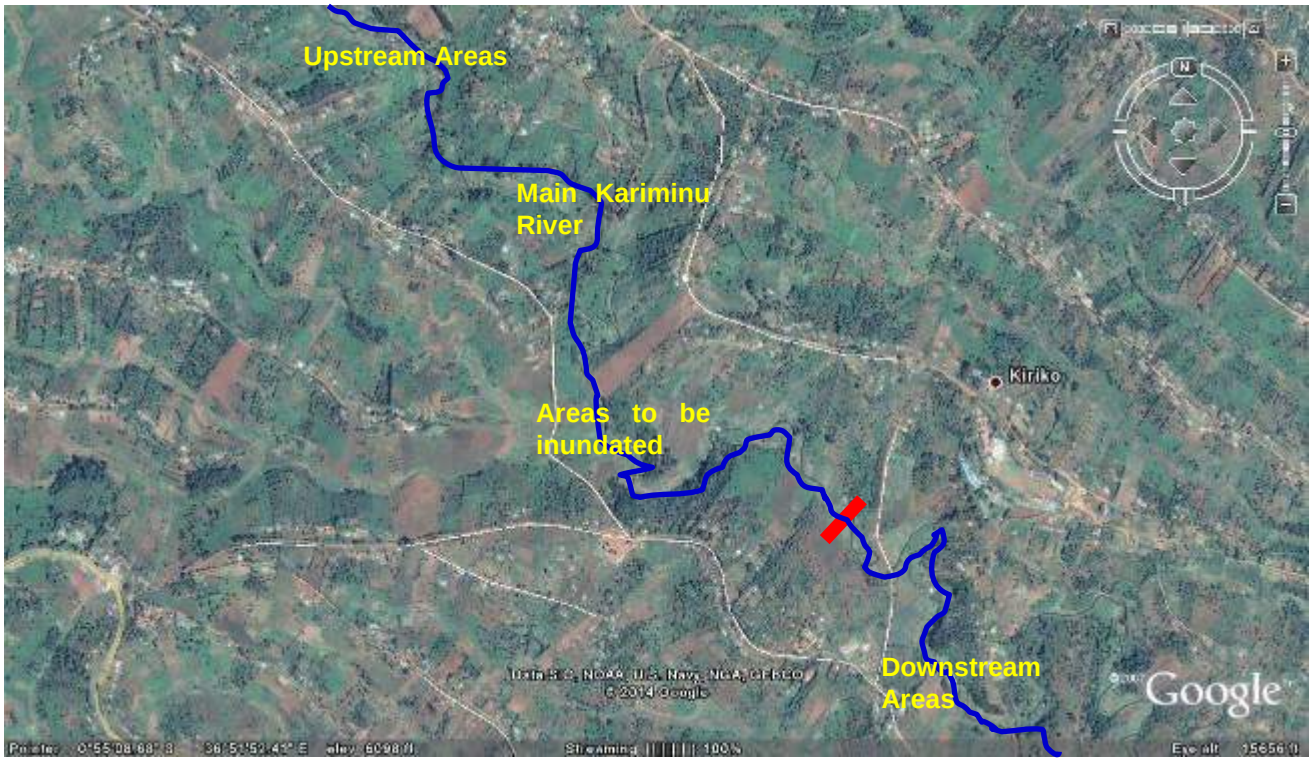
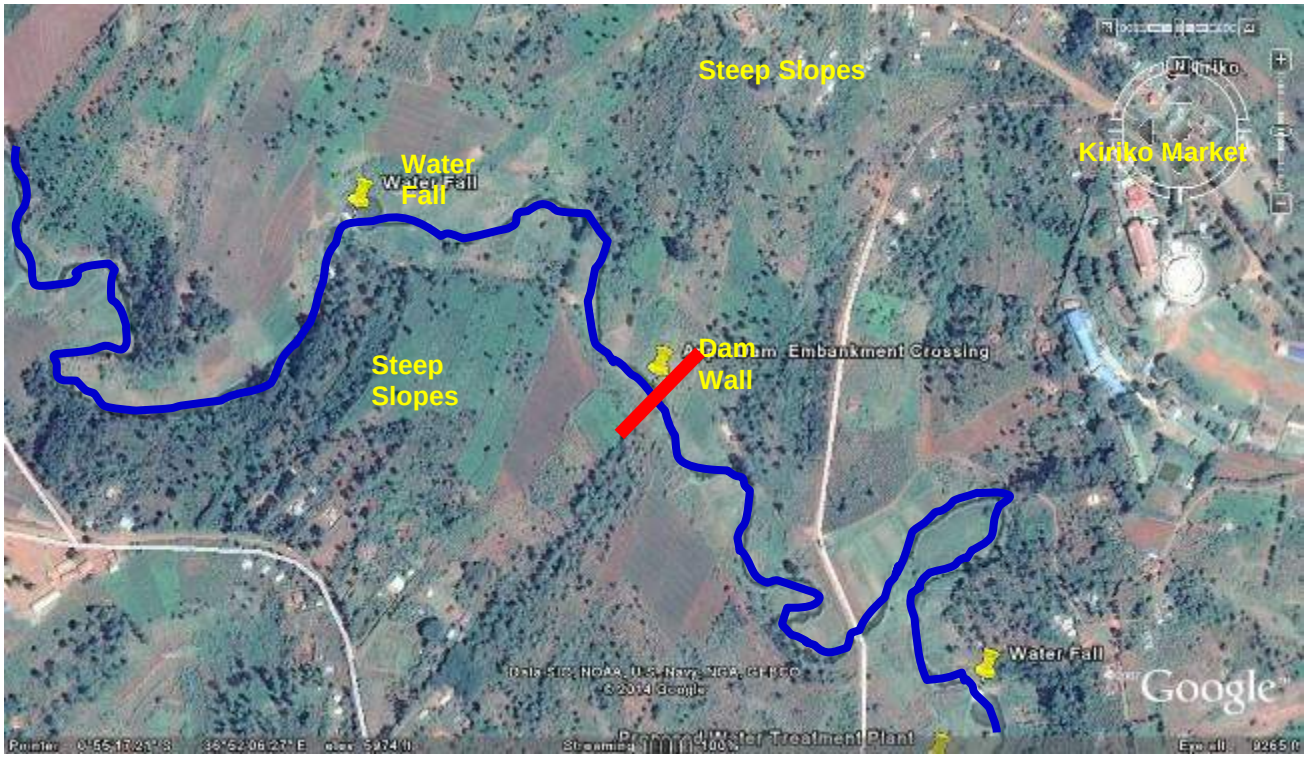


Figure 6: Aerial Image of Dam Location Features





2.4.3 Area to be Served and the Adjoining Land

The area to be served by the proposed Kariminu II dam is mainly to Juja and Ruiru sub-districts, specifically Juja and Ruiru towns and the immediate surroundings currently served from Ndarugu and Ruiru rivers respectively through local water treatment facilities. The local

community currently water supply to the community neighbouring the project area is from Kariminu River to the resident's access directly or through the existing community water schemes. At the moment, there are no provisions in the design to supply the adjacent areas and the transmission pipeline. However, there are recommendations to provide easy access to the dam water for basic domestic water for the immediate landowners.

2.4.4 Downstream of the Dam

Areas downstream of the proposed Kariminu dam wall are characterized by riverine farming of tubers and vegetables for subsistence purposes with mixed coffee, tea and food crops (maize, pineapples, vegetables, fruits and fodder) in the general river corridor outside the flood plain. The flood plain next to the bridge extending downstream is utilized for farming during the dry weather, but flooded during the rainy season.

There are 3 water pumps, owned by Kariko Community, Kariko Coffee Factory and Kariko Secondary School respectively on an area immediately downstream the dam wall proposed for installation of the water treatment plant. Like the dam area, the residents depend on the river as their main source of water for domestic, livestock and irrigation. The extents to which normal flood flow will be retained at the dam, therefore, have a direct link to the livelihoods downstream.

The water treatment works are also located with the immediate downstream area of the dam embankment (~700m). Sitting on approximately 4ha. of land, the works will be linked to the dam off-take through a direct gravity raw water pipeline running along the flood plain of the river. It is noteworthy that land required for the works may not fit within the flood plain and hence land acquisition beyond will be necessary.

Figure 7: Water Treatment Works Location (Downstream the Dam)

2.4.5 Water Transmission Corridor

The area traversed by the treated water transmission pipeline is generally settled and extensively cultivated. Major land use is settlement in rural setting with scattered institutions (schools, churches and colleges). The zone is a transition from the tea growing areas to the coffee growing with notable food crop production (mainly maize and fruit trees). The

transmission pipeline is divided into three sections as described below;

(iv) A 5.5km stretch linking the water treatment works to the Northern Collector corridor near Kamwangi Market. The pipeline on a 6m wide way leave will run generally along the river basin but away from river banks for safety. It is expected that the water will flow by gravity to the corridor but wholly on private land to be acquired,

(v) The current corridor is 18m wide transmitting water from Ngethu to Gigiri and it has been indicated that it cannot accommodate an additional pipeline. The proposed treated water main from Kariminu II Dam will run along the right hand side of the Northern on a 6m way leave upto the junction with the Ruiru – Githunguri Road. The preliminary characteristic of the proposed corridor is defined by the control points presented in the table below;

(vi) There is a 6.5km long stretch linking the Northern Collector to Bennett's Ridge where the consumer water reservoirs will be located. The pipeline will run along the road reserve and no additional land will be required. This also applies to the pipelines to Ruiru and Juja that will also run along road reserves.

Table 1: Control Points for the Extension on the Northern Corridor

Beacon Name	Northing (m)	Easting (m)	Elevation(m)	Approximate Location
P5	9894326.410	266672.947	1769.569	Near Kamwangi market
P6	9893420.383	266550.686	1768.269	At the gate of Bright star academy Kamwangi
P7	9892231.017	266598.049	1744.104	
P8	9891087.805	266486.635	1726.668	
P9	9890297.915	266409.515	1724.042	Near Ituru primary school
P10	9889032.468	266256.630	1671.882	
P11	9888444.262	266136.223	1702.469	Near KPLC offices Gatundu town
P12	9887573.986	265792.878	1702.661	
P13	9886573.954	265438.354	1695.976	
P14	9885485.057	265154.652	1690.388	Near Ng'enda hospital
P15	9884701.281	264824.093	1691.775	Near Nembu trading center
P16	9883867.754	264530.798	1684.276	Near Nembu trading center
P17	9883085.285	264274.201	1684.787	
P18	9882195.546	263958.413	1661.708	
P19	9881531.876	263597.269	1667.166	
P20	9880740.449	263173.413	1677.111	
P21	9880052.799	262999.693	1676.619	
P22	9878995.197	262774.661	1672.602	Near Kwamaiko town center

Figure 8: Sections of the Treated Water Transmission Pipeline Corridors

Proposed Pipeline Section from T/Works to the Northern Collector

Sections of the Northern Collector Corridor

2.5 Analysis of Project Alternatives

2.5.1 Dam Site Selection Criteria

(i) A site where the width of the river is narrow but rapidly widening upstream.
(ii) A site where water can flow under gravity from the reservoir to treatment works.
(iii) A site, which would not interfere with arable land, highways, railways and costly estates or towns.
(iv) A site whose bed soil does not contain solute minerals which may affect the quality of water.
(v) A site where construction materials for the embankment are available nearby is an added advantage.
(vi) The topography at site should be favorable for locations of spillway and intake pipes.
(vii) The average annual flow should be higher than the average annual water demand.
(viii) The rate of flow in the stream during dry season is more than the water demand.

2.5.2 Site Selection

A reconnaissance was carried out of the area. The general topography and geology of the area was observed. Some hydrological data was collected. Approach to the site, communication, and availability of construction materials were judged as far as practicable without going much into the details. Topographical maps of scales 1:10,000 and 1:2,500 for preliminary investigations were produced. Preliminary investigations were carried out in order to have the following information:

(i) Report on the overall geological structure and history of the area, with general geological plan and section indicating location of faults, barriers and river courses.
(ii) The effect of impounding reservoir within the catchment areas
(iii) Determination of public utilities, which the project might affect, such as roads, buildings, historical sites and pipelines
(iv) Comparison of different dam sites

The essence of preliminary investigation is to examine as many as possible different dam sites. For this project, three sites were compared as follows:

(i) Option 1: At Easting 262955 and 9897963 Northing 250m down of the existing water fall off the Buchana – Kiriko market road. The dam axis is proposed to be perpendicular to the Buchana Coffee Factory drying beds.
(ii) Option 2: At Easting 262650 and 9898375 Northing about 600m upstream of bridge on road to Kiriko market off the Thika – Kamae road
(iii) Option 3: At Easting 262130 and 9898452 Northing 1,400m upstream of bridge on road to Kiriko market off the Thika – Kamae road

Table 2: Options Comparative Scheme

	Description	Option Axis 1	Option Axis 2
a)	Area of catchment (km^2)	105	105
b)	Length of dam in (m)	336	305
c)	Dam Height (m)	46	23
d)	Mean annual rainfall (1920 -2005)	1420	1420
e)	Estimated Volume of Embankment	1.477×10^6	950×10^3
f)	Longest distance of catchment from the proposed dam site in (km)	52	48
g)	Surface area of the reservoir (m^2)	1.35×10^6	1.10×10^6
h)	Volume of reservoir (m^3) at Pmf	18.9×10^6	11.2×10^6
i)	Estimated Cost (Kes)	10,041335,975	8,818,803,475

Source: Feasibility Report

2.5.3 Selected Option

Option 1 was dismissed because of the following reasons;

(i) The left ridge opposite the coffee drying beds is low and it will be impossible to achieve a 40m high dam hence reducing the reservoir capacity
(ii) The water fall will be submerged raising environmental concerns
(iii) To achieve a 40m high dam, more earthworks will be required making it less cost effective.

Options 2 and 3 were further analyzed based the maximum possible dam height at the chosen sites. The two sites are ideal for development of impounding reservoirs. However, the dam option axis 1 site was chosen because:

(i) The site topography allows storage efficiency of 12.8 for the dam on axis 1 and 11.8 for dam axis 2
(ii) Geology of the site is appropriate for an earth fill dam with borrow pits located within the reservoir
(iii) Storage capacity is eight million more than dam axis 1.

From the above, the recommended site for Kariminu Dam development is option axis 1 for a 40m high dam and the recommended type of the dam is a clay core earth fill dam. This is because materials for this type of dam are easily available in the vicinity of the project. From experience materials for rock fill dam are not easily available in this part of the country.

2.5.4 Transmission Pipeline

The raw water mains will be determined by the orientation of the dam with respect to the location of the water treatment works. This, therefore, is not a critical option issue in this regard. However, the link treated water rising main to the Northern Collector Corridor will be designed such as to run on the river valley to enhance gravity flow to the Northern Collector. However, the way-leave has to be acquired in full irrespective of how far it is from the river banks arising from the land tenure system in Kenya. It will also avoid immediate crossing of the Northern Collector until at the Ngewa Junction where it crosses to link with Bennett Ridge tank location. There are no conflicting alternatives in this regard.

2.6 Design Concepts

2.6.1 Basic Consideration

The basic principle of design was to produce a satisfactory, functional structure at a minimum total cost. Consideration was given to maintenance requirements so that savings achieved in the initial cost of construction do not result in excessive maintenance costs. Maintenance costs vary with the provisions of upstream and downstream slope protection, drainage features, and the type of appurtenant structures and mechanical equipment. To achieve minimum cost, the dam was designed for maximum use of the most economical materials available, including materials excavated for its foundations and for appurtenant structures.

A dam must be safe and stable during all phases of the construction and the operation of the reservoir. To accomplish this, the following design criterion was met:

(i) The embankment, foundation, abutments, and reservoir rim must be stable and must not develop unacceptable deformations under all loading conditions brought about by construction of the embankment, reservoir operation, and earthquake.
(ii) Seepage flow through the embankment, foundation, abutments, and reservoir rim must be controlled to prevent excessive uplift pressures, piping, instability, sloughing, and removal of material by erosion of material into cracks, joints, or cavities. The

amount of water lost through seepage must be controlled so that it does not interfere with planned project functions.

(iii) The reservoir rim must be stable under all operating conditions to prevent the triggering of a landslide into the reservoir that could cause a large wave to overtop the dam.

(iv) The embankment must be safe against overtopping or encroachment of freeboard during occurrence of the IDF (inflow design flood), (Probable Maximum Flood, PMF) by the provision of sufficient spillway and outlet works capacity.

2.6.2 Dam Location and Components

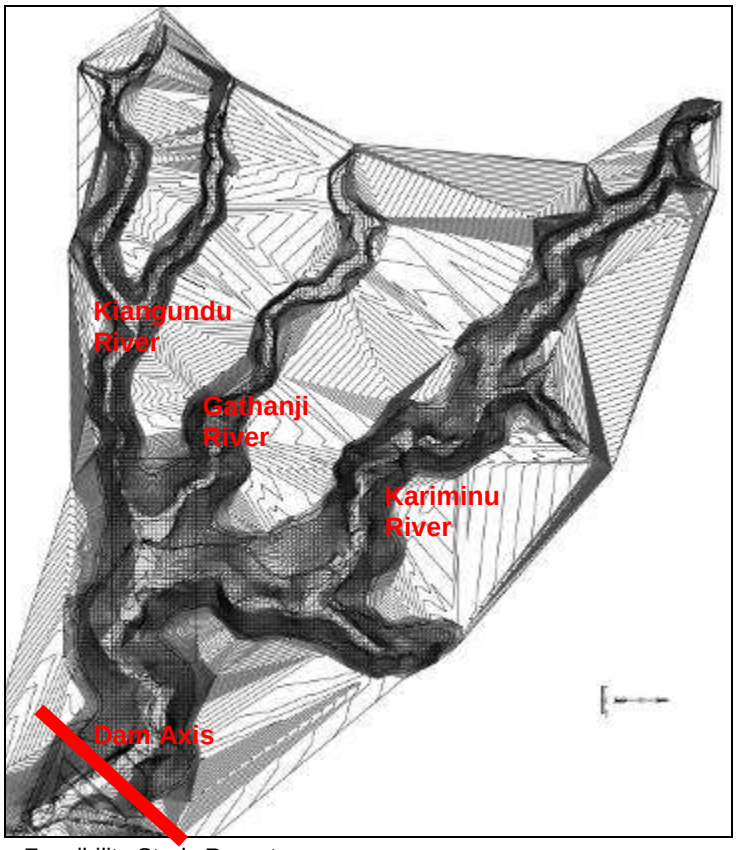
The Embankments

The embankment will have a slope of 1:2.5 on the upstream side. There will be a 15 m high cofferdam near the dam heel with a 4 m crest/bench. The downstream slope will be 1:3 with a berm at 1,835m a.s.l. The core top will be 1,858m a.s.l. and 10m wide. The core slopes at 1:0.5 giving a bottom width of 49 m that will be excavated to 7m depth. On either side of the core are 2.4 m thick filters. The downstream filter extends along the embankment bottom all the way up to the dam toe where there will be a toe drain.

A toe drain will be provided on the downstream side of the dam. Its materials can be developed from the rock deposits within the potential cuts or potential borrow areas. Rip- rap erosion protection is required. A source of rip-rap will be identified within the site and therefore rip-rap will be from the reservoir area or very near the reservoir area. It is also recommended that additional rip-rap material be sourced in the vicinity of the dam site because more quantities of coarse boulders that could serve as rip-rap will be needed. It will be necessary to provide a grout curtain under the core trench depending on results obtained from the drilling and permeability testing. The purpose of this grout curtain would primarily be to address the potential for seepage through fractured zones oriented roughly parallel to the valley wall along with zones oriented roughly parallel to bedding if any.

Depending on the effectiveness of the seepage cut-off efforts, it may also be necessary to install drainage tunnels below the spillway structure and within the left abutment upstream of the diversion channel excavation. An estimate of the cost of these tunnels has been included in the overall estimate developed for this study, however, the actual location and configuration of these tunnels should be determined during subsequent stages of the design.

Figure 9: Location of the Embankment Wall



Source: Feasibility Study Report

The Diversion Culverts

The diversion culvert is required to pass diversion flow during construction, to regulate flood flows, to empty reservoir in case of emergency, to allow for reservoir lowering for inspection and repairs and to allow for routine de-sludging of reservoir bottom. The approach channel will be aligned straight to the diversion culvert to allow equal distribution of flow though it and in a way to avoid excavation, thus lowering the cost.

The diversion culvert will be 373m long and mostly straight in alignment with a gentle bend at about 115 m from the downstream end. An adequate slope for drainage will be ensured. At win rectangular cross-section for the culvert with a top semi - circular dome will be adopted. One of the culverts will be blocked at the upstream side of the tower to form a dry culvert where the supply pipe size dn 1,200 mm will pass and will also be the access to the intake tower. The second culvert will be closed at the tower and incorporate a gate to control the release of some of the flood waters through it and flushing of the bottom of the reservoir during flooding period. The control gate chamber for this second culvert will be located at the tower. The control valve for the supply pipe will be located at the downstream end of the first culvert to enable dewatering of the conduit for inspection purposes.

A cut and cover construction in concrete will be preferred to a tunnel cutting for ease of construction and topographical considerations which would otherwise require a much longer tunnel. The culvert will be placed on the rock bed to the right of the river channel facing downstream. The proposed diversion culvert will be twin culverts square in cross-section of

2x4m wide x 4m high with a semi-circular dome on top. The walling will be reinforced concrete of 1.0 m thickness to resist the heavy embankment loads as per preliminary design.

The Spillway

A spillway is a structure used to provide the controlled release of flows from a dam or levee into a downstream area, typically being the river that was dammed. Spillways may also be known as overflow channels. Spillways release floods so that the water does not overtop and damage or even destroy the dam. Except during flood periods, water does not normally flow over a spillway. Floodgates and fuse plugs may be designed into spillways to regulate water flow and dam height. Other uses of the term "spillway" include bypasses of dams or outlets of a channels used during high-water, and outlet channels carved through natural dams such as moraines.

Off-Take Tower

The off-take structure will serve the following purposes:

(i) Water inlet into the supply system
(ii) Block debris and fish
(iii) Provide multilevel weirs for temperature control
(iv) Provide temporary diversion openings
(v) Provide bulkheads for closure
(vi) Provide control gates and measurement devices

An off-take tower structure is preferred to a central control shaft. The of-take tower has a long downstream conduit thus higher frictional losses and lower possibilities of cavitation. With gates at the upstream end of the diversion culvert for the tower, danger from leakage into or out of the abutment is reduced and it is possible to dewater the culvert for inspection.

The central shaft has the advantage of protection from freezing and thawing, but these ice action forces are not expected in this region. A central shaft does not require a bridge for access; however the tower can be accessed via the tunnel or a surface boat.

The of-take tower will be a 46 m high free standing circular tower in concrete. A free standing structure will allow flexibility in locating on site. It is easier to construct and allows better arrangement of conduits, openings, access structures and instruments as opposed to an inclined tower. The circular shape is to take advantage of its superior hydraulic characteristics. The internal diameter will be 10 m with a wall thickness of 1.0 m at the bottom.

2.6.3 Water Treatment Works

The proposed water treatment process comprises of the following:

(i) Cascade Aeration
(ii) Pre-chlorination
(iii) Dosing with Sodium Carbonate (Soda Ash), to adjust the pH
(iv) Dosing with aluminium sulphate (alum), as coagulant aid,
(v) Dosing with Polyelectrolyte, as coagulant aid (when necessary)
(vi) Clarification

(vii) Rapid Gravity Filtration
(viii) Disinfection with Chlorine
(ix) Dosing with Sodium Carbonate (Soda Ash), to adjust the pH for corrosion control

Sludge Treatment and Disposal process comprises of the following

(i) Sludge Drying Beds to receive Sludge from Clarifiers
(ii) Backwash Water Lagoons, a good Environmental Practice to recycle backwash water from the filters.

The following Structures and Building are required according to the treatment process outlined above:

(i) Inlet Works Comprising of:
- ✓ Overflow
- ✓ Cascade Aerator
- ✓ Chlorine, Sodium Carbonate and Alum Dosing Points
- ✓ Flow Measurement

(ii) Flash Mixer
(iii) Distribution Chamber to Clarifiers
(iv) Centrifloc Type Clarifiers
(v) Rapid Gravity Sand Filters
(vi) Treated Water Tank
(vii) Chemicals and Plant Buildings comprising of:
- ✓ Chemical Mixing and Dosing Building
- ✓ Pump Room and Air Blower Room
- ✓ Gas Chlorination Building
- ✓ Chemical Storage Building
- ✓ Administration Building
- ✓ Workshop and Staff Room
- ✓ Generator and Switch Room

(viii) Sludge Disposal and Treatment Facilities comprising of:
- ✓ Backwash Water Lagoons
- ✓ Sludge Drying Beds

(ix) Staff Houses and Retail Shops

2.6.4 Water Transmission Pipeline and Reservoirs

Item	Pipeline Specifications		
1.	Kariminu 2 Dam to Water Treatment Works		
	Location	Kariminu Dam	Treatment Works
	Approximate Ground Elevation	1,820 masl	1,800 masl
	Approximate Hydraulic Elevation	1,820 masl (Bottom Draw=off)	1,810 masl
	Approximate Distance	5.5km	
	Design Capacity	70,000m^3/d	
	Pipeline Diameter	800 mm	
	Norminal Pressure Rating	10 bar	

Item	Pipeline Specifications		
2.	Water Treatment Works to Ngewa Junction		
	Location	Treatment Works	Ngewa Junction
	Approximate Ground Elevation	1,785 masl	1,675 masl
	Approximate Hydraulic Elevation	1,785 masl	1,735 masl
	Approximate Distance	19.6 Km	
	Design Capacity	70,000 m3/d	
	Pipeline Diameter	800 mm	
	Norminal Pressure Rating	16 bar	
3.	Ngewa Junction to Bennett's Ridge Reservoir		
	Location	Ngewa Junction	Bennett's Ridge Reservoir
	Approximate Ground Elevation	1,675 masl	1,580 masl
	Approximate Hydraulic Elevation	1735 masl	1,640 masl
	Approximate Distance	6.5 Km	
	Design Capacity	47,000 m3/d	
	Pipeline Diameter	600 mm	
	Norminal Pressure Rating	16 bar	
4.	Bennett's Ridge Reservoir to Ruiru Town		
	Location	Bennett's Ridge Reservoir	Ruiru Town
	Approximate Ground Elevation	1,580 masl	1,530 masl
	Approximate Hydraulic Elevation	1,580 masl	1,550 masl
	Approximate Distance	6.5 Km	
	Design Capacity	(47,000 m3/d x1.5) peak demand	
	Pipeline Diameter	800 mm	
	Norminal Pressure Rating	10 bar	
5.	Ruiru Town to Juja Town		
	Location	Ruiru Town	Juja Town
	Approximate Ground Elevation	1,530 masl	1,520 masl
	Approximate Hydraulic Elevation	1,550 masl	1,530 masl
	Approximate Distance	9.0 Km	
	Design Capacity	(12,000 m3/d x1.5) peak demand	
	Pipeline Diameter	600 mm	
	Norminal Pressure Rating	10 bar	

2.6.5 Water Use Options

Water Supply

The Kariminu II Dam source (optimum yield of 103,000m^3 per day) is expected to supply Ruiru with ultimate demand (Year 2035) of 114,198m^3 per day and Juja with 38,066m^3 per day respectively. The Kariminu II Dam source is expected to be supplemented by Gatamaiyu dam (optimum yield of 47,124m^3 per day). The Master Plan proposes that the bulk supplies from each of the sources will be combined for strategic reasons before distribution to each of the two water demand centers.

Although the design of the water treatment plant is outside the scope of the assignment, it is assumed that the design of the treatment plant will consider the optimum yield throughput from the dam of103, 000m^3 per day and the basis of sizing of the intake structures.

Irrigation

The dam is being developed to supply domestic water and not for irrigation purposes. However, the local communities may directly abstract for limited irrigation if issued with appropriate permits. Piped water will not be used for irrigation.

Other Benefits

The local residents expect they would benefit from the dam project. Some of the benefits expected include;

(i) Create source of employment during and after construction of the project to the local community hence improvement of living standards,
(ii) Provision of local water supply,
(iii) Introduction and commercialization of fishing activities for economic gain as alternative for other income generating activities like tea farming, coffee farming and pineapple farming which may be affected by the dam.

2.7 Project Activities

2.7.1 Planning and Feasibility Studies

The project justification has been described under this report; following the need confirmation the project went through feasibility study process to determine its sustainability capacity to meet the demand and compatibility with land use and social features. This ESIA is part of this process and establish areas of environmental and social conflicts and appropriate mitigation measures.

2.7.2 Design Work

Design work entailed significant ground activities; this includes reconnaissance survey, topographical survey, geotechnical investigation (identification of the geological setting, seismic risk assessment, geophysical survey, identification of the soil technical parameters) and studies of the hydrology of Kariminu II Dam. The activities involve partial clearing of vegetation in some sections, intrusion into private lands and excavations in some parts to determine geological profiles among others. Interactions with the local communities for first hand information particularly with respect to special physical features, land ownership and desired design considerations was also undertaken during this stage.

The rest of the work was carried out at the desk levels such as to include design calculations and drawings, consultations between various stakeholders and the client, design reporting and development of detailed quantities and project costs estimates. The financial and economic analysis as well as studies to undertaken risk assessments was also carried out as part of the design work. Implementation schedules and responsibilities are also prepared under this stage. Environment and social impact assessment study utilized the design outputs, in determining quantified impacts and appropriate preventive action plans. The environmental management plan is guided by the details in the design principles.

2.7.3 Construction Phase

During the construction phase of a dam there are several significant features to be observed they include;

Resettlement Activities

There will only be limited displacement of households though with notable land take from the dam area. This follows the fact that residents prefer settling on the elevated grounds while undertaking heavy cultivation on the lower zones. The area is characterized with semi-permanent and permanent homesteads on family owned land parcels. The process of land acquisition and appropriate compensation is ongoing and appropriate compensation will be undertaken before the project commences.

The water treatment works requires ~4ha. This land will be acquired about 700m downstream the dam embankment wall. In addition the works will be accessed by a dedicated road running from the main public road. Alongside the treatment works, the 5.5km link treated water rising main to the Northern Collector will also be acquired whose width measures 6m wide leading to ~3.3ha. The area is habited with settlements and agricultural activities and hence, like the dam area, appropriate compensation of livelihoods will be necessary before construction commences.

Site Clearing

Vegetation clearing of the area covered to pave way for campsites establishment, parking yards for the contractors machineries and the construction site of for the proposed dam. In the proposed location the predominant vegetation is plantations of tea, coffee and pineapples. There are also a significant number of trees mainly Eucalyptus ssp., Graveria, wattle tree as well as fruit trees and a large of volume of ground covering shrubs and grasses. A record of the biomass removed, and particularly the trees will have to be kept to facilitate environmental compensation in addition to the monetary payments to the land owners.

In addition to the clearance of vegetation, there site clearance will generate huge volumes of top soil rich in organic and humic content for disposal. This materials management may be used for reclamation of wastelands or other safe disposal mechanism.

Sanitation Management

It is suspected that there are graves and pit toilets in some parts of the areas targeted for inundation. These features will not be buried under the water due to water quality as well as cultural reasons. For this reason, any graves and pit latrines will be decommissioned and removed under supervision in collaboration with the landowners, local leaders and the security agents.

Public Amenities

Disruption of access roads, power lines and water abstraction points are likely to be disrupted during the construction process. The project will be responsible of services relocation, provision for alternative amenities (access roads, bridges/crossings), public water access points (water pumps, transmission pipelines and public abstraction points). This will be undertaken in collaboration with the relevant services providers and authorities.

Material Sourcing and Haulage

It is expected that materials will be obtained from within such as to include gravel and hard stone quarries. Ideally, the entire earth fill should be drawn from within the reservoir area and, if required, from the cut spillway area. Therefore borrow areas within the reservoir area should be given first preference, followed by those located on the valley sides close to the proposed embankment. Borrow pits in the reservoir have the added advantage of increasing the upstream storage capacity. Results indicate that adequate suitable borrow material of low permeability and non-dispersive can be obtained from the reservoir area. The required borrow material for the embankment is 1.477Mm^3. Based on an excavation depth of 3m, usable borrow area of 900,000m^2 will be enough for the earth fill embankment. Rock material for riprap will be obtained in Thika, a distance of 37km from the site. However, appropriate approvals would be required for materials extraction.

Restoration Activities

Upon completion of the project, it will be necessary to restore all sections damaged by the construction activities including surface destruction, access roads, river banks and downstream flood plains. Other areas to be restored include material sources and spoil disposal areas. The dam surroundings will also require landscaping through re-vegetation for aesthetic purposes as well as conservation of the environment.

2.7.1 Commissioning

This will be the formal hand-over and operationalization of the dam upon completion. Among other activities, the contractor and the client will ensure there are no unresolved social concerns, the facility has been completed to the design details, affected sites have been well rehabilitated and that all components are operational. In addition to the paper work, there will be a physical evaluation of the facility that will involve the contractor, AWSB, relevant Government departments and the design consultant. The inspection of the dam will ensure all the issues of dam safety are adequately considered and all the structures are operationally ready and approved to function as planned.

2.7.2 Dam Operations

The very initial stage of the dam operation will be to ensure it is relieving water from the catchment through the rivers and runoff during the rains. This could take up to one year during which there will be strict management of flows in the river to ensure dependants and ecosystems downstream are sustained. Upon the dam filling, the water will be utilized in accordance to established guidelines and regulations agreeable to the Water Act and other regulatory authorities

2.8 Key Dam Linkages

Dam construction and operation have notable local implications to the environmental and social settings of the host areas. These linkages are to be analyzed through this ESIA process as well as the RAP study process and other associated socio-economic studies. Among the key linkages include the following;

(i) Land-take is perhaps the one linkage with the highest social impacts especially to the

affected land owners and the immediate surrounding communities. The linkage has potential for displacement of people and their livelihoods as well as loss of agricultural crops. A standalone RAP study is to provide details in this regard,

(ii) Loss of vegetation land covers including agricultural crops, tree cover and under cover (shrubs and grass). This will have effects on local climatic conditions as well as climate change aspects at the global levels. Retention of flood flow, however, is a mitigation measure for flush-flooding downstream associated with climate change scenarios,

(iii) Water quality of Kariminu River and tributaries downstream could get affected temporarily during the construction period. This will arise from earth moving and fills and also the construction of the dam embankment wall,

(iv) Presence of the dam will change the general life of the community in respect to access to water, safety risks, potential water related health issues and security consciousness, especially on terrorism and criminal acts targeting public water,

2.9 Dam Safety and Stability

From the resistivity survey carried out at Kariminu dam site, the following conclusions are made:-

(i) The resistance variation in the area is related to the geology of the subsurface, revealing the stratigraphic layering and the rock characteristics in terms of weathering. It should however be noted that the shading does not indicate that the formations shaded is homogeneous, but it comprises intercalated lava flows with the same range of resistivity values.

(ii) On the hillsides the slightly weathered or un-weathered rock is relatively shallow, being less than 10m deep. However, within the valley the un-weathered rock is relatively deep, being more than 20m.

(iii) No structural discontinuities have been positively identified in the profiles.

(iv) From the results of trial pits and the associated soil tests;

- ✓ The regolith is thick enough to provide sufficient borrow material for the embankment.
- ✓ The percentage of fines for the soils is suitable for constructing a homogeneous embankment and obtains a reasonable compacted density.
- ✓ The permeability of the soil material at the site is sufficiently impermeable.

The following recommendations for further investigations have been made from the preliminary study done at the Dam site:-

(i) Drilling of exploratory holes is highly recommended to compare the geophysical results and results of actual drilling. About 6 boreholes, four along the dam axis (two on either side of the river) and two upstream preferably at the location of the low resistivity sections to give a clear picture of the subsurface. This will indicate the depth of the solid rock

(ii) Drilling should be done to a depth of about 30m on the hillsides and up to 50m within the valley where the un-weathered rock is relatively deep. This will be accompanied by sampling and appropriate logging.

(iii) Standard penetration tests (SPT) on the soils should be done on site during the core drilling. This will indicate the level of stiffness of the soil and estimate the shear strength.

(iv) Permeability tests should also be carried out during the drilling to determine the rock permeability levels with depth. This will indicate the seepage characteristics of the underlying rock.

(v) Rock samples will be tested for petrology, porosity, density, uni-axial compression and point load tests. This will indicate the ultimate and the allowable bearing capacity.

2.10 Decommissioning Phase

While it is not envisaged that the dam will be decommissioned any time soon, the need may arise in future. Should this arise, a decommissioning audit of the dam and its components will need to be undertaken at least 12 months prior to the exercise and approved by NEMA. The decommissioning audit will generate a Decommissioning Plan to guide the process. The same process will be applied for the decommissioning of lesser components including;

(i) Construction camp sites and installations upon completion of the construction works,

(ii) Removal or reconstruction of key dam features including the spillway, water transmission pipelines, water treatment plant, etc.,

2.11 Implementation Schedule and Project Estimated Cost

The project is expected to take 3 years (36 months) of construction works from the date of commencement. The duration of the transmission is yet to be determined. This period, however, is dependent on the completion of preliminary activities including land acquisition and contract mobilization.

Cost Estimate of the dam is **KES 6,058,180,000. (KENYA SHILLINGS SIX BILLION, FIFTY EIGHT MILLION ONE HUNDRED EIGHTY THOUSAND)** only. The cost breakdown is as follows;

Table 3: Project Cost Estimates

Item	Description	Unit	Qty	Rate KShs.	Amount KShs.
a	Direct Construction Costs				
1	Clearing and grabbing	Ha	95	100,000.00	9,500,000.00
2	soil stripping	M2	95,000	200.00	190,000,000.00
3	Fill	M3	678,800	1,100.00	746,680,000.00
4	Excavations	M3	250,000	1,000.00	250,000,000.00
5	Diversion Canal/Intake tower	M3	18,000	38,000.00	684,000,000.00
6	Open Spillway	M3	19,000	38,000.00	722,000,000.00
7	Filters	M3	38,000	12,000.00	456,000,000.00
8	Foundations and Grouting	L.S	1	800,000,000.00	800,000,000.00
9	Access	L.S	1	100,000,000.00	100,000,000.00

Item	Description	Unit	Qty	Rate KShs.	Amount KShs.
10	Pipes and Fixtures	L.S	1	100,000,000.00	100,000,000.00
	Subtotal				**4,058,180,000.00**
b	**Additional Costs**				
	Treatment Works, Pipelines and storage				2,000,000,000.00
				Total	**6,058,180,000.00**

3.1 An Overview

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

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

3.2 Policy Provisions

3.2.1 Constitution of Kenya

Article 42 of the Bill of Rights of the Kenyan Constitution provides that 'every Kenyan has the right to a clean and healthy environment, which includes the right to have the environment protected for the benefit of present and future generations through legislative and other measures'. Under Chapter 5 (land and Environment), Part 1 is devoted to land. It requires that land be used and managed in 'a manner that is equitable, efficient, productive and sustainable, and in accordance with the following principles;

(i) Equitable access to land
(ii) Security of land rights
(iii) Sustainable and productive management of land resources
(iv) Transparent and cost effective administration of land
(v) Sound conservation and protection of ecologically sensitive areas

Part 2 of Chapter 5 of the constitution is dedicated to Environment and Natural Resources. Article 69 in Part 2 provides that the state shall;

(i) Ensure sustainable exploitation, utilization, management and conservation of the environment and natural resources, and ensure the equitable sharing of the accruing benefits
(ii) Work to achieve and maintain tree cover of at least ten per cent of the land area of Kenya
(iii) Encourage public participation in the management of, protection and conservation of the environment
(iv) Protect genetic resources and biological diversity
(v) Establish systems of environmental impact assessment, environmental audit and monitoring of the environment
(vi) Eliminate processes and activities that are likely to endanger the environment
(vii) Utilize the environment and natural resources for the benefit of the people of Kenya

Further, Article 70 states that if a person alleges that a right to a clean and healthy environment recognized and protected under Article 42 has been, is being or is likely to be, denied, violated, infringed or threatened, the person may apply to a court for redress. The sub-project should ensure compliance with the constitution in so far as equitable sharing of the resources, between the stakeholders. Further, the project should ensure the sustainability of livelihoods and biological resources within the project areas are protected. Any development proposals should also be cognizant of the increased powers under the Constitution given to communities and individuals to enforce their rights through legal redress

3.2.2 The Kenya Vision 2030

Kenya Vision 2030 is the current national development blueprint for period 2008 to 2030 and was developed following on the successful implementation of the Economic Recovery Strategy for Wealth and Employment Creation which saw the country's economy back on the path to rapid growth since 2002. GDP growth rose from 0.6% to 7% in 2007, but dropped to between 1.7% and 1.8% in 2008 and 2009 respectively. The objective of the vision 2030 is to transform Kenya into a middle income country with a consistent annual growth of 10 % by the year 2030". The 2030 goal for urban areas is to achieve "a well-housed population living in an environmentally-secure urban environment." This will be achieved by bringing basic infrastructure and services namely roads, street lights, water and sanitation facilities, storm water drains, footpaths, and others.

One of the aims of the vision is to make Kenya to be a nation that has a clean, secure and sustainable environment by 2030. This will be achieved through promoting environmental conservation to better support the economic pillar. Improving pollution and waste management through the application of the right economic incentives in development initiatives is critical. The current land use practices in the country are incongruent with the ecological zones. For instance, large portions of land in high potential areas have been subdivided into uneconomic parcels, while some parts of land in the medium and low potential areas are rapidly being converted into agriculture, despite the fragile environment they are located in.

3.2.3 National Environment Action Plan (NEAP)

According to the Kenya National Environment Action Plan (NEAP, 1994) the Government

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

3.2.4 National Policy on Water Resources Management and Development

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

While the National Policy on Water Resources Management and Development (1999) enhances a systematic development of water facilities in all sectors for promotion of the country's socio-economic progress, it also recognizes the by-products of this process as waste water. It, therefore, calls for development of appropriate sanitation systems to protect people's health and water resources from institutional pollution. Development projects, therefore, should be accompanied by corresponding waste management systems to handle the waste water and other waste emanating there from. The same policy requires that such projects should also undergo comprehensive EIAs that will provide suitable measures to be taken to ensure environmental resources and people's health in the immediate neighbourhood and further downstream are not negatively impacted by the emissions.

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

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

Among the key objectives of the Sessional Paper No. 6 of 1999 on Environment and Sustainable Development (1993) are;

(i) To ensure that from the onset, all development policies, programmes and projects take environmental considerations into account,
(ii) To ensure that an independent environmental impact assessment (EIA) report is prepared for any development before implementation,

(iii) To ensure that effluent treatment standards which will conform to acceptable health standards

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

3.2.6 The Agricultural Policy

In Kenya the agricultural policy revolves around key areas of policy concern including increasing agricultural productivity, especially for small-holder farmers, emphasis on irrigation, encourage diversification into non-traditional agriculture commodities, enhancing food security, encourage private sector led development and ensure environmental sustainability.

The policy observes that droughts and floods have increased in frequency and intensity in the past three decades resulting in high crop failure and livestock death. Increased land degradation has decreased land resilience thereby exacerbating the effects of drought and floods leading to devastating famine that has taken a toll on human and animal lives. Some of the famine experienced could have been avoided or their impacts significantly mitigated. Inadequate early warning systems, disaster unpreparedness, farming practices that are environmental unfriendly, destruction of rainfall catchment areas mostly as a result of human activities (settlement, farming).

Involvement of women in small-scale agriculture (with over 75% of the labour force) is appreciated as an important factor towards improvement improves agricultural performance. However, despite their contributions women still face a number of hindrances especial limited access to productive resources like land ownership, inputs, extension services and marketing services that need to be addressed.

Environmental degradation and rising poverty is of major concern for agricultural development. The continued scarcity of productive land and increasing poverty levels has led to an increase in agricultural practices that conflict with the environment particularly in the rural areas. pressure on high potential areas is pushing people to migrate into ASAL lands where they practice inappropriate farming practices leading to environmental degradation and thereby creating a vicious cycle of environmental degradation and poverty.

3.2.7 The Land Policy

Environmental management principles include to restore the environmental integrity the government shall introduce incentives and encourage use of technology and scientific methods for soil conservation and maintain beaches at high and low water mars and put in place measures to control beach erosion. Fragile ecosystems shall be managed and protected by developing a comprehensive land use policy bearing in mind the needs of the surrounding

communities. Zoning of catchment areas to protect them from further degradation and establishing participatory mechanisms for sustainable management of fragile ecosystems will also be done. it will also develop procedures for co-management and rehabilitation of forest resources while recognizing traditional management systems and sharing of benefits with contiguous communities and individuals. Lastly all the national parks, game reserves, islands, front row beaches and all areas hosting fragile biodiversity are declared as fragile ecosystems.

Conservation and sustainable management of land based natural resources. The sustainable management of land based natural resources depends largely on the governance system that defines the relationships between people ,and between people and resources. To achieve an integrated approach to management of land based natural resources, all policies ,regulations and laws dealing with these resources shall be harmonized with the framework established by the Environmental Management and Coordination Act(EMCA),99.

3.2.8 Athi Water Service Board Strategic Plan

AWSB is one of the 8 water service boards established under the ministry of water and irrigation. It has a mission of transforming the quality of life of the communities through innovative and sustainable water service solutions. Hence it ensures provision of quality and affordable water and sewerage services in its area of jurisdiction through the 12 appointed water service providers. AWSB has 4 main objectives which are in line with the Kenya vision 2030, Millennium Development Goals, constitution of Kenya 2010. This includes;

(i) Ensuring institutional sustainability by effectively managing the transition to the devolved system of Government,
(ii) Increase access to bulk water and sewerage services by preparing relevant water and sewerage master plans, mobilizing finances and developing new and augmenting existing water and sewerage systems,
(iii) Enhance stakeholder communication and engagement to gain stakeholder support and their good will in the catchment areas,
(iv) Mainstream cross-cutting issues during project design and implementation by ensuring all projects are environmentally and socially sustainable,

The major functions of Athi Water Service Board include:

(i) Development of National Public Water Works for Water Services,
(ii) Formulation of development and investment plans in liaison with county governments,
(iii) Provide input to the national development and financing plan
(iv) Provide technical assistance to WSP for county asset development,
(v) To facilitate the establishment of county WSP and employ staff to carry out these functions,

3.3 Legal Framework

Applications of national statutes and regulations on environmental conservation suggest that the Ministry of Water and Natural Resources and Athi water Service Board will have a legal duty and social responsibilities to ensure the proposed dam development is carried out without

compromising the status of the natural resources in the area, environment resources, social and cultural setting as well as the economic potential of the local communities health and safety. This position enhances the importance of this environmental impact assessment for the proposed site to provide a benchmark for its sustainable operation. The key national laws that govern the management of environmental resources in the country have been briefly discussed below. It is noteworthy that wherever any of the laws contradict each other, the Environmental Management and Co-ordination Act 1999 prevails.

3.3.1 The Environment Management and Co-ordination Act, 1999

Part II of the Environment Management and Coordination Act, 1999 states that every person in Kenya is entitled to a clean and healthy environment and has the duty to safeguard and enhance the environment. In order to partly ensure this is achieved, Part VI of the Act directs that any new programme, activity or operation should undergo environmental impact assessment and a report prepared for submission to the National Environmental Management Authority (NEMA), who in turn may issue a license as appropriate. The second schedule of the same Act lists water programmes and sewage disposal works among the key activities that must undergo environmental assessments.

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

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

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

3.3.2 EMCA Regulations

Water Quality Management Regulations, 2006 (Legal Notice No. 120)

These regulations were drawn under section 147 of the Environmental Management and

Coordination Act 1999. In accordance with the regulations, every person shall refrain from acts that could directly or indirectly cause immediate or subsequent water pollution and no one should throw or cause to flow into water resources any materials such as to contaminate the water. The regulation also provides for protection of springs, streams and other water sources from pollution.

Waste Management Regulations, 2006 (Legal Notice No. 121)

The regulations are formed under sections 92 and 147 of the Environmental Management and Coordination Act, 1999. Under the regulations, a waste generator is defined as any person whose activities produces waste while waste management is the administration or operation used in handling, packaging, treatment, conditioning, storage and disposal of waste. The regulations requires a waste generator to collect, segregate and dispose each category of waste in such manners and facilities as provided by relevant authorities. Regarding transportation, licensed persons shall operate transportation vehicles approved by NEMA and will collect waste from designated areas and deliver to designated disposal sites.

Noise and Excessive Vibration Pollution Control Regulations, 2009

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

Part III, Section 11(1) states that any person wishing to (a) operate or repair any machinery, motor vehicle, construction equipment or other equipment, pump, fan, air-conditioning apparatus or similar mechanical device; or (b) engage in any commercial or industrial activity, which is likely to emit noise or excessive vibrations shall carry out the activity or activities within the relevant levels prescribed in the First Schedule to these Regulations. Any person who contravenes this Regulation commits an offence.

Section 13(1) states that no person shall operate construction equipment (including but not limited to any pile driver, steam shovel, pneumatic hammer, derrick or steam or electric hoist) or perform any outside construction or repair work so as to emit noise in excess of the permissible levels as set out in the Second Schedule to these Regulations. These purposes include emergencies, those of a domestic nature and /or public utility construction.

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

construction, demolition, mining or quarrying work shall ensure that the vibration levels do not exceed 0.5 centimeters per second beyond any source property boundary or 30 metres from any moving source.

Air Quality Regulations

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

Part VII on occupational air quality limits in section 29 states that an occupier of premises shall ensure that exposure of indoor air pollutants does not exceed the limits stipulated under the Factories and Other Places of Work rules or under any other law. Other sources are recognized at sections 32 and 33 are those arising from construction equipments and materials as well as particulate matter from demolitions of structures and buildings as well as stockpiled dry materials.

Biodiversity Regulations

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

3.3.3 The Factories Act (Cap. 514)

This Act deals with factories and other places of work. Sections 21 and 22 of the Act provide that moving parts of machinery should be secured so as to be safe to every person employed or working at the premises. Part VI of the Act provides for the general welfare of the workers with respect to supply of drinking water, washing facilities and first aid among other aspects. Related to the workers welfare, Part VII section 51 states in part “every work place in which there is given off any dust or fumes or other impurity of such a character and to such an extent as to be likely to be injurious or offensive to the persons employed, or any substantial quantity of dust of any kind, all practicable measures shall be taken to protect the persons employed against inhalation of the dust or fume or other impurity and to prevent its accumulation in any workroom, and in particular, where the nature of the process makes it practicable exhaust appliances shall be provided and maintained as near as possible to the point of origin of the dust or fumes ...

Section 4 of Kenya subsidiary legislation of 2004, Legal Notice No. 31 of Kenya Gazette Supplement No. 25 of 24th May, 2004 of the Factories Act Cap 514, requires that, all workplace owners to establish a safety and health committee, which shall consist of safety representatives from the management and the workers. The number of the committee members will range from 3 to 7 depending on the size (number) of employees. The Act also requires the management to appoint a competent person who is a member of the management staff to be responsible for

safety, health and welfare in the workplace. Section 13 goes ahead to state that a health and safety audit of the workplace be carried out every twelve months by a registered health and safety adviser. If the owner(s) or management contravenes any of the rules, he/she shall be guilty of an offence.

3.3.4 The Water Act 2002

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

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

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

Section 76 states that no person shall discharge any trade effluent from any trade premises into sewers of a licensee without the consent of the licensee upon application indicating the nature and composition of the effluent, maximum quantity anticipated, flow rate of the effluent and any other information deemed necessary. The consent shall be issued on conditions including the payment rates for the discharge as may be provided under section 77 of the same Act.

3.3.5 Water Rules

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

Other sections within the rules imply that WRMA can impose water quality sampling

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

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

3.3.6 The Public Health Act (Cap. 242)

Part IX section 115 of the Act states that no person/institution shall cause nuisance or condition liable to be injurious or dangerous to human health. Section 116 requires Local Authorities to take all lawful, necessary and reasonably practicable measures to maintain their jurisdiction clean and sanitary to prevent occurrence of nuisance or condition liable for injurious or dangerous to human health. Such nuisance or conditions are defined under section 118 and include nuisances caused by accumulation of materials or refuse which in the opinion of the medical officer of health is likely to harbour rats or other vermin.

3.3.7 The Forest Act

The Forest Act No7 of 2005 consolidates all forests under the act, and prescribes heavy penalties for damage to forests and trees. Charcoal burning in a forests or farmlands without a license or permit is an offence. Section 52(1) deals with felling, cutting, burning, injuring or removing of any forest produce only cover state, local authority or provisional forest. It sets heavy penalties for damaging trees. This will assist farmers in maximizing benefits from growing trees. Section 40(1) of the act sets to ensure that the forest areas under her management are maintained for biodiversity, cultural or recreational use. In addition it protects the concession area from destruction and encroachment by other persons.

Section 41(1) says that all indigenous forests and woodlands shall be managed on a sustainable basis for purposes of, Conservation of water, soil and biodiversity, River line and shoreline protection. Cultural use and heritage. Recreation and tourism, Sustainable production of wood and non wood products, Carbon sequestration and other environmental services Education and research purpose and .Habitat for wildlife in terrestrial forests and fisheries in mangrove forests. The Act puts emphasis on the need to strengthen community-based institutions by creation of Community Forest Associations, which gives the public a greater participatory role to the community in the forest conservation

3.3.8 The Agriculture Act

Part IV no. 48 states that if the Minister considers it necessary or expedient so to do for the purposes of the conservation of the soil of, or the prevention of the adverse effects of soil erosion on, any land, he may, with the concurrence of the Central Agricultural Board, make rules to ensure the preservation of the environment. These rules may include,

(i) Breaking or clearing of land for the purpose of cultivation is prohibited
(ii) Control, regulation or prohibition of grazing or watering animals.
(iii) With this prohibiting rules, the clearing or destruction of vegetation is deemed necessary by the minister for the preservation of soil and its fertility

Part IV no. 48(b) state the act require the regulating or controlling of

(i) The afforestation or reforestation of the land,
(ii) The protection of slopes, catchment areas or areas where rules made under (e) stating- for the maintenance of water in a body of water within the meaning of the Local Government Act
(iii) Rules made under section 48 may provide for the seizure and forfeiture of any stock pastured in contravention of a land preservation order.

3.3.9 Pest Products Control Act

CAP 346, of the act says that no pest control product shall be sold without a label which has been approved by the board. Each label shall;

(i) Show name of pest control product and a description of its form and name of its active ingredients.
(ii) The class designation of the pest control product in capital letters and shall be classified as the first schedule.
(iii) Information detailing the nature and degree of hazard identified by appropriate precautionary symbol
(iv) Information identifying any significant hazards in respect to handling, storage, display and disposal of the pest control product with information that will include instructions respecting procedures to alleviate hazards and when required by the board, instructions respecting decontamination procedures and disposal of the pest control product and the empty package.

Pest control product is to be used only In accordance with the directions on the label. It is an offence under the pest control products act to use or store a pest control product under unsafe conditions

3.3.10 Physical Planning Act (Cap286)

Section 24 of the Physical Planning Act gives provision for the development of local physical development plan for guiding and coordinating development of infrastructure facilities and services within the area of authority of County, municipal and town council and for specific control of the use and development of land. The plan shows the manner in which the land in the area may be used. Section 29 of the physical Planning Act gives the county councils power to prohibit and control the use of land, building, and subdivision of land, in the interest of proper and orderly development of its area. The same section also allows them to approve all development applications and grant development permissions as well as to ensure the proper execution and implications of approved physical development plans. On zoning, the act empowers them to formulate by-laws in respect of use and density of development.

Section 30 states that any person who carries out development within an area of a local authority without development permission shall be guilty of an offence and the development shall be invalid. The act also gives the local authority power to compel the developer to restore the land on which such development has taken place to its original conditions within a period of ninety days. If no action is taken, then the council will restore the land and recover the cost incurred thereto from the developer. In addition, the same section also states that no person shall carry out development within the area of a local authority without development permission granted by the local authority. At the same time, sub-section 5, re-enforce it further that, no licensing authority shall grant under any written law, a license for commercial use for which no development permission had been granted by the respective local authority.

Section 36 states that if in connection with development application a local authority is of the opinion that, the proposed activity will have injurious impact on the environment, the applicant shall be required to submit together with the application an Environmental Impact Assessment report. The environmental impact assessment report must be approved by the National Environmental Management Authority (NEMA) and followed by annual environmental audits as spelled out by EMCA 1999. Section 38 states that if the local authority finds out that the development activity is not complying to all laid down regulations, the local authority may serve an enforcement notice specifying the conditions of the development permissions alleged to have been contravened and compel the developer to restore the land to its original conditions.

3.3.11 The Penal Code (Cap. 63)

Section 191 of the Penal Code states that any person or institution that voluntarily corrupts or foils water for public springs or reservoirs, rendering it less fit for its ordinary use is guilty of an offence. Section 192 of the same act says a person who makes or vitiates the atmosphere in any place to make it noxious to health of persons/institution in dwellings or business premises in the neighbourhood or those passing along public way, commit an offence.

3.4 Institutional Structure of the Water Sector

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

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

3.4.1 Water Services Regulatory Board (WASREB)

The regulatory Board is responsible for the regulation of the water and sewerage services in

partnership with the people of Kenya. The mandate of the regulator covers the following key areas;

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

3.4.2 Water Resources Management Authority (WRMA)

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

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

3.4.3 Water Services Trust Fund (WSTF)

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

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

3.4.4 Water Services Boards (WSBs)

The WSBs are responsible for the efficient and economical provision of water and sewerage services in their areas of jurisdiction. AWSB is among the eight catchment Boards established under the Water Act 2002 vide gazette Notice No.1775 of 21st March 2003..It is licenced by the Water Service Regulatory Board (WASREB). It is mandated to;

(i) Ownership and custodian of water and sewerage assets/infrastructure,
(ii) Planning, development and expansion of water and sewerage services infrastructure,
(iii) Appoint viable and well managed water service providers and ensure they have appropriate systems among others; enforce water quality monitoring, ensure effective and efficient maintenance systems and procedures to minimize interruptions to water supplies,
(iv) Build capacities of water service providers to embrace efficiency, accountability and responsibility to water supplies,
(v) Monitoring and supervision of water and sewerage services provision by WSPs.

3.4.5 Water Services Providers

Water Service Providers are the utilities or water companies. They are state owned but have been commercialized to improve performance and run like business within a context of efficiency, operational and financial autonomy, accountability and strategic, but minor investment.

3.5 NEMA Compliance

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

3.6 Sectoral Integration

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

Other stakeholder authorities include; Kiambu counties, Ministry of Water and Natural Resources, Ministry of Agriculture, Livestock and Fisheries, local community and Kariminu dam committee.

3.7 The World Bank Safeguards

3.7.1 OP/BP 4.01 (Environmental Assessment)

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

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

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

The World Bank considers environmental impact assessment (EIA) as one among a range of instruments for environmental assessment. Other instruments used by the World Bank include regional or sectoral environmental assessment, strategic environmental and social assessment (SESA), environmental audit, hazard or risk assessment, environmental management plan (EMP) and environmental and social management framework (ESMF). The Bank undertakes environmental screening of each proposed project to determine the appropriate extent and type of environmental assessment. Proposed projects are classified into one of three categories, depending on the type, location, sensitivity, and scale of the project and the nature and magnitude of its potential environmental impacts:

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

Environmental Assessment is used in the World Bank to identify, avoid, and mitigate the potential negative environmental associated with Bank lending operations. The purpose of Environmental Assessment is to improve decision making, to ensure that project options under consideration are sound and sustainable and that potentially affected people have been properly consulted. The magnitude of the proposed Kariminu dam falls under category A and hence full ESIA and RAP required.

3.7.2 OP/BP 4.04 (Natural Habitats)

The policy is designed to promote environmentally sustainable development by supporting the protection, conservation, maintenance and rehabilitation of natural habitats and their functions. The policy seeks to ensure that World Bank-supported infrastructure and other development projects take into account the conservation of biodiversity, as well as the numerous environmental services and products which natural habitats provide to human society. The policy strictly limits the circumstances under which any Bank-supported project can damage natural habitats (land and water area where most of the native plant and animal species are still present). This project has no notable interaction with notable natural habitats apart from limited localized riverine aquatic systems.

3.7.3 OP/BP 4.11 (Physical Cultural Resources)

This policy is meant to assist in preserving physical cultural resources including the movable or immovable (above or below ground, or under water) objects, sites, structures, groups of structures, and natural features and landscapes that have archaeological, paleontological, historical, architectural, religious, aesthetic, or other cultural significance including sites and unique natural values. Physical cultural resources are important as sources of valuable scientific and historical information, as assets for economic and social development, and as integral parts of a people's cultural identity and practices. The objective of this policy is to avoid or mitigate adverse impacts on physical cultural resources from development projects. There are no cultural features at the site. However, a chance to find cultural features during construction analysis has been discussed under the section on Impacts and mitigation measures.

3.7.4 OP/BP 4.12 (Involuntary Resettlement)

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

Involuntary resettlement is triggered in situations involving involuntary taking of land and involuntary restrictions of access to legally designated parks and protected areas. The objective of this policy is to avoid or minimize involuntary resettlement, though participation in

resettlement planning and implementation and, where this is not feasible, to assist displaced persons in improving or at least restoring their livelihoods and standards of living in real terms relative to pre-displacement levels or to levels prevailing prior to the beginning of project implementation, whichever is higher. The policy prescribes compensation and other resettlement measures to achieve its objectives and requires that borrowers prepare adequate resettlement planning instruments prior to Bank appraisal of proposed projects. There are potential displacements by sub-projects such as solid waste disposal sites, wastewater treatment plants, markets and parks that are all space intensive. A RAP study was, therefore, considered for such projects.

3.7.5 OP/BP 4.36 (Forests)

The policy on forest safeguards seeks to realize the potential of forests to reduce poverty in sustainable manner, integrate forests effectively into sustainable economic development and protect the vital local and global environmental services and values of forests. Among the principles is to screen as early as possible for potential impacts on forest health and quality and on the rights and welfare of the people who depend on them. The area is characterized with agro-forestry that would be highly affected. The Kenya Forest Services (KFS), therefore, plaid a great role in ensuring sustainability.

3.7.6 OP/BP 4.37 (Safety of Dam)

The World Bank requires supervision by dam safety professionals for its financed projects. The Borrower is also expected to adopt and implement dam safety measures in design, construction and operations and maintenance. Safety precautions will be enhanced for large dams (dam height greater than 15m) that require design reviews, supervised preparation and implementation of the construction and operations as well as undertaking periodic safety inspections of existing dams.

Operations and management (O&M) planning of a dam covers organizational structure, staffing, technical expertise, and training required; equipment and facilities needed to operate and maintain the dam, O&M procedures; and arrangements for funding O&M, including long-term maintenance and safety inspections. The O&M plan for a dam other than a water storage dam, in particular, reflects changes in the dam's structure or in the nature of the impounded material that may be expected over a period of years. A preliminary plan is provided to the Bank for use at appraisal. The plan is refined and completed during project implementation; the final plan is due not less than six months prior to the initial filling of the reservoir.

Emergency preparedness plan for a dam specifies the roles of responsible parties when dam failure is considered imminent, or when expected operational flow release threatens downstream life, property, or economic operations that depend on river flow levels. It includes the following items: clear statements on the responsibility for dam operations decision making and for the related emergency communications; maps outlining inundation levels for various emergency conditions; flood warning system characteristics; and procedures for evacuating threatened areas and mobilizing emergency forces and equipment. The broad framework plan and an estimate of funds needed to prepare the plan in detail are provided to the Bank prior to appraisal. The plan itself is prepared during implementation and is provided to the Panel and Bank for review not later than one year before the projected date of initial filling of the reservoir

3.7.7 OP/BP 4.10 (Indigenous Peoples)

This policy contributes to the Bank's mission of poverty and sustainable development by ensuring that the development process fully respects the dignity, human rights, economies and cultures of indigenous peoples. For all projects that are proposed for Bank financing and affect indigenous peoples, the Bank requires the borrower to engage in a process of free, prior, and informed consultation. The policy is not triggered.

3.7.8 OP/BP 4.09 (Pests Control Management)

The policy is meant to minimize and manage the environmental and health risks associated with pesticides use and promote and support safe, effective and environmentally sound pest management. This being partly an Agricultural based project, this policy is relevant due to the anticipated application of various levels of pesticides and herbicides and hence potential agro-chemical residuals interaction with the dam water quality.

4.1 General Overview

The area is characterized by a mixed social setting (area is co-habited by more than one community) hot and wet climatic conditions, agro-farming (mixture of agriculture and forest) and medium to high poverty levels. The physiography of the area is undulating landscape, with steep valleys where the rivers cross. The section below gives a brief description of the various environmental aspects of the project.

4.2 Topography and Physiography

The geology of the area is part of the eastern border zone of the Rift Valley, filled with Kainozonic volcanic and sediments underlying the Upper Athi generating good aquifers. Soils on the other hand develop from weathering activities of the volcanic rocks and are highly fertile with high levels of perforation. The project area is generally hilly with steep slopes and deep valleys in most locations. The surface physiography is influenced by the Aberdares to the Northwest and western direction that also constitutes the main water catchment. The slope is generally to the southeast and eastern direction getting gentle towards east influenced by the flat low lying Yatta plains. The dam may not necessarily change the local topography but the general aesthetic conditions of the project will slightly change. The transmission corridor, however, will not be affected.

The investigated site is located on Karimenu River, a tributary of the Chania. The valley drops sharply from about 1,860m to 1,820m elevation at the bottom; a slope of about 11%. The river meanders within the valley, an indication that there have been sediment-building activities in the past – probably pyroclastics flows or hill slumps. Details of the topography in the immediate dam and reservoir area may be obtained from the main project topographic survey map. The proposed site is near Kiriko Market and adjacent to the Kiriko Coffee Factory. The proposed dam axis lies in between the coordinates 262657E, 9897936N and 262915E, 9898182N.

Figure 10: Topographical View of the Project Area



4.3 Drainage and Hydrology

4.3.1 Drainage

The project area is well drained both horizontally because of the horizontal valleys, vertical

slopes and loamy red volcanic soils which are porous and allow for all infiltration, the ranges are covered by tea zones. Due to this, cases of flooding are not likely to happen. Clearing of vegetation on the steep slopes is strictly discouraged as flush surface runoff is likely to dominate the region. The catchments are constituted by lower Aberdare ranges feeding to the numerous rivers and streams around while downstream, the drainage is inflienced by Tana Catchment basin to which Kariminu River is part of the minor tributaries through Chania and Thika Rivers. The drainage and hydrology of the project area is influenced by the Athi Catchment basin to which Ruiru River is major tributary of Athi River. tributary of Athi River. The surface drainage is also influenced by the steep slopes of the Aberdares on the west, though towards the east and southeasterly direction, the surface slope gets mild with influence from the low lying Kapiti Plains on the east and south of the project area.

The project will not affect the local surface drainage though the streams discharging from the catchments into the dam will be submerged. However, drainage channels from the market centers and settlement areas discharging into the dam are potential transport channels for pollutants into the dam water.

4.3.2 Hydrology

The Kariminu River system is located on the southern slopes of the Aberdare ranges. The river system originates from the lush forest of the kikuyu escarpment forest and flows on a south-easterly direction through the forest and settled areas to join the Chania River near Thika town. Chania River then discharges into Thika River downstream of Thika town flowing into Masinga dam. The Kariminu River rises on the southwestern slopes of the Aberdare ranges at an altitude of 2,600m ASL and flows in an easterly direction through the kikuyu escarpment forest emerging from the forest approximately 2km to the south west of Mataara Tea Factory and rural market centre A number of tributaries discharge into Kariminu River e.g. Gathanji Stream, Gakuru-ini streams which confluence at an elevation of 1,822.39m asl flowing approximately 157.86m asl to join Karimenu river. Karimenu, Nyakibai, Mataara and Kimakia Rivers form the Lower Chania River all forming a dendritic drainage pattern.

The Kariminu River sub-catchment forms the western edge of the Tana River drainage basin and is bordered on the west by Ndarugu river sub-catchment which is one of the sub-catchments in the Athi river drainage basin. The catchment receives high rainfall that is distributed throughout the year. The highest annual rainfall is over 2,000mm recorded in the upper ridges and reduces to 1,300mm in the main coffee growing areas downstream of the dam site.

The Kariminu River was gauged at regular gauging station (RGS) 4CA19 located at coordinates 37 M 02552, UTM 99062 and at RGS 4CA23 at coordinates 37M 02759, UTM 988953. These gauging stations have not been in operation since 2005 and 2006 respectively, however, RGS 4CA19 has recently been re-activated. RGS 4CA19 with a catchment area of 75km^2 and RGS 4CA23 with a catchment area of 140km^2. The gauging stations and their catchment areas are:

(i) River Gauging Station RGS 4CA19 (with a catchment area of 75km^2) was operated from July, 1960 to December, 1982 when it was abandoned. It was re-opened in 1997 to 2006 but the data from September, 2003 to June, 2005 are not available. The gauging station is located near the road bridge over Kariminu River on the

Gakoe Rural Market Centre to Mataara Rural Market Centre and is approximately 1km downstream of the forest edge. It was recently re-established by the Water Resources Management Authority, Murang'a Sub-regional office. The station was rated and the discharge data from this station was used to estimate the flow through the proposed Kariminu II dam. The data gaps for the period January, 1983 to 1999 were filled by ratio comparison of the long term mean monthly discharges at RGS 4CA23 which is located downstream,

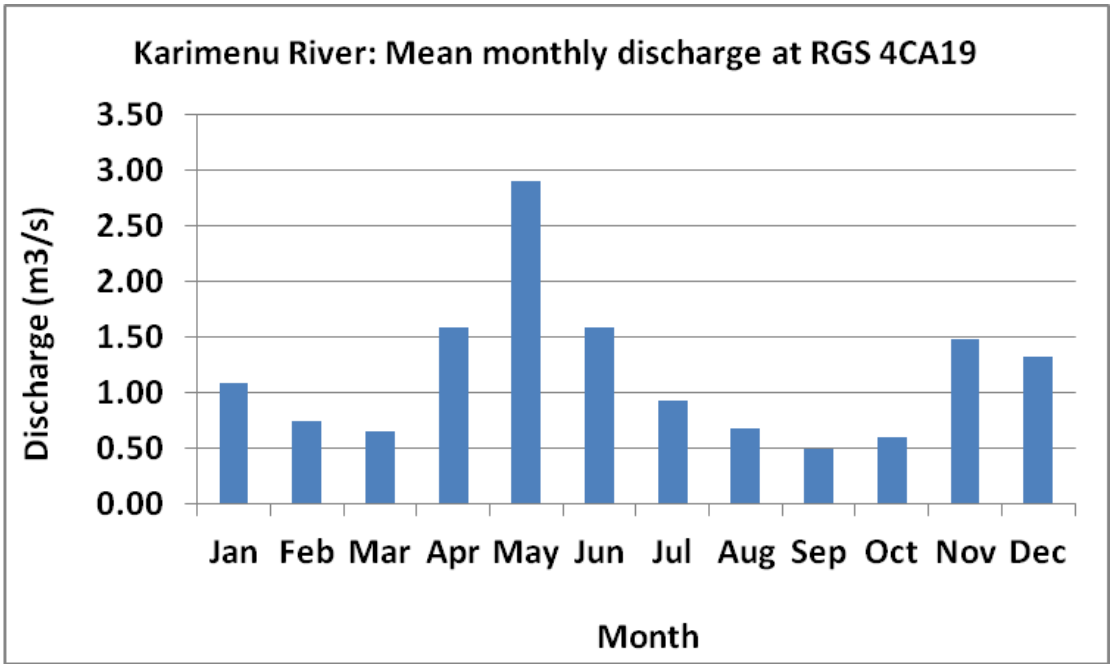
(ii) River gauging station RGS 4CA23 with a catchment of 140km^2 is located on Kariminu River downstream of RGS 4CA19 at coordinates 37 M 0275923, UTM 988953 near Maryhill Girls High School. The gauging station operated consistently from November, 1970 to April, 1999 but the data for 1997 is not available. It then operated inconsistently from February, 2000 to August, 2005. The station is rated and the discharge records from this station have been analyzed.

The mean monthly and long-term mean monthly summary of discharges are illustrated in the Table and Figure below. The data for 2006 were computed by ration comparison of the recorded flows at RGS 4CA19.

Table 4: Mean Monthly Discharge at RGS 4CA19

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Discharge m^3/s	1.084	0.741	0.655	1.593	2.902	1.587	0.938	0.681	0.499	0.601	1.480	1.326

Figure 11: Long Term Mean Monthly Discharge at RGS 4CA19



The proposed dam is located on Kariminu River at coordinates 37 M 026263, UTM 9898215 and at an approximate altitude of 1,873m a.s.l. The catchment area upstream of the proposed dam axis is 105km^2. Based on area proportioning, the catchment area upstream of the proposed dam

location is 140% of the area upstream of RGS 4CA19 with a catchment area of 75km^2. The area proportioning has been applied to the mean monthly discharges through RGS 4CA19 to estimate the mean monthly flow through the dam location. The estimated mean monthly discharge through the dam location is depicted in Table 3 below. The table also shows the mean monthly flow volume through the dam.

The estimated mean annual discharge through the proposed dam is 1.646 m^3/s. Based on the computed flow volumes through the proposed dam, the flows for April, May, June, November and December would provide adequate flows to fill the Kariminu II reservoir. The periods between April to June and November to December have been selected to provide water for storage as it is assumed that due to the availability of rainfall and higher flows in the rivers, there is negligible water use for other purposes and thus the water is available for storage. Water available for storage during these periods is summarized in the Table below.

Table 5: Estimated Mean Monthly Discharge at Proposed Dam Location

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Q m3/s	1.518	1.038	0.916	2.261	4.062	2.222	1.313	0.950	0.698	0.842	2.071	1.856
Q m^3 x10^6	4.07	2.51	2.45	5.86	10.88	5.76	3.52	2.55	1.81	2.26	5.37	4.97

Table 6: Estimated Flow Volumes At During the Rainy Seasons

Month	Monthly flow volume (million cubic meters)	Month	Monthly flow volume (million cubic meters)
April	5.86	November	5.37
May	10.88	December	4.97
June	5.76		
Total	22.50		10.34

The Water Act of 2002 and the Water Resources Management Rules of 2007 define how water resources may be used, and the aspects the Water Resources Management Authority (WRMA) must consider when making allocations. Of particular importance is the Compensation/Environmental Flow (Reserve), part of which is that volume from the resourced required to meet basic human needs. The Water Act 2002 defines the Reserve as that quantity and quality of water required:

(i) To satisfy basic human needs for all people who are or may be supplied from the water resource; and,
(ii) To protect aquatic ecosystems in order to secure ecologically sustainable development and use of the water resource

The Water Resources Management Rules states that *"the Reserve in all instances will comprise of one element related to the quantity of the resource and the respective probability associated with that quantity and a second element related to the quality of the reserve".* Thus, the Reserve is the portion of the water resources which is set aside to meet demands for ecological and basic human needs. Currently, the Reserve is determined from flow duration analysis for rivers where discharge records are available. Under Water Resources Management Rules of 2007, the Reserve Quantity for rivers and streams shall not be less than the flow value that is

exceeded 95% of the time as measured by a naturalized flow duration curve at any point along the water course. However, due to lack of complete river flow data, the Reserve is computed from the recorded data and the 95% exceedance flow taken as the Reserve.

To estimate the Reserve at the proposed dam site on Kariminu River, flow duration analysis for the data recorded at RGS 4CA19 was undertaken and transposed onto the dam location through area proportioning. The results from the analysis show that the Reserve value at the dam location without the dam is equal to 0.207 m^3/s (95% exceedance). However, with the development of the dam, the Reserve could easily be increased to cater for downstream abstractors. In this regard, it is recommended that the Reserve be increased to the 85% exceedance equal to 0.441 m^3/s.

Figure 12: Flow Duration Analysis at RGS 4CA19 and the Dam Site

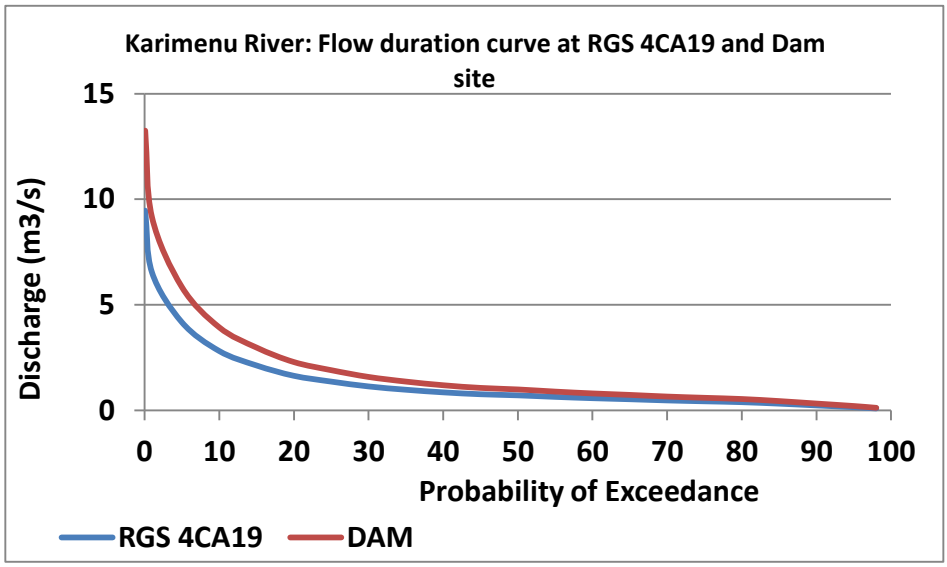
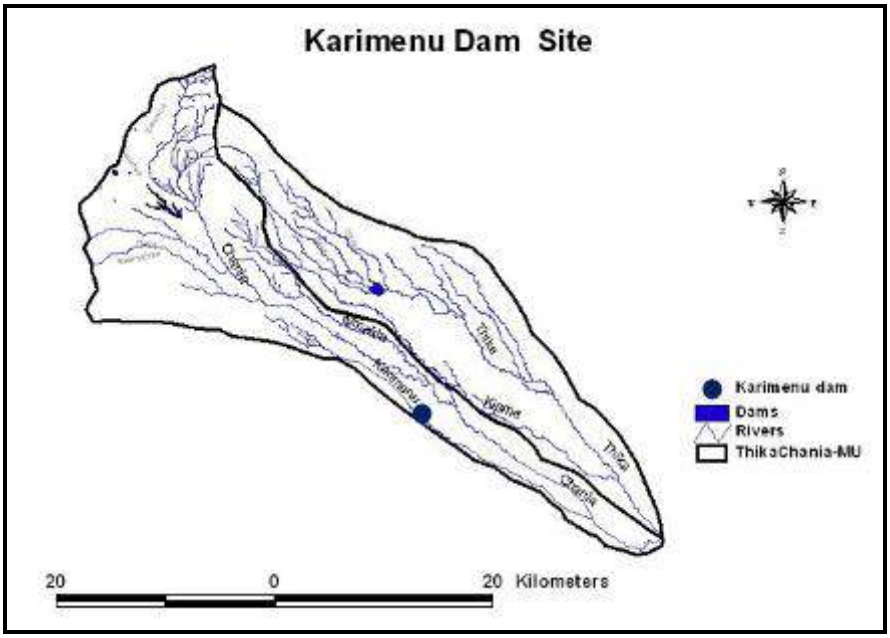


Figure 13: Hydrology of the Kariminu Sub-Basin



Source: Feasibility Report

Figure 14: Kariminu River Catchment (Aberdare Forest)

Figure 15: Drainage Features

Kariminu River U/S Dam Site

Kariminu River at Dam Site

Kariminu River D/S Dam Site

Tributaries into Kariminu River U/S of Dam Site

4.4 Water Resources

4.4.1 Overview

Kiambu County is generally endowed with numerous springs, streams that constitute one major Kariminu River that serves the project area. The river provides the main source of water to the residents of Kariminu who use the water either directly or through water schemes such as Kariminu Water Scheme. But due to costs of harnessing water resources most of the resource is under-utilized. Among other rivers in the project area include Chania and Thika Rivers to the north, Ndarugu River, Ruiru River and Komu River and numerous other streams. Other sources of water in the region are numerous boreholes in the area with an average yield of $7m^3$/hr and pumps set at an average depth of 200 to 300m deep. However, due to the steep terrain, it is rare to find wetlands around the project area.

4.4.2 Surface Water

Surface water quality is generally fresh and clear. However, with increasing agricultural activities, settlements and urban expansion, the water sources are potentially faced with pollution threat. There has not been consistent monitoring of the water quality from surface sources in the area, and particularly the smaller streams and tributaries to the main rivers. However, surface water looks physically clean, a situation attributed to the proximity of sources (the Aberdare slopes and springs) while the conditions progressively changes downstream as the sources interact with varying land use activities including agriculture, urban development and settlements. Among the key pollutants in surface water sources within the dam project location may include agrochemical residuals (from agricultural activities), nutrients arising from livestock keeping an application of the manure on the steep slopes as well as domestic wastes Among the potential pollutants observed include agrochemical residuals (pesticides, herbicides and fertilizers), infiltration from cattle pens and pit latrines as well as contaminated runoff from markets.

The proposed Kariminu II Dam is located within a convergence point of all the potential pollutant sources, among them Gituamba and Kanyoni Market centers whose storm water and raw sewage is likely to discharge directly into the dam at certain points. The table below illustrates findings from sampling of water at the dam site.

The dam designed for storage of storm water that would then release progressively downstream during the dry conditions. The gradual release will act as a balancing phenomenon for the river flows downstream. This will also regularize water quality downstream. The water treatment works and the transmission pipeline do not have notable implications the surface water quality. However, among the by-products of water treatment process include flocculation sludge and backwashing water that may affect the immediate Kariminu River water quality.

Table 7: Water Quality Results

Parameter & Units	level	Sample Source					Remarks
		Kariminu Water Fall	Karimiu Bridge	Nguruwe-ini River	Gathanje River	Kariminu upstream	
pH Scale	6.5 – 8.5	6.60	6.61	6.21	6.57	6.59	The surface waters are generally neutral
Colour mgPt/L	max 15	<5	<5	<5	<5	<5	Within acceptable limits
Turbidity N.T.U	Max 5	0.3	0.1	0.4	30.1	0.3	High turbidity levels at Gathanje river
Conductivity (25^0 C) µS/cm	Max 2000	44.1	43.8	35.1	41.7	43.1	Within acceptable limits
Iron mg/L	Max 0.3	0.24	0.2	0.3	0.8	0.2	Levels of iron are high at Gathanje River
Manganese mg/L	Max 0.1	<0.01	<0.01	0.14	0.18	<0.01	High manganese levels at Nguruwe-ini and Gathanje Rivers
Calcium mg/L	Max 100	2.4	3.20	2.4	3.2	4.0	Within acceptable standards
Magnesium mg/L	Max 100	0.97	0.49	0.97	1.95	1.95	Within acceptable standards
Sodium mg/L	Max 200	4.0	4.0	2.5	2.0	1.0	Within acceptable standards
Potassium mg/L	Max 50	2.7	2.7	1.6	1.9	2.2	Within acceptable standards
Total Hardness mg$CaCO_3$ /L	Max 500	10	10	10	16	18	Within acceptable limits
T. alkalinity mg$CaCO_3$ /L	Max 500	20	12	14	16	16	Within acceptable limits
Chloride/ mg/L	Max 250	NIL	4	1.0	1.0	2.0	Within acceptable limits
Fluoride mg/L	Max 1.5	0.15	0.14	0.11	0.12	0.14	Within acceptable limits
Nitrate mgN/L	Max 10	0.96	0.98	0.77	0.88	0.91	Within acceptable limits
Nitrite mgN/L	Max 0.1	<0.01	<0.01	<0.01	<0.01	<0.01	Within acceptable limits
Sulphate Mg/l	Max 450	<0.3	0.3	<0.3	0.7	<0.3	Within acceptable limits
Free CO_2 Mg/l	-	14	12	8	8	12	_
TDS Mg/l	Max 1500	27.3	27.2	21.8	25.9	26.7	Within acceptable limits

4.4.3 Ground Water

It is inferred from the geophysical data interpretation that there is a shallow aquifer at about 20m below ground level and a second one at 40m below ground level, the datum being the valley bottom. Alternative sources of water in the project area are ground water including boreholes and shallow wells and springs. It has been observed that deep aquifer boreholes with depths of ranging between 250 – 300m yields an average of $3m^3$/hr. It is, however, noted that the depth of the aquifers in most places is a major constraint in the exploitation of groundwater in the area, in addition to the maintenance of wells and springs. Wells found around the project area are

reportedly dug to depths of between 10m and 20m. Groundwater quality is influenced by potential infiltrating agrochemical residuals, nutrients from cattle pens and application of animal manure on farms as well as discharge into the ground of human wastes from pit latrines.

4.4.4 Rainwater

The project area receives an annual average rainfall of 1,420mm with two distinct peaks, in (April – May and October – December) with September being the driest month. It is noted that during the rains the river breaks its banks of the Kariminu River and floods making the lower parts of the river (downstream of the proposed dam wall) to be unproductive. There are notable investments in rainwater harvesting at homestead levels as well as the institutional premises. This significantly provides clean drinking water effectively circumventing challenges of water borne diseases.

Figure 16: Water Use

Water Abstraction Pump houses

Direct Water Access Points for the Public

Irrigating Food Crops on the Flood Plain

4.5 Biodiversity

The Project area ecological status has been degraded over the decades from agriculture and settlements, production of coffee, tea, pineapples vegetation and food crops demanding more land with rising population. There is no indication that species of unique or special biodiversity value occur at the site or in its environs. The Project site is therefore deemed to have very limited biodiversity value.

Biodiversity of the project location is highly influenced by the Aberdares ecosystem with respect to indigenous plant cover species. However, due to human activities, the indigenous plant

species have been displaced by exotic species that have also acquired economic values among the communities. Such plant species include tea, coffee, Eucalyptus spp, Cypress ssp., Caussurina spp. and Graveria SSP and wattle trees species. Other plant features include grass species, ferns, nappier grass, avocado, banana, yams (mainly in the river flood plains), cassava, sugar cane, pineapple, arrowroots, and coffee). However, any migration of wildlife into the area would be influenced by the Aberdares ecological system with elephants and hippos being the main species (this would be of concerns upon the commissioning of the dam).

Human habitation and agricultural activities have also significantly interfered with both terrestrial and aquatic habitats in the project areas. There is no terrestrial wildlife observed in the project areas since most land is under agricultural use for many years pushing the animals into the Aberdare forest. However, limited rodents like squirrels, moles and different bird species among others are found in the area (specific habitats characteristics will be established during the detailed assessment. Among the aquatic species present include frogs, fresh water fishes are found naturally in the rivers. Livestock keeping is significant with dairy cows, sheep, goats, poultry and house pets (dogs and cats) may also constitute part of the wider biodiversity).

The proposed project may significantly influence the biodiversity of the area through proliferation of aquatic species, attraction of new species extinction of others. It is also observed that;

(i) The project area does not host any protected area.
(ii) There are no conservation zones around Kariminu II dam project area.
(iii) There are no biosphere reserve are observed around the project
(iv) There are no RAMSAR sites are observed around the project

4.5.1 Fauna

The area is predominantly under farming and human settlements as well as notable institutional presence and market centres. For this reason, there is no terrestrial wildlife observed in the project areas since most land is under agricultural use for many years pushing the animals into the Aberdare forest. However, limited rodents like squirrels, moles and different bird species among others are found in the area (specific habitats characteristics will be established during the detailed assessment.. However, there are rodents such as squirrels, moles and snakes as well as different bird species among others. Livestock rearing is significant dairy cows, sheep, goats, poultry, and house pets i.e. dogs and cats.

Figure 17: Weaver Birds (A Common Feature)

4.5.2 Aquatic Life

Kariminu River harbours limited aquatic life influenced by the moderate water quality. Present aquatic animals are frogs, fish of different species like mudfish found naturally in the river. To greater extent sections of the catchment is utilised for fish farming mainly for local consumption. Among the aquatic species present include frogs, fresh water fishes are found naturally in the rivers. There is no notable economic value on aquatic ecosystem including fishing and hence the intensive encroachment on all surface water bodies.

4.5.3 Vegetation and Flora

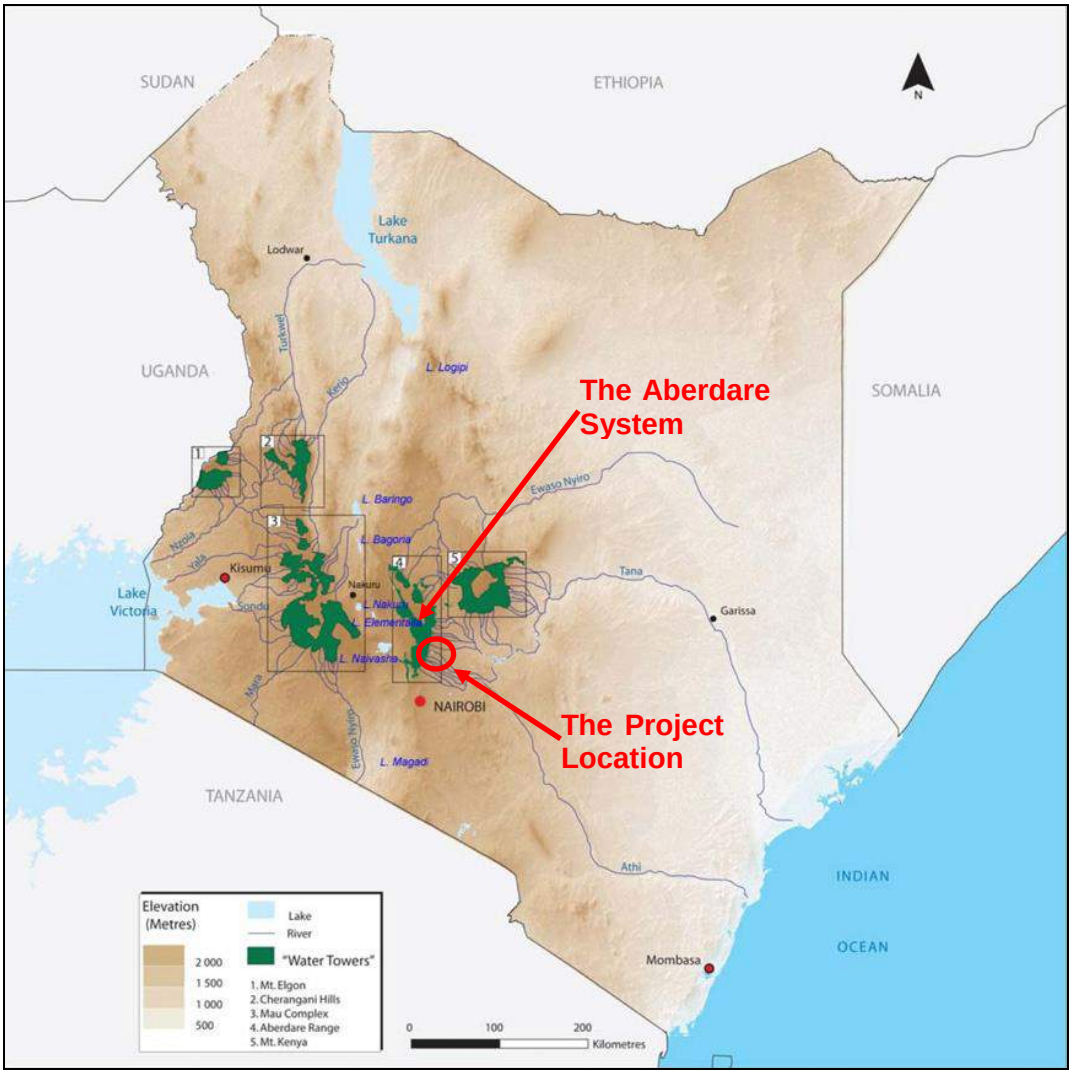
The project area vegetation cover is largely influenced by the aberdares but has been altered significantly through human activities specifically for agricultural purposes. (Kariminu river sub-catchment is in agricultural zone (IV) hence its viability for agricultural production). Some of the notable flora species include: Grass species (Kikuyu grass, ferns, nappier grass), Tree species (wattle tree, bamboo, gravellia, blue gum), farm crops (macadamia, mangoes, tea, avocado, banana, yams, cassava, sugar cane, maize, pineapple, arrowroots and coffee) and some riverine vegetation.

Figure 18: Land Cover

General Ground Cover (Agro-Forestry)

Tea Coffee Pineapples

Figure 19: Ecological Influencing Systems of Kenya



4.6 Geology and Soils

4.6.1 Geology Characteristics

The general area is mainly covered by Tertiary to Quaternary volcanic material overlying the Basement System rocks at a relatively greater depth. The volcanic suite comprises of pyroclastic tuffaceous and aggromelitic rocks intercalated with basalts which overlie the basement. The geology has been described in the report of Kijabe Area by Thompson (1964) These tuffs could be an extension of the Kerichwa valley tuffs of Middle Trachytic Division widely distributed in the Nairobi-Kiambu area as per the Nairobi report by Saggerson (1991), although the Kijabe report does not refer to them as such, though the descriptions is similar. Soil types are depended on underlying rock formations, surface drainage conditions and rainfall patterns.

The proposed dam site is located in a densely forested highlands varying from 1470m to 2610m above sea level. This region is deeply incised by east flowing streams. The valleys are narrow or V-shaped with narrow steep slopes, characteristic of young landscapes. The uplift, the relatively

soft volcanic rocks and the heavy rains explain this rapid down cutting and the streams flow in parallel courses. The geology's area is dominated by an alkaline volcanic activity producing a large succession of lavas and associated tuffs. It can be assumed that these slopes are of red clay soils 2 to 5m thick. Topsoil should be removed before starting building the embankment. There is no visible instability in the slopes around the dam but the water in the dam will create instabilities in the red clays.

4.6.2 Soils

Soils in Kiambu County develop from weathering activities of the volcanic rocks and are highly fertile with high levels of perforation. The soil organic matter content ranges from moderate (1.46% Total Organic Carbon (TOC) to adequate (3.26% TOC.) 87% of farms have TOC below adequate level and, therefore, low soil organic carbon matter content. The low soil organic matter content results in low water holding capacity and may lead to soil erosion by runoff water during the rains. This can also impact negatively on the microbial activities in the soil. Application of well rotten manure or compost will improve the organic matter content in the soil. This will supplement the soil nutrients and improve soil structure, water retention capacity and soil microbial activities.

Soils in the area are developed from weathered volcanic rocks and are moderate to high fertility, well drained clay loams. This explains the suitability of the soils for major crops such as cabbages, kales, carrots and potatoes in addition to tea, coffee and pyrethrum. The project area is characterised with high vegetation cover comprising of agricultural crops (tea, coffee, horticultural crops, maize and nappier grass) as well as agro-forestry (mainly blue gum, wattle and graveria species being the most common) in addition a variety of shrubs. With this level of vegetation cover, soil erosion (and indeed risks of landslides) is not significant.

Sediment release from land cover of specific plants is determined and is dependent of the root mass per unit area as well as duration of growth. Bamboo has the lowest with 15t/km^2/yr though its presence in the project is very low while maize has the highest with 2,000t/km^2/yr (it is present around the project area but in low quantities). Tea is at 220t/km^2/yr while forest cover allows only 20t/km^2/yr associated with the associated undergrowths that holds soil together. The project area has more tea bushes, medium areas coverage for forest and limited maize growing areas.

4.6.3 Mineral Resources

The area is not endowed with mineral resources as most of the area is farmlands where they grow pineapples and other food crops e.g. maize, arrow roots among others for subsistence use.

4.7 Climatic Conditions

4.7.1 Temperatures

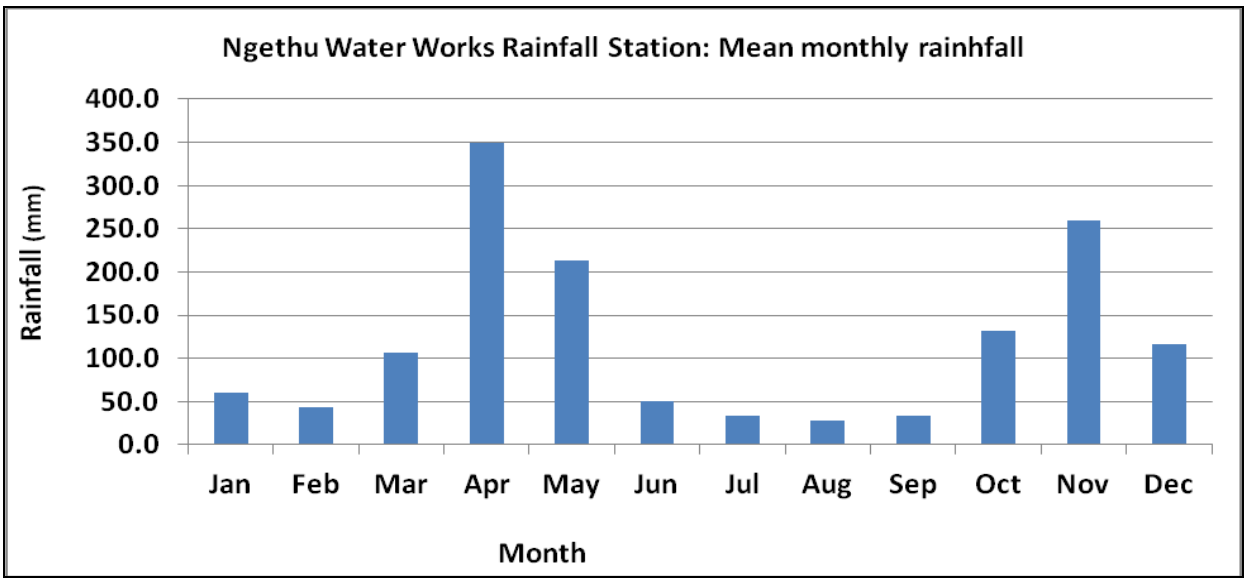
Temperature is also influenced by altitude due to the Aberdare ranges. Mean annual temperature varies from low in higher regions to high in lower region between 17^{o}C and 25^{o}C. The mean temperature in the project area is 26^{0}C with temperature ranging from 17.1^{0}C in the

upper highlands to 34^{0}C in the lower midlands. July and August are the months during which the lowest temperatures are experienced, whereas January to March is the hottest months.

4.7.2 Rainfall

The Kariminu River sub-catchment is characterised by equatorial climatic conditions and rainfall is highly influenced by altitude and comes in two seasons. Long rains occur between March to May and short rains between October and December. The annual mean rainfall varies from 1,070mm to 1,750mm per annum as deduced from the analysis of rainfall records at Ngethu Water Works Station No.9036308. The mean monthly rainfall distribution is depicted in the table and figure below. The sub-catchment experiences a long-term mean rainfall of 1,430mm.

Figure 20: Mean Monthly Rainfall (at Ngethu Water Works)

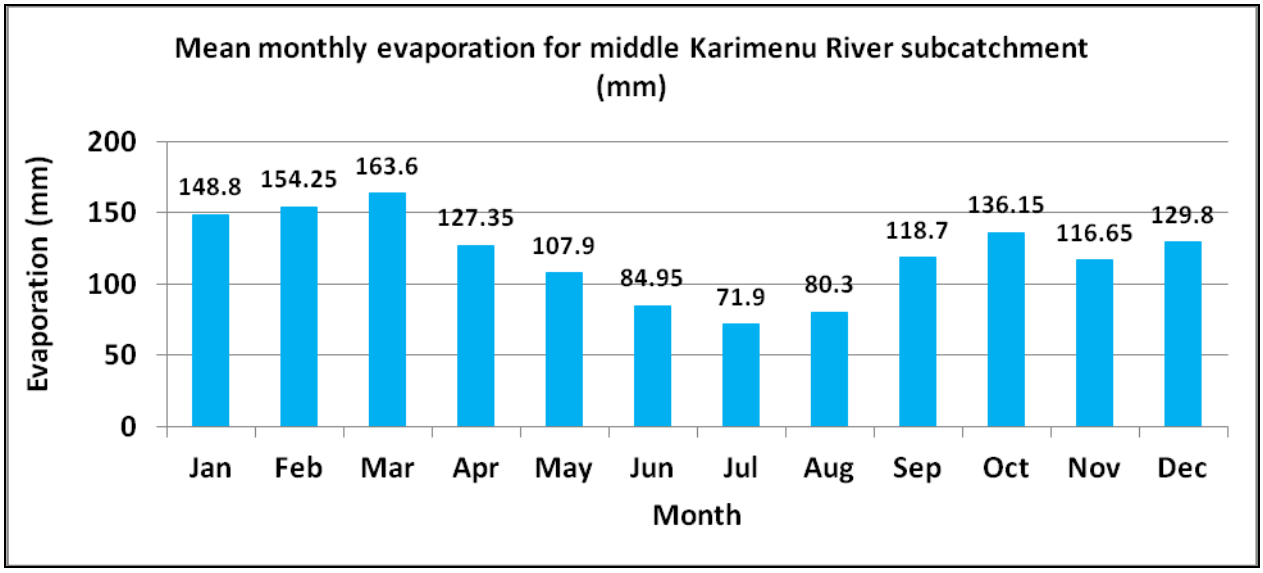


4.7.3 Evapo-Transpiration

Estimates of the rates of evaporation from open water surfaces have direct relevance to problems of economic importance for the county and the country at large. Such evaporation data make an essential element in studies of crop water requirements; they are basic to catchment area research and management, and have considerable bearing on the feasibility of irrigation projects. However, there is lack of adequate instrumentation to measure the evaporation rates in Kenya. Consequently, records observed at distant locations are used to give an estimate of the possible evaporation rates in a region.

For Kariminu River sub-catchment, two stations, namely Thika Meteorological Station and Kimakia Forest Station was selected to estimate evaporation rates in the sub-catchment. The proposed Kariminu River Dam area lies within the middle distance between the two stations. The average evaporation rates from the two stations are assumed to be the average evaporation that would be expected from the proposed dam. From the stations the expected mean daily evaporation from the middle reaches of Karimenu River sub-catchment including the dam development location is shown below;

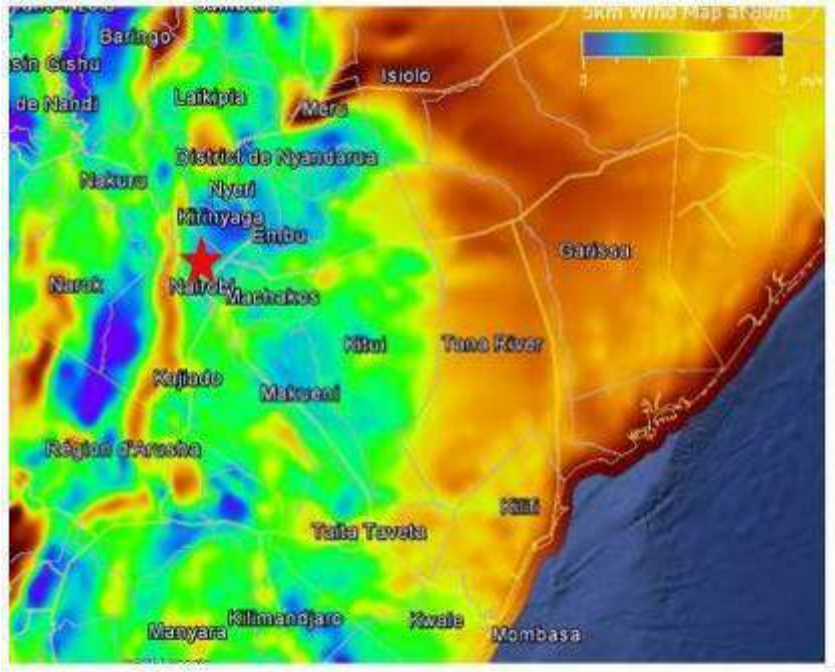
Figure 21: Mean Daily Evaporation Trends for Kariminu Sub-Catchment



4.7.4 Wind and Humidity

The main wind – direction is easterly, evaporation ranging from 100 to 150mm per month while the humidity varies from 50% to 90%.

Figure 22: Wind Patterns over Kenya



4.8 Status of the Catchment and Silt Transportation

The presence of sediments in rivers has its origin in soil erosion, where the erosion is a result of series of complex and interrelated natural processes which would loosen and move away the soil and rock materials under the action of water, wind and other geological factors. The most

important factors which influence the erosion from any area are rainfall regime, vegetal cover, soil type, land slope and land use. Land use is an important factor that controls the rate of erosion and poor cropping practices and removal of vegetation by fire accelerates soil erosion. For the Kariminu River sub-catchment, a major transformation of the middle catchment from forest and bush land into agricultural land has been observed.

On suspended sediment load transport, the Ministry of Water and Irrigation undertook some suspended sediment sampling and analysis in the period from 1979 t0 1982. However, due to the major changes that has occurred in the sub-catchment, the sediment load analysis results of over thirty years ago are not representative of the current situation. Under these conditions, the Practice Manual for Water Supply Services in Kenya (2005) provides some guidelines in estimating the sediment load as given as 500$m^3/km^2/yr$ for low erosion class, 1,000$m^3/km^2/yr$ for high erosion classes and 1,500$m^3/km^2/yr$ for heavy erosion classes.

The fact that Kariminu River sub-catchment has undergone major changes on its vegetal cover would suggest moderate levels of soil erosion and consequently moderate levels of sediment load of 1000 $m^3/km^2/year$. The conclusion on moderate levels of sediment load is justified by the fact that while some vegetal cover is cleared for planting pineapples, a major source of soil erosion; other areas in the sub-catchment have been planted with tea bushes which are effective in preventing erosion. Thus, the 105 km^2 catchment area for the dam will essentially deposit 105,000m^3 of sediment load per year. With a lifespan of 50 years, 5.25Mm^3 will be required for dead storage.

Assuming the main collector for the sediment will be Kariminu Dam, it implies in 1 year, 105,000m^3 of storage water volume will be rendered not effective for that purpose every year. The dead water storage of the dam (that is the volume just below the water off-take level) is designed at 1,000,000m^3. This implies that in 8 – 9 years, there will be no dead storage and the off-take level will be a risk of submergence or blocked leading to excessive silt into the raw water drawn for treatment.

5.1 Administrative Location

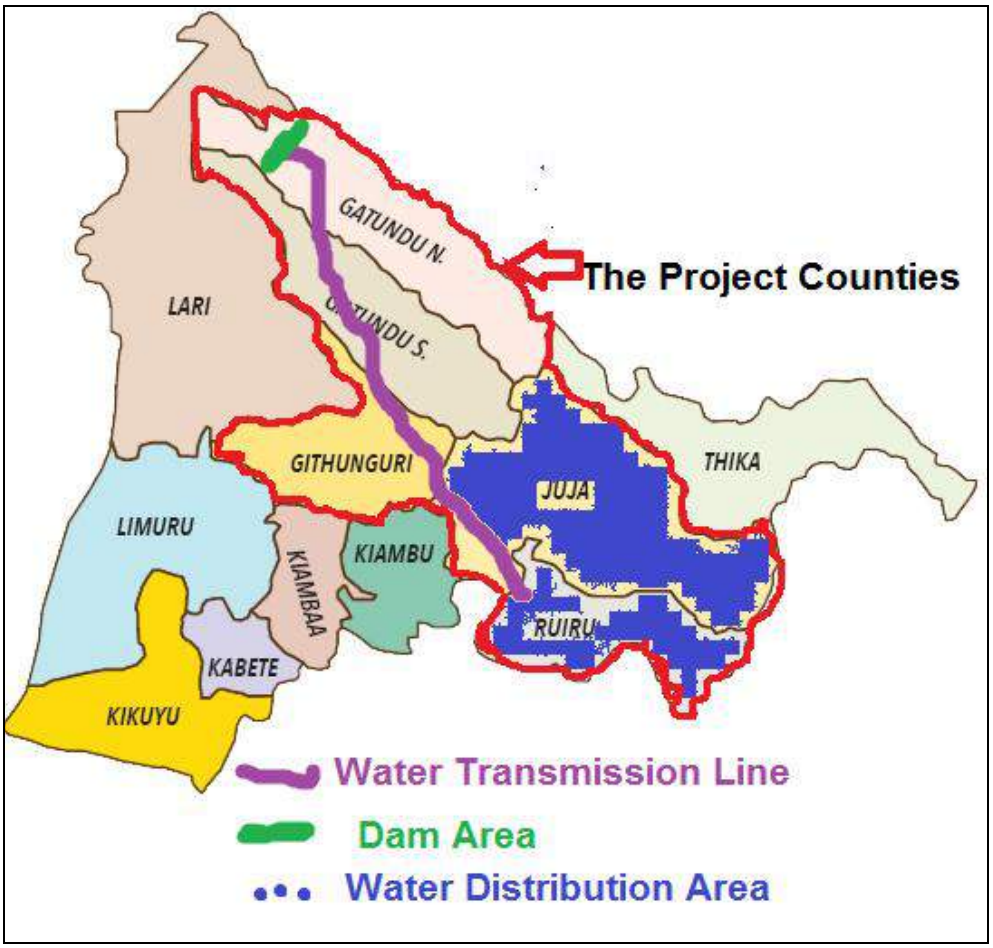
Kariminu water project consist of three components namely Kariminu dam, a water treatment plant and the water transmission line from the dam site to Ruiru and Juja towns. The Kariminu dam is administratively located in Gatundu North Sub-County, Kiambu County and 75km north of Nairobi. The dam falls within the two locations namely Gathaiti location (Kanyoni and Ndiko sub-locations) in Mang'u Division and Gituamba Location (Gituamba and Kiriko sub-locations) in Chania Division. It is located within the eight villages of Iruri and Gitina (Gituamba Sub-location), Gitwe and Town (Kiriko sub-location) and Muvau, Githing'a, Ngurueini, Gathanje and Bush.

The water treatment plant will be located in Buchana village, Kiriko sub-location. The water transmission line will traverse four sub-counties including Gatundu North, Gatundu South, Githunguri and Ruiru. In these sub-counties, the wtare project will be featured in the following locations:

(i) Gituamba, Gathaiti, Chania and Nyamangara locations in Gautundu North sub-county;
(ii) Ituru, Ng'enda, Kimunyu, Kamwangi and Muthati in locations Gatundu South sub-county;
(iii) Komothai and Ngewa locations in Githunguri sub-county;

The water supply areas include Juja and Ruiru towns both in Ruiru sub-county.. The figure below shows the administrative location of Kariminu water project within greater Kiambu County.

Figure 23: The Project Administrative Areas



5.2 Political location

Kariminu water project will feature in the five constituencies including Gatundu North, Gatundu South, Githunguri, Ruiru and Juja and in various wards as follows:

(i) Gituamba, Chania and Mang'u wards in Gatundu North Constituency
(ii) Kiamwangi and Ngenda s wards in Gatundu South Constituency;
(iii) Ngewa ward in Githunguri Constituency
(iv) Gitothua, Biashara, Gatongora, Kahawa/Sukari, Kahawa Wendani, Kiuu, Mwiki and Mwihoko wards in Ruiru Constituency
(v) Murera, Theta, Juja, Witeithie and Kalimoni wards in Juja Constituency

5.3 Population Features

According to the 2009 Kenya Population and Housing Census, Kiambu County had a total population of 1,623,279 with 802,609 being male and 820,670 being female. The average population growth rate in the project sub-county is 2.81% and the sex ratio is approximately 1:1.02. During the 2009 population centres, the project sub county was Gatundu while the project area fell within Kiriko and Gtuamba sub-locations in Gituamba sub-location. These administrative areas have since been subdivided where currently, the project falls within two locations and three sub-locations namely Gathaiti location (Kanyoni and sub-location) within

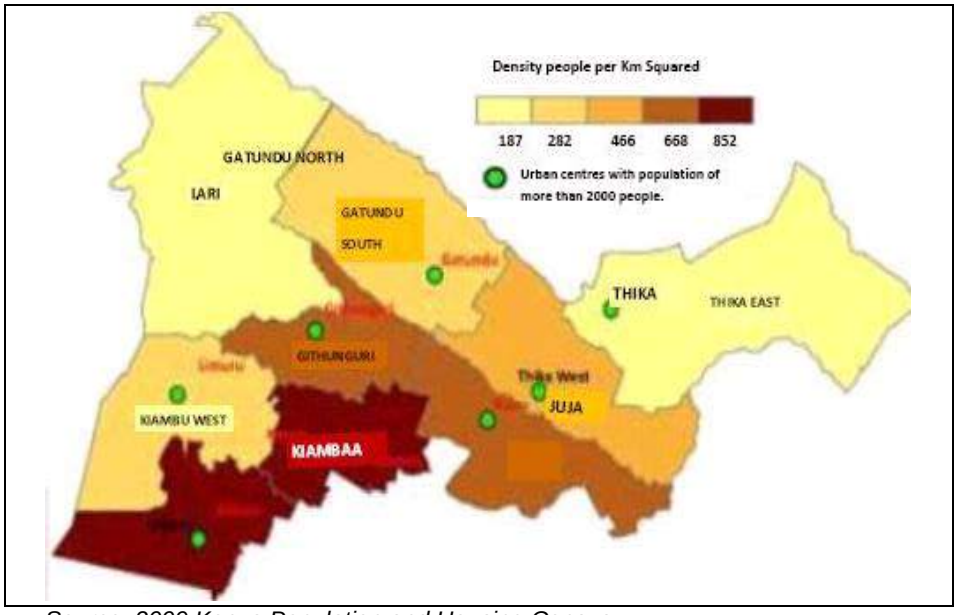
Mang'u divison and Gituamba (Gituamba and Kiriko sub-locations) . The administrative units of the project areas according to the 2009 population census is as illustrated in the table below:

Table 8: Population Trends

Area	Male	Female	Total	Households	Areakm2	Density
Githuguri Sub-County	29,083	29,688	58,771	15,709	61.3	959
Ngewa location	11,141	11,252	22,393	5,985	24.6	911
Komothai location	4,861	5,000	9,861	2,715	16.1	611
Thika west Sub-County	109,914	108,630	218,544	72,051	327.1	668
Juja location	17,298	16,836	34,134	11,233	45.9	743
kalimoni location	10,165	9,696	19,861	6,039	121.3	164
Komo location	2,168	1,993	4,161	1,514	39.2	106
Thika West location	69,093	69,679	138,772	45,856	91.0	1,524
Biashara	21,957	24,679	46,636	14,486	43.2	1,079
Ruiru Sub-county	120,550	120,457	241,007	75,184	292.0	825
Gikumari Location	6,972	6,835	13,807	3,793	112.9	122
Githurai Location	50,687	52,358	103,045	33,185	32.2	3,206
Kaahawa Sukari Location	12,005	13,450	25,455	7,877	5.6	4,581
Theta Location	11,318	11,816	23,134	6,184	31.1	743
Mugutha Location	7,975	7,912	15,887	4,789	59.5	267
Ruiru Location	31,593	28,086	59,679	19,356	50.8	1,175
Gatundu Sub-county	103,722	111,069	214,791	55,716	478.4	449
Kamwangi Location	9,740	10,631	20371	5,410	27.8	732
Ngenda Location	22,522	23,903	46,430	12,398	59.0	787
Mangu Location	3,052	3,251	6,303	1,585	6.4	978
Gituamba Location	7,289	7,606	14,895			

Source: 2009 population census

Figure 24: Population Density Map



Source: 2009 Kenya Population and Housing Census.

The average age for the youngest household heads is 27 years while the oldest is 92 years translating to an average age of household heads as 58 years. In the project locations, there is no notable gender population difference where 50% are male and 50% are females. The marital features of household heads in the project area are as tabulated here below:

Table 9: Marital features of household heads

Gender of household head	Marital status of household head		
	Married	Single	Widow
Female	24	3	22
Male	100	0	2

Table 10 Population Projections for the Project Supply Urban Centers

Town	2009 Census			2012 Census			2015 Projections			2017 Projections		
	Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total
Ruiru	119,147	119,711	238,858	129,627	130,240	259,867	141,028	141,696	282,723	149,181	149,887	299,067
Juja	20,488	19,958	40,446	22,290	21,713	44,003	24,251	23,623	47,874	25,652	24,989	50,641

Source: Kiambu District Planning Unit, 2011

5.4 Settlement Patterns and Housing

Settlement patterns are influenced by ecological and climatic factors including land fertility, rainfall amount and type of farming practiced and crops grown as well as number and intensity of economic activities and access to services (administrative, health and education). For example, cash crops such as tea and coffee attract a high population because residents have a higher preference for cash crops farming compared to food crops. Another reason for clustered settlement is the growth of market centres including Kamwangi, Kanyoni, Kiriko and Gituamba among others.

The above factors have led to emergence of two types of settlements in the project area including clustered and scattered settlements. Clustered settlement patterns are commonly found around market centres. Scattered settlement patterns are found mostly in the far flung areas outside market centres and their vicinities including sloppy areas and valleys. The average population density in the project sub locations is 536 persons per Km^2. The Table below shows that Gituamba sub-location has the highest population density of 541 persons per km^2 as presented in the table below;

Table 11: Population Density

Area	Area (km^2)	Density
Githuguri Sub-County	**61.3**	**959**
Ngewa location	24.6	911
Komothai location	16.1	611
Thika west Sub-County	**327.1**	**668**
Juja location	45.9	743
kalimoni location	121.3	164
Komo location	39.2	106
Thika West location	91.0	1,524
Biashara	43.2	1,079
Ruiru Sub-county	**292.0**	**825**
Gikumari Location	112.9	122
Githurai Location	32.2	3,206
Kaahawa Sukari Location	5.6	4,581
Theta Location	31.1	743
Mugutha Location	59.5	267
Ruiru Location	50.8	1,175
Gatundu Sub-county	**478.4**	**449**
Kamwangi Location	27.8	732
Ngenda Location	59.0	787
Mangu Location	6.4	978
Gituamba Location		

Source: 2009 Kenya Population and Housing Census.

The main types of houses in the counties are individual-owned, Government-owned and Local Authority-owned. The houses can be categorized by the type of material used namely; wall, floor and main roofing material.

Figure 25: Sample Housing Structures



Stone walled Flats building and a bungalow house


Buchana Catholic Church Building


Drum Sheets walled house


Timber walled house


Mud Walled Houses

5.5 Land Tenure And Land Use

5.5.1 Land Tenure

Land within the project area and its immediate neighbourhood is privately and publicly owned with the former accounting for over 90%. The publicly and government owned land in the area include the 30 meter Kariminu river line reserve, the 19 meters traversed by the Ndakaini-Nairobi water pipeline corridor, land constructed with roads and institutional land (schools, health centres and market areas). Privately owned land include the formers white settlement farms and land historically owned through clans which has however been replaced with individual land ownership vested to individuals where land changes ownership through inheritance or purchase.

Currently, majority of the people own the land on which they are settled where majority have title deeds or ownership documents. Others have land rightfully bequeathed to them but the transfers have not been affected. It is notable that most of the land in the community has shared Title deeds where by the title deed is shared amongst family extended members. Further, majority of land owners who owns big portions of land are not residing in the area, the land and the crops is maintained by workers. Those who do not have adequate land lease from others at a cost of KShs. 120,000.00 for one acre per year. The current cost for an acre of land in the area is approximately KShs.1.2 million.

5.5.2 Land Use

Land use is dictated by agro-ecological zones, soil fertility and climate as well as cultural practices. Land use in the project area is dominated by crop growing where majority of the land

is planted with tea, coffee and pineapples. Other land use activities in the area include: subsistence farming, livestock keeping, fish farming, housing, land occupied by infrastructure, forestry and the rest consist of water masses. In the urban and market areas, land is built-up with residential, commercial and industrial buildings.

5.5.3 Stakeholder analysis

There are stakeholders who will directly or indirectly interact with the project at the dam or the transmission corridors. The stakeholders range from local residents to the county governments as well as cooperative agencies as presented in the following table:

Table 12: List of stakeholders

Sector	Name of Stakeholder	Main Activities and Interaction Areas	Proposed Roles During Dam Construction and Maintenance
Agriculture	Gachege Tea Factory Agriculture	Tea Farming And Processing	Advise Tea Growers To Surrender Their Farms For The Dam
		Extension Survives	Assess Crops That Will Be Damaged
		Increased Production In Agriculture	Train Farmers On Environmental And Soil Conservation
Settlement	Residents and Landowners	Cultivation, livelihoods,	Coexistence with the dam and associated components
Education	Education Department	Management Of Education Programmes	Educating Pupils And Teachers On Importance Of Water
Religious Premises	Churches	Accesses to churches, safety of the church activities	Sensitization and awareness of the worshipers
Health	Government	Curative, preventive and promotion care	Prevention and curative care

5.6 Social Environment

5.6.1 Education

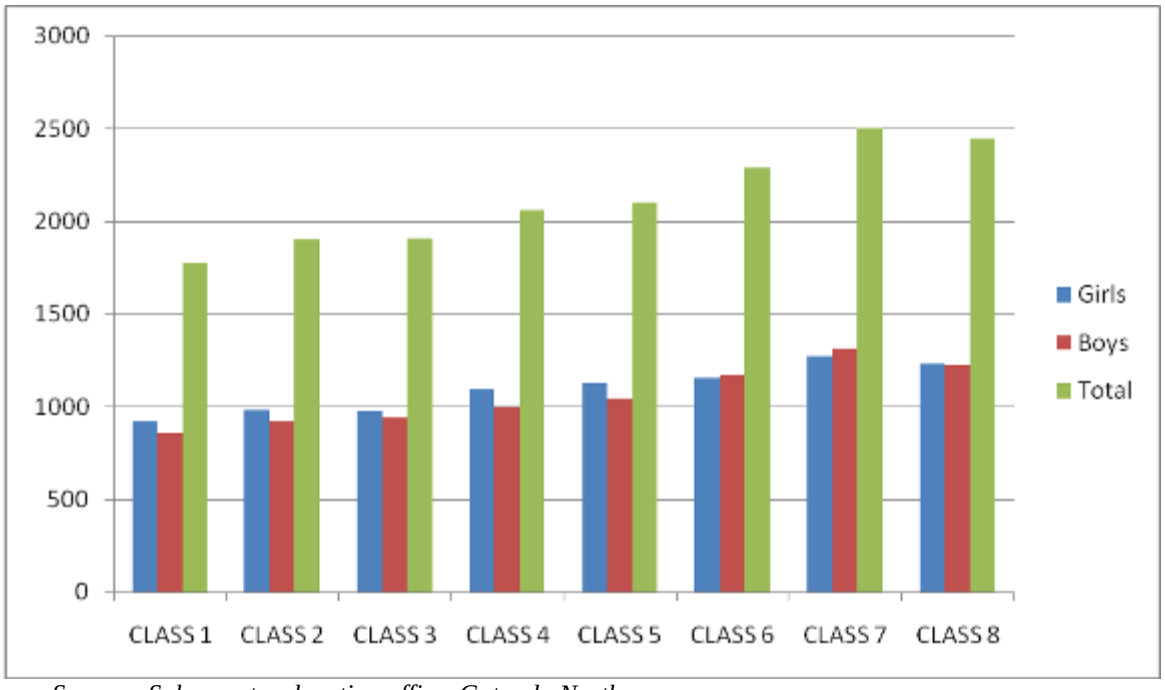
The following table summarises the major socio-cultural features in the project area:

Area/ village	Location	Houses /structures to be affected	Social features	Gender features
Ituru	Ituru	house is wall, earth floor is roofing	No learning institution along the transmission line will be affected	Men-business Women -cultivating household chores and ,business activities
Kiringa-inii		No houses to be affected	No institution to be affected	Women-cultivating Men-mining, farming
Gatundu south market	Gatundu south	Some residential houses will be affected(on the right)	No institution will be affected	Men - Business Women business
Ishaweri	Gatundu	New residential houses on the right(one floor storey)	No institution will be affected	Men-business/casual jobs Women cultivation

Area/ village	Location	Houses /structures to be affected	Social features	Gender features
Ithingu	Gatundu	Two homesteads and a nursery school to be affected on the right	Precious nursery school to be affected-35 pupils	Women Cultivation Men Business/casual jobs
Karembu	Gatundu	No structures to be affected	No school along the line	Women Cultivation Men Business and casual jobs
Ng'enda	Ngenda		Kiriri women's guide girls school(right)	Women Cultivation Men Cultivation/business and casual jobs

Kiambu County has high literacy level which stands at 90.1%. The project area is thus characterized with high literacy levels. There are also a number of ECD centres, primary and schools as well as tertiary institutions (public and privately operated). Gatundu North sub-county currently has a total of 60 public schools with a total population of 16,527 pupils including 8,578 boys and 8,473 girls. Class and gender distribution in the public primary institutions is as presented in the following figure:

Figure 26: Distribution of Pupils in Public Primary Institutions



Source: Sub-county education office, Gatundu North

The education institutions within the project area and its immediate neighbourhood are presented in the following table:

Table 13: Education Institutions at the Dam Area

Sub – Location	Schools
Kanyoni	Kiangunu secondary
	Buchana Primary
	Murata Wa Twana Primary
	Sam junior Academy
	South kanyoni primary
	St. peter karipitu
	Kanyoni township Academy
Gituamba	Iruri Primary
	Iruri secondary
	Gituamba youth Polytechnic
	Samrose Academy
	Simon Pete Academy (Secondary)
Kiriko	Our Lady of Patmos Girls Secondary
	Kiriko Primary
	Kiriko Boys Secondary
	Kiriko Special School

Figure 27: Sample Education Institutions

5.6.2 Water Supply

There is no formal water supply reticulation in the project area. Observed access to water practices included the following;

(i) The communities, therefore, obtain water for their domestic and livestock requirements directly from the rivers (surface water sources) in the absence of formal water supply reticulation. This also applies to the transmission pipeline corridor.
(ii) Institutions and factories have invested in pumping water from the river, part of which will be disrupted by this project.
(iii) Among the homesteads were also observed to obtain their water from shallow wells whose water quality could not be established.

The water is consumed untreated, though the quality is not expected to be harmful to human consumption (see water quality results).

Figure 28: Access to Water


Public River Water Access Point


Rainwater Harvesting


Ground water Shallow Wells

5.6.3 Health

Gatundu north sub-county is currently served by Igegania sub-district hospital which offers out patient, maternity laboratory and pharmacy services. It also has six health centres, six being government funded and two faith based and three dispensaries. The main health facilities in the project area include Kanyoni level 2, Gituamba community dispensary, Gituamba medical clinic and other four private clinics.

5.6.4 Diseases

The percentage Distribution of Population by Incidence of Sickness in the area reveals tjat morbidity rates are 20% where sickness is common among males (22.2%) than females (18.3%). The commonest diseases in the project area include Malaria (34.2%), Diarrhoea (29.3%) and upper/lower respiratory diseases (14.8%) and are presented in the following table:

Table 14: Common Disease Prevalence

Sickness	Prevalence
Malaria	65%
Wounds	50%
UTI	30%
URTI	80%
Eye infections	10%
Intestinal worms	40%
Skin diseases	40%
Pneumonia	40%
Ear infections	10%
Chicken pox	10%

Source: Public Health technicians

The commonest diseases in the project area include: Diarrhea, Malaria, Flu, Eye infections, Respiratory Problems, Hypertension, Stomach problems, Toothaches, arthritis and Tumor. Residents seek medical attention from both public and private health centres. The public health centres accessesd include: Gakoe Dispensary; Ngorongo Hospital; Igegania Sub-District Hospital, Gatundu District Hospital; Gakoe Dispensary, Gituamba dispensary, Igeagania Sub-

District Hospita, Kanyoni Health center; Kiambu Hospital and Thika Hospital. They also seek medical attention from private health facilities including Galaxy Medicare Consultants, Nazareth Hospital and Limuru. There is no reliance on traditional medicine in the area. The distance to health facilities accessed range from 1.5km to over 75 kms. Transport means used to access health facilities include: private car, Bodaboda, walking, hired transport as wellm as Public Transport

Figure 29: Sample Health Facilities

5.6.5 Sanitation and Hygiene

The project area is not served with water borne sanitation facilities. The major towns including Kanyoni, Gitwamba and Kiriko also are not provided with proper sanitation facilities neither is there drainage or waste management systems. The residents, therefore relies basically on pit latrines while only a few uses septic tanks and soak pits. Overflowing sewage, surface runoff and solid wastes are washed direct into the water bodies within the locality. In addition to general wastes, there are cattle sheds points around the water line

Figure 30: Point Sources of Water Pollution

Sample Pit Toilets

Sample Graves Sample Cattle Pen Soil Erosion

5.7 Economic Setting

The economy of the project area is determined by climate and available economic opportunities mainly arising from its proximity to Nairobi City and Thika Town. Thus the main activities are mainly agriculture and trade. The following table summarises the major economic features in the project area:

Area /Village	Location	Economic Features
Ituru	Ituru	Farming – maize, bananas, beans, avocadoes, sweet potatoes, pumpkins, nappier grass Animals reared Dairy Cows, chickens
Kiringa-inii		Farming – maize, beans, bananas, nappier grass, avocadoes, Stone mining (Kiringaini quarrying site)
Gatundu south market	Gatundu south	Business Rental houses Farming – coffee, bananas, nappier grass, maize, beans
Shaweri	Gatundu	Bananas, maize
Ithingu	Gatundu	Nappier grass, banans, maize
Karembu	Gatundu	No vegetation to be affected
Ng'enda	Ngenda	Maize, bananas, beans, nappier grass

Source: Field Assessment

5.7.1 Agriculture

The project area experiences bimodal type of rainfall where long rains fall between Mid-March to May followed by a cool season usually with drizzles and frost during June to August and the short rains mid-October to November. Thus Agriculture is predominantly the main economic activity and main source of livelihood for the majority of the population. It is the leading sector employing over 80% of the population directly and indirectly. The agricultural sector in the area is faced with many challenges that include erratic weather, fluctuating commodity prices, high cost of inputs and unexploited potential in trade and industry.

5.7.2 Crop Growing

The project area is notably self sustaining in food production in addition to cash crops thus agriculture becoming the main livelihoods for the households. The main crops grown include tea, coffee and pineapples. The main food crops grown are maize, beans and Irish potatoes. Other crops grown include mangoes, cabbages and flowers, bananas, avocado, tree tomatoes, sugarcane, arrow roots and sweet potatoes.

Figure 31: Main Crops Grown


Tea


Coffee


Pineapples


Agroforestry


Bananas


Vegetable on Flood Plains

5.7.3 Livestock Keeping

The main livestock enterprises are dairy cattle, poultry, pigs and sheep. Production trends for livestock and livestock products have been increasing over time. This sub-sector has been encouraged by a ready urban market in Thika, Ruriu, Kiambu and Nairobi and the availability of local food processing factories such as Farmers´ Choice Ltd, Ken chic Co. Ltd, and Brookside dairies, among others.

Figure 32: Dairy Farming


Nappier Grass


Dairy Cow


Typical Cow Shed

5.8 Natural Resources

Land is the primary natural resource in the area seconded by surface and sub –surface water. Though the area does have Permanent Rivers a large number of populations of the residents depend on raw water from rivers such as Kariminu River and boreholes. In addition, the project area has forest resources which are natural and also manmade that provides fuel, raw materials for wood products, soil conservation and prevention of water catchment areas.

5.9 Trade, Tourism and Industry Sector

Trading is one of the main economic activities in the area and is a major source of employment and market outlet for agricultural products. Kamwangi market, located along Thika – Naivasha road is the main town. Pineapples which are major economic activity in the area are sold in retail; there are no organized societies for fear of loss as it has been the case of coffee and tea.

This centre has a very busy market conducted twice in a week; Tuesday and Friday. There are four main markets in the project dam area namely Buchana, Gituamba, Kanyoni and Kiriko markets. Neighbouring the water transmission line are a number of markets ad scattered kiosks (some located in homestead compounds). The water distribution areas of Ruiru, Juja and Thika are awash with trading activities including wholesale/retail trade, banking and financial services and industrial production. Trade in these urban centres includes wholesale and retail shops, hardware shops, welding, financial institutions, Mpesa shops, butcheries, cereals and vegetables/ fruits, hotels, garages, Transport business, hawking, furniture shops, supermarkets, petrol stations, car washing sheds, small kiosks, farming of vegetables, maize and beans. There are two coffee factories (Kariko Coffee factory and Buchana Coffee factory) within the proximity of the dam area. Gacheche Tea Factory that serves tea farmers around the project area.

Figure 33: Trade and Employment

Kanyoni Market

Gituamba Market

Employment in Tea Estates

Buchana Coffee Factory

Kiriko Tea Collection Centre

5.10 Financial Institutions

The urban towns of Ruiru, Juja and Thika are well served by banks and other financial institutions that are concentrated in along the CBD of Ruiru town. The main financial institutions in the town are Kenya Commercial Bank, Cooperative Bank, Family Bank, National Bank, Equity Bank and Post Bank. In addition, there are numerous micro-finance institutions including K-rep and KWFT. The rural areas where the water dam and transmission lines are located have minor financial agencies including Tai SACCO, Cooperative and Equity located at Kamwangi Market

as well as M-pesa and bank agencies (KCB's Mtaani and Cooperatives' Jirani), Kenya women finance trust, Eclof Kenya micro finance, Jacaranda Sacco, Unes Sacco and Tai Sacco. Some of the insurance companies include; Washa insurance company, the monarch insurance and Solace insurance among others.

5.11 Infrastructure and Communication

The tarmacked roads include the Kanyoni – Mang'u – Thika road that connects the project area to Nairobi and Thika and Mangu-Gatundu town road. All other roads are dry weather roads which makes it impassable during rainy seasons to connect to the hinterlands. There are also minor roads criss-crossing the project area as well as foot bridges and pedestrian crossings. Public services available in the area include vans or matatus, minibuses and taxis transporting passengers to Thika, Ruiru, Juja and Nairobi city. Motorbikes also known as "bonda bondas" transport people to the hinterland areas.

Figure 34: Modes of Transport

Motor Cycles

Walking

School Transport

The area is covered well by the local mobile service providers in including safaricom, Yu, Orange and Airtel. Mobile phones are therefore commonly used as the means of communication. There are a number of cyber cafes that provide internet services. Electricity is readily available with many of the markets connected. However, some households have not connected despite availability of the Rural Electrification Programme.

5.12 Sources of Energy

The main source of energy in the area is electricity which is channelled from Thika as the main unit of electricity though there are many other sources of energy such as fire wood and biogas which people us to cook food and other house hold activities.

5.13 Cross Cutting Issues

5.13.1 Social and Cultural Aspects

The dominant ethnic group in the rural setting of the dam area and transmission corridor is the Kikuyu who consists of several clans thereby depicting monolithic culture based on Kikuyu customs and traditions. According to Kikuyu mythology, all of creation began at the summit of Mount Kenya. Although Gĩkũyũs historically adhered to indigenous faiths, most have today

converted to Christianity. Despite this adherence to Kikuyu customs and traditions, modern influence has eroded the traditional way of life for this community replacing indigenous believes with Christianity.

The urban towns of Ruiru, Juja and Thika are cosmopolitan in where residents are bilingual in English and Swahili. In addition, a large percentage speaks their ethnic tribal mother tongue. The dominant ethnic groups are the Kikuyu, Luhya, Luo, Kalenjin, Kamba, Kisii and Meru. There are also non-Africans consisting of Asians, Europeans and Arabs.

The project area is dotted with a number of institutions including social halls (Ruiru Catholic Church in Majengo Estate, P.C.EA Social Hall and Digithu Restaurant and Social hall), a number of religious institutions (churches, mosques and temples among others). Churches found in the project area include: Fathers house family church, Ruiru Baptist church, AIPCA church, Intercommunity international church, Redeemed gospel church, PCEA Ruiru church, St. Francis of Asis Catholic church, Deliverance Church, Bethel Ruiru Town and ACK Diocese of Thika. Others are catholic church (Martyrs of Uganda catholic church, St. John the Baptist, Catholic church Buchana Oasis of Hope, Buchana, etc), P.C.E.A Marima, Christian church international, Gospel Power Center and PAG Church – Kanyoni. Others include Iruri Catholic Church, Elim Church, Victory International Church and Restoration International Church among others. Close to a 100% of the residents within the dam area are of Kikuyu ethnic group where over 99% are Christians by religion.

The residents share various Socio-Cultural Assets including Churches, Schools; Coffee Factory; Tea buying Centre; Health Centres. There are also Cultural Resources and Assets in the area including the Mugumo Tree, Muringo, Mlebu; Mtundu and Fig tree. Other cultural assets in the area are numerous graves spread across a number of households.

Figure 35: Sample Religious Premises

5.13.2 HIV and Aids

HIV/AIDS is a major health problem with a prevalence rate estimated at 4.1%. However, the prevalence is higher in the coffee and tea zones and major urban markets. The main causes of the spread of HIV/AIDs include unsafe sexual behaviour, drug abuse especially drinking of illicit brews, peer pressure, ignorance, and family breakdowns among others. The socio-economic impact of HIV/AIDs in the county include; high school dropout rates, increase in female and children headed families, rising poverty levels; high mortality and morbidity rates and an increase in the number of OVC's in the county.

5.13.3 Gender

Gender can be defined as being a male or female and translated into the opportunities enjoyed by either of the two sexes as prescribed by the societal values and norms. The society in the project area has put restrictions on these opportunities thus causing disparities between male and females. In the project area, gender disparities are manifested through school enrolment, property ownership, access to credit and discrimination on places of work among others.

The main challenges facing males in the project area include: lack of technical knowhow, absence of role models, child labour, lack of drugs, poor infrastructure, low income, poor roads, insecurity and unauthorized tea hawking. The main challenges facing males in the project area include insecurity when late (night) at tea/coffee buying centres and markets, lack of capital, heavy family responsibilities, low impacts in decision making, absence of role models, child labour, lack of drugs, poor infrastructure and low income. The following are the main observations in gender status;

(i) Appreciable low gender disparities in provision of education and attainment of education at all levels of schooling
(ii) High status of women in society in decision making and development
(iii) Inadequate awareness and understanding of gender issues
(iv) Biases in property ownership/rights favouring men

5.13.4 Disadvantaged People

Problems facing the elderly people and people with disabilities include increased poverty, increased rates of abandonment of elderly persons and inadequate shelter and health for the elderly. There are vulnerable groups of people, communities and local economies within the proposed project area including women, children, the elderly and handicapped.

CHAPTER 6: LAND ACQUISITION AND COMPENSATION

6.1 Resettlement Action Plan (RAP)

RAP Study, a comprehensive evaluation of the land requirements and acquisition plan and associated compensation factors, is undertaken with respect to the ground settings including land sub-divisions, settlement trends, land use features and developments as well as going land values in the area. In this regard, the RAP Consultant is;

(i) Studying relevant Kenyan laws and procedures regarding displacement, land acquisition, and compensation;
(ii) Reviewing RAPs reports prepared for other recent similar projects by the Client in the same area;
(iii) Undertaking a detailed field survey of the proposed project to assist in defining the contents of the RAP report;
(iv) Consulting with the appropriate AWSB staff and other consultants to ensure harmony;
(v) Consulting with project affected persons (PAPs) affected by project.

For an effective exercise, the RAP exercise requires identification of the highest water levels and the buffer zone as defined from the Design Report and drawings. The high water levels and the buffer zone should also be pegged on the ground for detailed assessment in the preparation of the assets inventory and the census for the PAPs.

The Consultant is preparing a RAP Report that meets the requirements of the Kenyan guidelines and other international best practices. The report describes any particular conditions on resettlement to overcome social risks and discontent. Analysis and valuation of the assets affected was carried out and an entitlement matrix prepared with the list of all the PAPs and the approximate entitlements. Interactions with the PAPs indicate their preferred mode of compensation and resettlement. Among the modes anticipated include;

(i) Money for land and associated development
(ii) Payable values for specific developments
(iii) Land for land and house for house
(iv) Disturbance costs for each PAP (usually set at 15% of the compensation value).

The compensation proposals are focused on land for money since there is no suitable land in the area that best matches the current land in economic productivity and values, The logistics of establishing an entire settlement and a community is perhaps beyond the available resources capacity.

6.2 RAP Objective

The basic objective of the RAP exercise is to carry out a Socio-Economic Survey (SES) among the PAPs falling within the project area so as to collect information and generate data which are necessary for preparation of an appropriate RAP report. The activities below have been undertaken,

(i) PAPs identification and asset inventory to establish all affected parcel owners and quantifiable developments on the land,
(ii) Rapid PAPs Census of the nature and status of affected people in regard to households compositions, leadership, livelihoods, health aspects, housing and other socio-economic factors,
(iii) Consultations with PAPs to explain the project and seek their opinions and suggestions on how the resettlements should be undertaken,
(iv) Compensation Assessments to estimate values and entitlements to the land owners as the preliminary stages of the compensation process,
(v) RAP Implementation schedules to ensure order and known timeframes desired for the compensation of the PAPs,
(vi) Grievance Redress Mechanism as a tool to moderate extreme differences in terms of valuation, compensation factors and impacts generated by the project.

6.3 RAP Scope

Resettlement Action Resettlement report is to detail the existing land ownership, household setting, livelihoods and physical developments at the cut-off date. The report will present a detailed inventory of the project affected persons (PAPs) and a schedule of land acquisition and displacements alongside appropriate compensation factors including relocation destinations. Opinions and views of the PAPs will be presented from consultation forums held during the RAP process such as to inform key concerns for consideration in the implementation process. Other issues to be covered include RAP implementation plan and monitoring guidelines for adoption. Specifically, the report will address the following;

(i) RAP guiding principles
(ii) RAP activities
(iii) Cost estimates
(iv) Institutional arrangements for the RAP implementation
(v) Project impact on human settlements including historical and cultural sites
(vi) RAP Implementation schedule
(vii) Internal and external monitoring and evaluation mechanisms

6.4 Land Requirements and Costs Estimates

6.4.1 Land Requirements Criteria

Land Compensation

(i) Dam area land comprising of the highest water mark and including an buffer zone (30m on average) characterised mainly with agricultural land use features. Most homesteads are on the elevated locations above the buffer zones,
(ii) Water treatment works located aboiut 700m downstream the dam embankment (to accommodate a spillway and the areas affected through safety risks)
(iii) Treated Water Transmission pipeline linking with the Northern Corridor at about 5.5km from the water treatmet works.
(iv) Storage tank at Bennett's Ridge

Transmission Way-Leave Land Requirement

The proposed water transmission pipeline has been planned in three phases namely the raw water mains to the water treatment works, the treated water mains linking the water treatment works to the main Northern Collector pipeline, the Northern Collector section to Ngewa Junction on the Ruiru – Githunguri Road, the link from Ngewa Junction to Bennett's Ridge where the storage tank will be stationed and the link pipelines to Ruiru and Juja Towns. Acquisition of the associated land strips can be described as follows;

(i) The 700m section from the dam embankment to the water treatment works will be acquired as part of the spillway, safety zone and the treatment works.
(ii) The ~5.5m pipeline from the Treatment Works link to Northern collector with and estimated at 6m wide way leave (an entirely new way leave through private land with mixture of pineaples, tea bushes and other food crops). However, there is no possibilities of affected homesteads since the pipeline will run along the river flood plain for enhanced gravity flow to the Northern collector,
(iii) It has been instructed that the pipeline will run along the Northern Collector to the proposed Storage tank ~20km along the Ruiru – Githunguri Road near Ngewa. An additional 6m wide corridor is assumed to supplement the existing Northern Collector way leave to accommodate the new pipeline),
(iv) The location of the storage tank to the supply areas has not been identified. It is assumed that the tanks will require not less than 1 acre of land so as to accommodate security and care take housing facilities.
(v) It is assumed the distribution pipelines will run within the road reserves, otherwise, land will require to acquire for the way leave as the design will indicate)

Buffer Land Requirement

From the highest water mark to an average minimum of 30m above the high water mark and as defined by the access roads above the dam. This has been staked out by pegging on the ground and asset inventories were ongoing at the time of this submission.

Compilation of the RAP Statement

RAP Study is Ongoing and will be submitted when ready

6.4.2 Compensation for Land and Developments

RAP Study is ongoing and will be submitted when ready

6.4.3 Grievance Redress Mechanisms

Being developed under the RAP process and will be submitted accordingly

Note:

At the time of this ESIA Study Report preparation, Asset Inventories for the affected land were going for purposes of RAP were ongoing. This process is a preliminary quantification of the land requirements for the dam area, water treatment works and water transmission pipelines with a view to providing compensation factors for land and development. This will be followed by PAPs engagement and ultimate RAP report that will inform the valuation and compensation thereafter.

CHAPTER 7: STAKEHOLDERS AND PUBLIC CONSULTATIONS

7.1 Introduction

Consultative Public Participation is an important process in ESIA studies. Through this process, stakeholders contribute to the overall project design by making recommendations and raising concerns. In addition, the process creates a sense of responsibility, commitment and local ownership for smooth implementation of the project.

7.2 The Consultations

Consultation and public participation involve extensive discussions and in-depth interviews with AWSB, leaders, individual water committee members, national and county government as well as residents within the dam area/neighbourhood. During Consultation and public participation, the consultant presentations covered the following:

(i) The Water Act that has mandated Athi Water Services Board to invest in the provision of water infrastructure in her area of jurisdiction,
(ii) The design targets to harness the flood flow water leaving normal river flow to continue downstream (upto 70% of the base flow should be left to flow downstream to sustain aquatic life and social requirements of the river basin). The dam specifications including a wall 40m high, crest of 300m long and crest width. The estimated storage capacity will be about 14Mm^3 with as a safe yield of 100Ml/d (100,000m^3/day).
(iii) The EMCA of 1999 that emphasizes that any project should undergo an Environmental impact assessment to establish the positive and negative impacts of a project. Mitigation measures should be formulated to counter the negative impacts that would be anticipated during and after construction.
(iv) The socio-economic issues addressed and that are likely to change as a result of the project including settlement structures, population totals, structures and growth rate; economy and livelihoods; socio-cultural relations. The RAP will be undertaken which will also establish the number of graves and pit latrines that will need to be relocated.
(v) Active participation of the communities in the proposed development during the construction process and post-construction operations of the project..

7.2.1 In-depth Interviews and Discussions

In-depth discussions revealed that the water provision in the county is 44% which is lower than expected margin. With over 60% of the population living in the towns, it has increased the demand for the scarce resource. Even those with connections are forced to rely on raw river water as their taps have gone dry. This is compounded by the fact that they still are forced to pay high bills and this has begun to be viewed as extortion. The dam project development in the area was seen as an opportunity for the youth to get employed and to improve their living standards as well as social economic development for the area.

7.2.2 Consultative Forums

Two public consultative meetings were conducted for Kariminu dam during the ESIA Project

stage that included a meeting with the Community Dam Committee on 19th September 2014 at Kamwangi market and a public baraza meeting with the community at Kariminu Coffee Factory on 13th November 2014 held at Kamwangi Market. The committee meeting was attended by 15 participants (list of participants is in annex) while the public meeting, was attended by a total of 229 participants drawn from various villages around the dam area.

Figure 36: Stakeholders and Public Consultations Meetings

Figure 37: Rapid Consultations with Public

Further Consultation meetings were also held on 27th May 2016 at Buchana Catholic Church with the Community Representatives where 22 participants attended. In addition, intensive rapid

consultations have been undertaken during the social economic surveys and the RAP process. The socio-economic survey interacted with a total 152 people in a 75% sample around the dam and water treatment areas alone.

Note that additional interactions with more social inputs are to be obtained through the PAPs consultations under the RAP process. The above consultations and interactions have presented the following scenarios.

7.3 Emerging Issues

7.3.1 Social Situations

(i) A majority of the respondents have lived in the area all their lives with only a few having migrated into the project areas from among other places other Kiambu areas, Muranga, Laikipia, Nyahururu, Thika and Nairobi,
(ii) The main occupation is farming though a few indicated among other involvements including business, employment within and outside the project area,
(iii) A majority of the respondents are educated upto primary school with a few holding secondary and university education certificates. This situation, however, is associated with the fact that most of the respondents are the landowners who are generally elderly people (>50 years),
(iv) Common diseases and infections are mainly environmental (malaria, influenza, diarrhea, typhoid, respiratory infections and eye infections. Others include dental problems, arthritis, ulcers, diabetes, hypertension, etc.
(v) The most common mode of local travel is walking and motorcycles (commonly known as bodabodas) in accessing the markets and services (schools, health services and churches). Links to the major towns including Thika and Nairobi City, the area is served by Matatus,
(vi) There is a general high quality of housing (stone walls, timber walls and iron sheet walls with iron sheet roofing) indicating a fairly well economic status,
(vii) The project area is well served with electricity (high connectivity), access to water (rain water harvesting, piped and direct from surface water sources). However, new communication technology has not picked in the area and all relies with the common mobile phones,
(viii) A large percentage of the residents are served with pit latrines for their sanitation needs and only a few use septic tanks for flush toilets
(ix) Increasing insecurity and family disputes were reported as main challenges facing the residents in the project area,
(x) There are a number of community based organizations in the area, mostly formed by the residents to meet their local needs.

7.3.2 Perceived Benefits

Benefits perceived to emanate from the project included;

(i) Job opportunities for the local people, especially the youth during the construction phase.

(ii) Appreciation of land values in the area following potential opportunities associated with the dam,
(iii) There are opportunities associated with the dam including water supplies to institutions, fishing, limited irrigation and tourism,
(iv) Potential enhanced pool market for the produce in the area, especially in regard to associated supplies to the dam operations and support services
(v) Improvement of transport in the area through the development of access road into the dam areas
(vi) Potential for access of water to residents and landowners along the transmission pipeline corridor,
(vii) The ultimate benefits in improved water supply for Ruiru and Juja Towns within the same county,
(viii) Acquisition of land for the dam construction has a potential economic opportunities for the affected persons,

7.3.3 Fears and Concerns

(i) The process of preparation and especially construction may not be all inclusive allowing the residents to participate in sharing ideas as well as getting opportunities for direct and indirect employment.
(ii) Those without land ownership documents feared that they may not get adequate compensation and/or may completely miss out. This may include those who don't have death certificates but have documents to establish them as the next of kin.
(iii) There were also fears that the government may offer little compensation than that of the market value
(iv) Those downstream raised concerns that the dam may take too long to be filled up with water. This may deny them access to the water for domestic and irrigation within the time before the dam is filled. Other counties where the water is consumed should pay a certain amount for the water.
(v) Residents left behind after others are resettled may no longer have an opportunity to benefit and still resume to growing arrow roots and fishing from the river.
(vi) It was observed that delays in construction of the dam and inadequate information has resulted to unnecessary psychological suffering on the residents who have no motivation to further develop their land as they fear of being evacuated.

7.3.4 Key Suggestions and Opinions

The following are among suggestions from the community whose details are in annex.

(i) There is need for informed about the start and construction duration for the project early in advance to enable affected persons plan their lives,
(ii) There was also a request for early notice for relocation of graves and compensation for the relocation. There may be need to identify a common place for relocation of the graves that will be exhumed. Further, advance information should be provided on when the census begin, the valuation and the total discloser of the amount of money to be paid,
(iii) During the whole process, there is need for the committee to be transparent at all times. The resettlement process should be humane as many in the past have been

treated very badly during valuation,

(iv) The RAP process should involve all family members while payment need to be undertaken with both of the land owning couples so that none of them elope with the money. The divorced women, children and unmarried women should also be included as the beneficiaries of the resettlement money. Compensation money to be paid to landowners directly,

(v) Those affected should be allowed to harvest the trees they have planted. Along the same line, there is need to draw a memorandum of understanding with AWSB for the community to be allowed to benefit from the dam in terms of fishing among other uses of the water,

(vi) The project may lead to further marginalization of the older women children who are orphans should be helped through special programmes built within the project financing,

(vii) Those hoping to be compensated feared that they will be attacked by their children over inheritance so as to get the money. This is worsened by the fact that some have joint account with their parents and also live on land that is commonly owned.

(viii) The perceived PAPs were divided over whether to be compensated with land for land instead of money which may bring a lot of wrangles in our families. Those who preferred land for land proposed that they be compensated three times the actual value to cater for lost attachment value,

(ix) There were suggestions that the PAPs be given basic investment knowledge to enhance associated benefits to the families.

8.1 General Impacts Overview

Construction of large dams is beneficial to the stakeholders and the country in general. However, it has its fair share of ecological as well as social challenges. Impoundment of large volumes of water has implications on the upstream systems through shifting of ecosystem boundaries upstream as a result of changes in flood regimes. At the dam site itself and the inundated areas, implications ranges from slowed silt, nutrients and pollutant transportation rate to downstream zones, potential loss and/or introduction of species (both plants and animals), displacement of social and economic features and land use changes for the residual riparian landowners. Finally, downstream impacts are associated with regulated flows of the affected rivers/streams, shifting of species to upstream areas, safety risks, deprived sediment load and land use changes due to the constant flows trends introduced by the dam.

The above concepts guide the identification of the impacts associated with the development and operations of the proposed Kariminu Dam, water treatment works and the water transmission pipelines.

8.1.1 General Impacts Outline

The impacts outline comprises the following;

(i) The hydrology of Kariminu River and associated rivers and stream will slightly change. Retention of flood flows and abstraction of water of the same for supply to the beneficiary areas implies none-availability of the equivalent flow for social and ecological requirements downstream the river. However, the dam is expected to moderate the flows downstream during the low flow periods,

(ii) Water quality issues with respect to the watershed and catchment land use practices. The main pollutants from the catchments include agrochemical residuals and silt while the immediate impact arising from the settlements (nutrients from cattle sheds and organic matter from pit latrines as well as urban wastes from the markets. Other sources of pollutants to the dam during and after construction include graves, contaminated soils from long term sanitation facilities and accumultaed agrochemicals on the soils at the dam site. Accumulation of the pollutants in the dam water (in the sediments and water phases) may slowly get discharged downstream effectively impacting on the water quality,

(iii) Retention of sediments in the dam and reduced flood areas downstream the dam will reduce the productivity of the flood plain ecologically as well as from the dominant agricultural cropping,

(iv) Geological trends studies in regard to physical water retention. This has got relation to loss of water through infiltration into possible fractures on the sub-surface geology. This water may be not be accounted for. Likewise, there is a possibility of recharge of water into the dam arising from ground water springs submerged or arising after the construction. The additional water may also not be accounted for,

(v) Completion of the dam may lead to emergence of new and/or increase of plant and animal species in the project area. There is potential migration of animal species to the dam area with potential safety conflicts with the local communities. Other species

residents of the area could also get extinct as a result of changing aquatic and climatic conditions,

(vi) The dam is submerging notable physical features including small fall, river meanders and some springs that would otherwise provide natural touristic points for the County Government of Kiambu,

(vii) The dam water may influence land use changes on the riparian zone. This will be dependent on the desires of the landowners as well as the allowable access and land use practices. There is potential for landowners to focus on changing land use to commercial purposes from agricultural while others may seek to enhance agricultural output through controlled irrigation. These scenarios may have notable impact to the dam water vice versa including compromise on the water quality and safety of the residents,

(viii) It is possible that the dam may attract increased population to the project areas leading to social impacts among them land use changes, increased settlements, diversity in economic activities, diversity in cultural features and changing public security,

(ix) The project will impact on critical amenities serving the communities. Among the amenities will include access roads and bridges linking the two sides of the valley, water supply pipelines, power lines and water access points in the rivers. Appropriate replacement of the same will be necessary,

(x) Key social impacts are associated with the anticipated disruption of social and economic activities arising from the construction works of the dam and laying of the water transmission pipelines. While there is will be a comprehensive compensation plan, the natural attachment to land and development, especially for the elderly may not work any monetary or replacement values.

The water treatment works and the treated water transmission pipeline are not expected to pose significant impacts to the environment. However, the construction may have limited and short lived social impacts that may include safety risks, disruption to accessibility and soil erosion and siltation of the river bed. Detailed impacts and mitigation measures in this regard have been discussed under this report.

8.1.2 General Mitigation Measures on General Impacts

This document shall serve as the main reference guide towards mitigation of the impacts associated with the project construction and operations thereafter. The document presents specific mitigation actions and a comprehensive environment and social management plan for integration into the project implementation. For effective integration of the mitigation measures, close collaboration will be required between the Contractor and the Project Supervision.

8.2 General Cumulative Impacts

8.2.1 Cumulative Impact Outline

The development of the infrastructure and abstraction of water from Kariminu River system will introduce changes in the river systems both upstream and downstream of the dam. Cumulative impacts are also attributed to the emergence of dams in the region among others including Thika Dam, Ruiru Dam, Theta Dam, etc. Among the cumulative factors include the following;

(i) Effects of the dam and associated water abstraction to the increasing demand for social needs and the ecological requirements, hence potential long term reduction to available flows,

(ii) Increasing demand of water in the area from the residents who depends on the River and its tributaries (the rivers and streams discharging into Kariminu River basin acts as the main water sources for the residents). This situation may lead to challenges to long term recharge of the dam from its catchment,

(iii) Potential change in the local weather including ambient humidity as a result of additional water surfaces arising from this dam as well as other dams emerging int the regions. This scenario may be experienced throughout the year,

(iv) Retention of water in dam across the Basin Rivers (implying all the dams developed on rivers within the region) will have a moderation effect to the base flow downstream over the seasons. This implies that even though the water supplies and contribution to the hydro-power generation activities (including the Thika Water Supply, irrigation demands in Yatta Furrow, the Seven Folks Dams, etc.) will receive reduced flows, there will be a regular discharge throughout the year,

(v) Downstream of the dam (and indeed all the dams in the region), the river flow dynamics may suffer modifications including others flood regimes, moderated but flower levels and runoff distribution, decrease in downriver sediment transport, decrease of downriver flux of nutrients as well as disruption of flora and fauna along the river length,

(vi) Productivity of river flood plains is dependent on deposition of silt from the catchment that brings with nutrients and minerals. Retention of silt in Kariminu Dam and other dams in the region over duration of time will effectively reduce the overall silt loading as well as the overall flood areas. This may lead to reduction in productivity on Kariminu River basin downstream as well as combined basin systems far downstream,

(vii) With every additional dam in the region (this including Kariminu Dam), there are slight changes to the biodiversity. There is potential attraction of new animal species into the water bodies including hippos, crocodiles, snakes and certain fish species and lesser aquatic fauna. Emergence of new wildlife species in the greater area may have notable conflicts with peoples safety,

(viii) Potential cumulative effects to Ruiru and Juja Towns from additional water supply and associated additional wastewater generated. There is perhaps inadequate sanitation capacity in the two towns to handle the additional wastewater,

(ix) Increasing reduction of overall flows in the regional rivers also affects the capacity of the handling the pollutants discharging from agricultural, settlements and urban areas including agro-chemicals, organic matter and urban pollutants through dilution.

The water transmission pipeline is not expected to impart significant cumulative environmental impacts. However, there are additive social impacts arising from land acquisition and loss of development including agricultural crops (tea, pineapples, coffee and food crops as well as trees). The existing Northern Collector measuring 18m wide is the single most combination of pipeline delivering water into Nairobi. Additional pipeline from Kariminu Water Treatment Works and others in the master plan are requires more land to be acquired. In addition, there are other separate pipelines running through the project region from sources delivering water to various consumer areas that cumulatively have notable future land use conflicts.

8.2.2 General Mitigation Measures to Cumulative Impacts

The main cumulative environmental and socioeconomic impacts resulting from the proposed development of Kariminu II Dam and other similar projects in the region will be related to the damming and abstraction of water and the resulting reduction in downstream flows in the rivers. The following are mitigation proposed measures;

(i) There shall be appropriate mechanisms for continuous assessments of the required downstream reserve flows including both environmental flows and also compensation flows (sustaining the base flow through the dam and ensuring only flood flows are retained in the dam),

(ii) On the basis of the above mechanisms, the management will need to establish operational procedures so that under periods with naturally low flows (e.g. extreme dry conditions) sufficient flows are allocated to;
- ✓ Cater for downstream demands from communities, households, agriculture (crop production and livestock), commercial or industrial requirements,
- ✓ Provide environmental flows of sufficient quantity to prevent critical decline of downstream aquatic environments and aquatic productivity,
- ✓ Ensure the maintenance of water quality (including the requirements related to sewage treatment and disposal) through adequate dilution of pollutants discharging into the downstream zones of the rivers. The pollution loading from sources may require to be monitoring and allocation of appropriate flows from the ALL the dams,
- ✓ Provide some flow for Satellite town's (Juja and Ruiru) water supplies and other beneficiary areas whilst taking account of available storage in reservoirs.

(iii) Design management monitoring and reporting procedures so that all the dammed rivers' flows can be monitored and reported on a regular daily basis both upstream and downstream each dam structures to provide the basis for day-to-day operational management decisions,

(iv) Prepare a programme for cumulative impact audits for ALL dams in the region which is expected to include the following primary considerations flow trends downstream, emerging water demand against the available flood flows to be shared, level of flow moderation downstream without compromising on the desired off-takes;

(v) Continuous consultations with the Agricultural Sector on flows availability for use in future agricultural activities in selected downstream areas (irrigation) in food production required by the increasing urban population.

(vi) It will be necessary that Athi Water Services Board consider integrating water transmission pipelines into defined corridors. This will make management and administration of water transmission pipelines much more easier and sustainable.

Cumulative impacts have been addressed comprehensively under the specific impact aspects in the following sections. Associated mitigation measures have also been presented.

8.3 Environmental Impacts and Mitigation Measures

The overall impacts arising from the dam construction are positive in all respects of environmental, social and economic perspective. Once constructed, Kariminu Dam will supplement water supply to Ruiru and Juja Satellite within the "Effective Envelope" of the

Nairobi Water Demand. Among the major environmental impacts likely to occur during the project implementation include

8.3.1 Sedimentation Impacts

Construction Impacts

During construction, activities will involve massive earth moving within the river flood plains and sections of the adjoining riverbanks and lands. They may lead to the following;

(i) This loosening of the soil on the steep slope terrain will create a situation where heavy rains will wash down the silt into the downstream areas including Kariminu, Gakuru-ini Rivers and ultimately Chania and Thika Rivers with effects to the downstream users.
(ii) The silt so washed down may contain high levels of organic matter and agro-chemical residual with potential risks to the associated aquatic life in the river basin downstream.
(iii) Construction of the dam is also associated with the provision of access roads developments which will also contribute to vegetation clearance outside the dam zones to the nearest public access road effectively contributing to siltation to the river downstream.
(iv) Excavation works for the water treatment works (situated ~700m from the dam wall) as well as the 5.5km stretch of the pipeline to run along the river flood plain will potentially generate and discharge silt into the river bed and hence affecting the water quality downstream,
(v) Surface runoff from the stretch of the Northern Collectors targeted for the pipelines is also a potential transporter of the silt so generated to the drains and streams and ultimately to the rivers.

Post Construction Impacts

Generally, dams and reservoirs hold approximately 90% of sediments from the catchments due to the embankment and limited scouring. The sediments generated depend on the catchment characteristics i.e. soils, topography and vegetation cover. The slope of the river is estimated at less than 1% and the flow is physically sluggish, a situation that indicates a higher retention and storage capacity and ability compared to the transportation speed. Due to the continual siltation of the dam and the overloading of the dam, effects could be felt upstream of the river basin and its tributaries.

From the hydrology studies of the project dam catchment area, it estimated that 105tones equivalent to 105,000m^3 per year of sediments will be moved per year into the dam. The implication of this is that with a lifespan of 50 years, the dam requires 5.25Mm^3 for dead storage. This storage will also deny downstream flood plains the opportunity for production on ecological and social terms.

Cumulative Sediments Impacts

Continued reclamation of the catchment areas and encroachments into the river flood plains by the riparian landowners will generate higher levels of silt into the dam hence progressively compromising on the design storage capacity. As shown above, with a maximum of 18.9Mm^3

design storage capacity for the dam, 5.25Mm^3 will be taken up by silt within 50 years of the dam, translating to about 30% loss in capacity.

Silt transported through river basins has immeasurable values to downstream social and ecological aspects. Silt depositions in flood plains bring nutrients and hence enhance productivity to the farmers in the affected rivers. Equally, ecological productivity (aquatic weeds and micro-flora required for aquatic macro and micro organisms) is dependent on silt brought in from the catchment areas. Enhanced retention of silt in the dam and other barriers along Kariminu River basin as well as all other dams in the region, therefore, may negatively affect the farmers relying on the silt deposition downstream for a long time as well as the nutrients required for ecological productivity in the rivers downstream including Chania River, Thika River and Tana River far downstream.

Mitigation Measures

- ✓ It is recommended that construction be undertaken during the dry conditions to minimize erosion when the soil is loosened. The top soil removed will be required to be moved to an alternative site where storm water cannot carry the soil to the streams.
- ✓ A water pan (silt trap) may be established downstream of the dam which will act as a soil trap to hold the excessive silt during construction.
- ✓ The steep slopes surrounding the dam construction should be stabilized, compacted and strengthen to reduce on erosion and potential landslides as a result of deep cutting,
- ✓ Drainage channels should be installed only when necessary,
- ✓ Encourage re-afforestation and improved farming systems upstream of the dam,
- ✓ Local residents are using the water river as principal source of water (drinking water). The residents should, therefore, be provided alternative access to clean drinking water during the construction period. Such as to include additional shallow wells, access to other streams or delivery of clean water with tankers to schools and institutions,
- ✓ Erosion and sediment monitoring and control plan should be prepared for the lifetime of the project.
- ✓ There should be a progressive catchment management plan targeting Kariminu River sub-basins as well as the tributaries feeding into it. In this regard, involvement of the communities, landowners and relevant authorities will be necessary,
- ✓ The design of the dam should provide for scouring or regulated discharge of silt to downstream riverine regimes for sustenance of agricultural and ecological productivity. This should be considered for all dams in the region,
- ✓ Develop a deliberate initiative for a collaborative monitoring of river flood basins productivity requirements and their reliance to the silt loading for all the dammed rivers associated with the Thika River sub-basin to guide an effective silt management at the dams' outlets.

8.3.2 Water Quality Impacts

Construction Impacts

Water quality in the local water courses may be affected by;

(i) Site clearing and the disruption of the natural drainage patterns,
(ii) The farming activities and the construction phase of the project may encourage increased water turbidity within the dam reservoir,

(iii) There will also be potential water contamination from hydrocarbons mainly from the contractor's machineries,

(iv) Cumulative contaminants arising from decommissioning of pollutant sources that might be slowly released into the water. Among the sources water pollution would be potentially submerged or incomplete decommissioning include graves, pit latrines and cattle pens,

(v) Vegetation and humic soils leading to elevated organic pollutant levels.

(vi) Construction of the water treatment works and the treated water transmission pipelines do not have significant impacts on water quality apart from the potential silt loading from the excavation activities.

Post-Construction

(i) The project area is characterized by agricultural activities (farming and livestock keeping) with community settlements. There is a large number of cattle pens along the high water mark and buffer line that will discharge residuals into the water. The factors most likely to affect the water quality are biomass (crops and animal waste), agro-chemicals (acaricides, pesticides, chemical fertilizer, which are used in the farms,

(ii) Pit latrines are also found on the lower sides (towards the water line) in almost every homestead. Infiltration of pollutants associated with human wastes cannot be ruled out with long term contamination of the water,

(iii) As a result of prolonged discharge of animal, human and plant matter into the dam, the water stored in a dam or reservoir is subject to undergo certain physical, chemical and biological transformations. These phenomena are induced by climatic conditions (heat exchanges, aeration, etc.), chemical exchanges from geological formations, aquatic chemical reactions and material degradations among others as well as biological reactions associated with the organic materials decaying (biomass and humic matter decomposition).

(iv) Nutrients deposited into the dam from agriculture activities may lead to eutrophication and growth of the aquatic vegetation hampering the free flow of the water at the off-take installations,

(v) On the other hand reduction in the flow of water downstream will consequently result to increased concentration of pollutants downstream especially during the dry season.

(vi) Water treatment works generates by-products among them sludge from the filters and clarifiers comprising of flocculants' residuals among other materials. The treatment process will involve backwashing of the filters and the resultant water will need to be disposed off. Expired and/or spilt water treatment chemical materials will also be generated as well as operations wastes such as limited lubricants from moving parts, spoil oils from the workshops. All these materials have the potential effects to surface water quality,

(vii) The dam water quality is faced with serious risk of contamination from the growing markets that will discharge surface runoff into the dam directly through surface drains transporting organic matter (including raw sewage), solid materials, contaminated silt and commercial wastes from stores and workshops,

(viii) The water user areas in Ruiru and Juja have the potential water contamination where pipelines cross with sewage lines and waste dumps risking the health of the target consumers.

Cumulative Impacts

It is common that stagnant water is exposed to enhanced pollutant accumulation arising from materials chemical and biological transformations as well as continued inflow of pollutants from sources. Among the cumulative effects to water quality may include odour and colouration.

Completion of the dam has the potential to attract social and economic activities win the area. Among these interests may include expansion of towns and markets in the vicinity of the dam (existing cases are Gituamba and Kanyoni Markets whose wastes currently discharge directly into Kariminu River), change of land use to create commercial facilities (recreation areas and hotels), increased land sub-divisions and settlements and even agro-industry investments. This scenario also applies to all other dams in the region whose cumulative impacts are likely to be felt in the downstream rivers including Chania and Thika Rivers.

All these features have potential for dam water contamination through;

(i) Increasing discharge of raw or partially treated sewage from the towns and markets,
(ii) Surface runoff carrying solid wastes, contaminated sediments,
(iii) Chemical pollutants discharges from stores
(iv) Oil/grease discharging from garages and workshops,
(v) Domestic wastes from increasing settlements.

Mitigation Measures

- ✓ All point sources of pollution around the dam including graves, pit latrines and livestock sheds within 50m of the buffer line shall be decommissioned and relocated through approved procedures and under supervision before construction begins (this will be part of the site clearing stage). Increase of aquatic macro-fauna along the periphery of the dam to ensure natural aeration of water,
- ✓ Encourage re-afforestation and better farming systems in the catchment areas for Kariminu dam and all other dams in the region,
- ✓ Institute a water quality monitoring system, programmes and maintaining appropriate records on water quality,
- ✓ Best management practices will be utilized during site clearing and construction to minimize erosion and sedimentation,
- ✓ Enhance 24Hr security of the dam to prevent possible criminal acts for the security of the public,
- ✓ In order to safeguard the dam from water contamination arising from the settlements and the markets, the design should provide appropriate isolation of the dam through CUT-OFF drains diverting local surface runoff from the dam such as to discharge downstream of the dam wall. Avoid sinking of pit latrines and graves within 50m from the dam buffer zone to reduce chances of water contamination,

8.3.3 Water Loss Impacts

Loosing water in water supplies is one challenges facing managers. While one could trace loss of water to pipes, there is also notable loss in reservoirs through evaporation, infiltration illegal abstractions inadequate treatment capacity. The design of the dam and its components in this regard, therefore, should be as important as the water distribution systems. Among the impacts include. All the potential points of water loss should be address and integrated into the dam

construction and operations.

Construction Impacts

(i) Development of the dam may create potential micro-climate due to changes in the air moisture, air temperature and air movement within the surrounding project area. Presence of surface water increases evaporation and may have a moderating effect on temperature although with little effect on the local climate.

(ii) From experience on existing dams in the region (Sasumua Dam, Thika Dam), the evaporation of this area is average 1,500mm/year for open surface water. This means daily ground evapo-transpiration is 4.3mm per day. If the ground was always wet, the equilibrium will be done between open surface water evaporation and ground evaporation of the same area (ground evaporation before reservoir created and open water surface evaporation after reservoir created). But the climate of the area has the ground dry during the dry season.

(iii) The water loss assessment over one year should be more important due to constant open surface evaporation. Nevertheless, the Master Plan shows that the water supplies of Nairobi and satellite towns are not sensitive to evaporation loss. This issue will be considering into the detailed hydrological study of the project. Water loss of the dam system is the seepage. From preliminary design the seepage is assumed to be less than 10l/s (and also assumed in Thika Dam located within the same locality). This issue will also be considering in the dam design.

(iv) During operation of the project there may be potential water loss at consumer points through wastage, leakage in distribution pipes and overuse through irrigation. This risk has been partially considered in the Dam design and the daily intake flow inside the raw pipes and the final treatment process.

(v) Other avenues of water loss are at the consumption points and include;
- ✓ Burst pipes,
- ✓ Leaking taps
- ✓ Overflowing storage tanks.
- ✓ High level of non-revenue water arising from low metering and illegal connections

Cumulative Impacts

Long term loss of water may be defined as follows;

(i) Cumulative loss of water through infiltration following inadequate compaction of the dam floor and sides. Assuming the observed loss of 10l/s in Thika Dam , the overall water loss in a year would be estimated at18Mm^3 in one year,

(ii) Long term loss through evaporation may also be significant. Going by the evaporation trends reported for the area of 1,500mm/year for open surfaces translated to over 1,300,000m^2 could lead to a notable loss of water over a duration of time,

(iii) Demand for water is ever increasing for various social and economic requirements. With the rising of potential water users, demand on the dam water may also rise and may lead to illegal abstractions from the dam. Such water may not be accounted for.

(iv) Similarly, potential illegal connections to the transmission pipelines may also lead to significant cumulative loss of water (this cannot be estimated at this stage),

(v) Additional water in any public supply system gives an impression of abundance leading to non-conservation attitude at the user points. This situation may go into

worsening the existing problem of unaccounted-for-water (UfW) in Ruiru and Juja like many other towns.

Mitigation measures

- ✓ Ensure appropriate compaction of the dam floor embankment walls to minimize leakages and infiltration upon commissioning of the dam,
- ✓ Introduce financial and economic initiatives towards water saving and responsible utilization by the users at all points,
- ✓ Institute strict surveillance around the dam and along all water transmission pipeline corridors to control illegal water abstractions. All water abstracted from the dam should be quantified and accounted for whether directly or indirectly,
- ✓ Educate and create awareness to the water users in the service areas of Ruiru and Juja Towns in general on the value of water and water resources for enhanced conservation,
- ✓ Consult on reasonable water tariffs to sustain the water supply as well as creating a sense of value for water to the beneficiaries,
- ✓ Ensure optimum maintenance of the water supply system components including pipelines, valves and consumer taps,
- ✓ Synchronize the water treatment output with the consumption to prevent potential overflows at the service points, reduce non-revenue water by ensuring low or nil illegal connections,
- ✓ Enhanced buffer with appropriate tree species around the dam may assist in checking on the rate of evaporation.
- ✓ It might require that Athi Water Services Board undertake a deliberate initiative to work out the global water balances in the project region involving the available water at the sources and the actual amount that reaches the users with a view to establishing the loses and points of loss.

8.3.4 Air Quality Impacts

Construction Impacts

The main sources of emissions during construction include dust related to site clearing, earthworks, traffic movements, loading and unloading of materials, stock piling of spoil. Dust emissions may also be generated at material borrow pits and the concrete processing plant. In addition exhaust emissions from the contractor's machinery and vehicles could contribute to air pollution. The changes to air quality may affect the residents, agricultural crops as well as the natural flora.

Post-Construction Impacts

(i) The dam will provide moderation of air moisture in the area hence no adverse variations between seasons.

(ii) Low variations in air moisture will create a uniform temperatures

(iii) Limited benthic conditions in the deep levels of the dam water could emit methane and other gases arising from partial anaerobic conditions. However, this is limited due to the size of the dam as well as moderation from heavy vegetation and adequate dispersal by winds,

(iv) Presence of heavy vegetation in the area will significantly moderate effects of dam related emissions,

(v) It assumed that pumping will be electric driven to ensure no aerial emissions are

anticipated from the project.

Cumulative Impacts

The long term effect to air quality is moderation on humidity throughout the year as well as reduced particulate matter discharge. This will add to the regional combined effect from among other water bodies Thika Dam, Ruiru I, Ruiru II Dam and other smaller open water bodies in the area. Overall, it is a positive impact.

Mitigation measures

- ✓ Ensure proper maintenance of the construction equipments and machinery,
- ✓ Practice dust control measures such as water sprinkling,
- ✓ Limit speed limits for the construction machinery and contractors vehicles,
- ✓ Ensure effective scoring as appropriate to reduce silt and also accumulation of organic matter in the lower layers of the dam.

8.3.5 Species Diversity Impacts

Construction Impacts

Dams contribute to alteration of the aquatic and terrestrial habitat hence an effect on the species populations. Impacts on the river ecology can be impacted by changes to its flow which may reduce habitat for aquatic vegetation, organisms as well as bird's species (weaver birds). Effects of construction can also have a negative impact on the riverine ecosystem through depletion of nutrients. The construction of the water treatment works and the treated water transmission pipeline will not impart impacts in this regard.

Earthworks and land fragmentation during construction activities will contribute to terrestrial flora disruption through total vegetation removal. The entire terrestrial habitat will be disturbed permanently because the project area will be covered with water. The reservoir will affect the productive agricultural land hence affecting the general biodiversity.

Specific Impacts will include;

(i) Removal of aquatic vegetation at the dam site and the raw water mains including grass and shrubs,
(ii) The proposed site for the new water treatment works is on a clear land covered with grass and no trees are to be removed,
(iii) Limited removal of vegetation including Eucalyptus ssp., graveria, shrubs and ground cover grasses along the transmission pipeline routes confined along the road reserves,
(iv) All the tanks anticipated to be construction are to be located on identified public land within active premises and no trees are expected to be removed,
(v) The water pipeline (from the intake to treatment works and from treatment works to service areas) may have limited affect the ground cover on road reserves, mainly grass cover,
(vi) All pipelines and service lines will follow established access roads and are confined within clear corridor with minimal need for removal of trees,
(vii) There are no wildlife to be affected anywhere in the project area during the construction period

(viii) Construction of the water treatment works, transmission pipelines and the storage tanks will have no significant impacts to the biodiversity whatsoever. All locations are already habited with human activities.

Post-Construction Impacts

The riparian aquatic vegetation could develop on the new water land transition zone with new species introduced and flourishing of the existing species. The dam project may lead to the introduction of new fish species and aquatic vegetation. There is potential migration into the dam of wildlife species including crocodile, snakes and hippos that consequently may create social safety conflicts.

The dam water would encourage the breeding of vectors such as mosquitoes and snails that are carriers of among other diseases malaria, bilharzias, diarrhea, typhoid, etc. .

Cumulative Impacts

While appreciating potential attraction of selected ecological species (animals and plants) into the project areas, the dam will enhance the effects of others in the area including Thika Dam, Ruiru I dam. Long term species diversity will be associated with the dam more than other components. The major cumulative effects would include;

(i) The tendency of migratory species moving between the dams and other water bodies (major rivers such as Chania river) creating potential conflicts with the human beings, including safety,
(ii) Among the wildlife include herbivores whose nature will have direct conflicts with landowners arising from crop destruction during movements,
(iii) There is potential for a progressive introduction of new species in the area including invasive plants and vectors (mosquitoes, snails and snakes) over time.

Mitigation measures

- ✓ Undertake an inventory of the biodiversity in the affected areas for purposes of preventing species extinction and identification of new species,
- ✓ Practice re-afforestation at the end of the project construction phase upstream,
- ✓ Creation of awareness on the proper land cultivation practices to reduce soil erosion and biomass accumulation in the dam reservoir,
- ✓ Engage the relevant authorities (KWS, KFS) in monitoring and establishing community interests and values in the evolving ecological setting,
- ✓ Initiate education, sensitization and awareness programmes for the communities on co-existence with new wild life and plant species. This should be extended to the entire region in order to deal with the issues holistically,
- ✓ The water pipeline should be aligned such as to minimize direct interaction with trees along the corridor. To avoid future conflicts with trees, the pipelines should run at least 2m from a tree and the corridor maintained so,
- ✓ Appropriate landscaping at the water intake, water treatment plant and all tank locations shall be done upon completion of the construction works ensuring replanting of trees and re-introducing ground cover. In this regard, a record should be maintained of the tree species removed for compensation through planting upon project completion,
- ✓ The Contractor(s) may be required to maintain a record of trees removed for necessary compensation through planting others.

8.3.6 Impacts on Hydrology

Construction Impacts

The hydrological impact mainly depends on the design, purpose and the dam operation. Dam construction will;

(i) Interrupt the river flow system resulting to direct consequence of change in the river stream flow patterns,
(ii) Sediment load transport downstream of the dam from excavations and earth works,
(iii) Potential change in the river discharge pattern downstream of the dam.

Post-Construction Impacts

(i) There would be consequential reduction in the water flow in the river that will adversely affect the water availability downstream, both from surface sources and inadequate recharging of ground water.
(ii) This may lead to an obstacle for downstream fish migration,
(iii) During high peak flows there would be reduced channel erosion further downstream of Kariminu dam due to change in the discharge pattern. The dam has the potential for downstream flood moderation during heavy rains and hence flood plain protection and enhanced better usage,
(iv) Change in the river hydrology may consequently also have an effect on the aquatic habitat such as an impact of fish breeding and migration hence habitat loss.

Cumulative Impacts

(i) The dam will be a net flow moderator from the wet season to dry season. This is achieved through storage of flood flow during the rains and moderated release of the same during the dry conditions in addition to the base flows. This scenario, enhanced by other dams in the region, will be beneficial to downstream dependants including irrigation schemes and power plants where there is no storage of flood water,
(ii) Likewise, storage of sediments and regular release will moderate nutrient feed to downstream requirements,
(iii) While checking on the flood flows, sections of the Kariminu river downstream flood plains will be denied the benefit of silt deposition for productivity.

Mitigation measures

- ✓ Ensure compliance with water resource regulation at all times with regard to downstream discharge regimes,
- ✓ The dam design should ensure provision for regulated sediment release to ensure downstream productivity,
- ✓ Maintain at least 30% of the base flow of the stream to sustain ecological and social requirements downstream,
- ✓ Provide mandatory buffer area for conservation of the riverine and dam ecosystem through the review of riparian land ownership,
- ✓ Installing gauging stations for monitoring the immediate trends in the upper zones of the river basin
- ✓ Monitor the relationship of the dam to the downstream flooding trends.

8.4 Social Impacts and Mitigation Measures

An environmental impact assessment study has been undertaken for the proposed Kariminu II Dam and associated components with a view to ensuring economic and social sustainability of the project. The assessment addressed the prevailing conditions, perceived community roles during and after project and both positive and adverse impacts of the proposed project activities.

8.4.1 General Positive impacts (Construction)

There are numerous potential beneficial impacts associated with the scheme. These include:

(i) Temporary and/or permanent direct increases in employment arising from construction activities and operation;
(ii) Social inclusion and accessibility to community facilities through the provision of better linkages through access roads;
(iii) Stimulation of Local Economy during the construction phase of the project that will stimulate local economic activities through creation of job opportunities for the construction workers and demand for goods and services
(iv) Education Benefits as increased access to water will remove the burden of collecting water from the girl child. Academic pursuit of the girl child at early stage leads to further education and competitiveness in the job market and hence poverty reduction.
(v) Those employed as casual workers will benefit from on-the-job skills training,
(vi) There are among the residents who may desire to dispose of their land for alternative livelihoods and finds this project as the best platform,
(vii) Potential loss of additional land along the treated water transmission pipeline including the 5.5km from the water treatment works and the Northern Collector and onwards to Ngewa junction and Bennett's Ridge tank location,

8.4.2 General Positive Impacts (Post-Construction)

(i) Creation of employment opportunities during and after commissioning of the dam,
(ii) Construction materials and provision of labour by the locals will lead to increased capital flow, and demand for goods and services will consequently increase,
(iii) Stimulation of local economy during the construction phase will contribute to raising of the living standards of local people and immigrants,
(iv) Augmentation of water supply to the target areas in Ruiru, Juja and Nairobi areas will narrow the water demand gap,
(v) Improved security within the project area since there would be deployment of security officers in the area to guard the dam,
(vi) There are no anticipated significant social impacts from the treated water transmission pipeline. However, the residents along the pipeline may require continuous sensitization on coexistence with the facility.

8.4.3 Potential Disruptions

There will be notable land-take for the dam area as well as the water treatment works and treated water transmission pipeline corridor. The estimated water coverage area for the dam is 1,350,000m^2 (about 135ha) excluding a buffer extending about 30m from the highest water

mark. Early observations show that the buffer line is not likely to significantly disrupt homesteads but will have high implications on the productive low lying land on the flood plains and hence minimal physical disruption to settlements.

The water treatment works is anticipated to cover 4ha of land to be acquired from private landowners. The target location has no homesteads but there are public utilities to be disrupted that include water pumps, coffee drying beds for Buchana Coffee Factory and agricultural crops including bananas and coffee bushes.

The Water Transmission pipeline is not expected to disrupt any homesteads but limited land will be acquired along the river valley to the Northern Collector (5.5km long 6m wide way-leave) and then along the Northern Collector to Ngewa Junction (20km long additional 6m way-leave) and finally to the Bennett Ridge (6.5km long 3m way-leave along the road reserve).

Actual nature of land take and quantified disruptions is covered in the Resettlement Action Plan (this was ongoing at the time of the report submission and will be submitted when ready. Other public services and amenities to disrupted include

(i) Two all-weather roads namely E1528 (Buchana – Kiriko – Gituamba) and E601 (Buchana – Gituamba – Kiriko market). This will significantly disrupt local movement of people,
(ii) In addition there are 3No. 240KV feeder power lines, 1No. 33KV power line and 1No. Single-phase transformer that will also be relocated. This line runs along the Buchana – Gituamba – Kiriko Road,
(iii) There are water pumps slightly downstream of the dam wall where the water treatment works will be located. These pumps will need to be relocated,
(iv) There are minimal disruptions from water transmission pipelines as they will be confined within the river flood plain (for enhanced gravity flow) and along the existing Northern Corridor alignment. No homesteads structures will be displaced along the target corridors. Targeted land, however, will be compensated.

A standalone RAP Study is underway to capture detailed land acquisition and compensation. This cannot be estimated at this stage. However, a preliminary assessment in this regard shows that all the land within the dam area is freehold private ownership and has notable development features including agricultural activities. It is also observed that the project will also influence land use changes with indirect disruption of the current social and economic activities within the locality (Resettlement Action Plan will be submitted upon completion). Among the specific impacts will include;

(i) There is potential social, cultural and economic disruption of the structure of the region, since will force people to relocate and affect their psychology negatively,
(ii) There are potential temporary water supply disruptions to Kariko community, Kariko school and Kariko factory during relocation of their pump houses,
(iii) There are indications that a section of the community, especially there elderly, have a deep touch with their homes of many years. If relocated, therefore, potential stress is possible that need to be managed,
(iv) Potential temporal disruption of socio-economic activities that rely on the river for downstream communities,

(v) Loss of land and agricultural opportunities and livelihoods resulting from inundation of the dam coverage area
(vi) Access roads, bridges and crossings on the affected rivers upstream of the dam location, will be relocated to prevent conflicts with the dam inundated area,
(vii) Disruption of power lines to Gituamba and Kariko markets.
(viii) The water transmission pipelines will not have any inference with services and public amenities along the corridors.
(ix) The tanks at Bennett's Ridge falls on public land and hence no impacts to the public.

Cumulative Impacts

Kariminu Dam and associated components including the transmission pipelines, adds into a list of land acquisition and displacement of people that has taken place in the region from other water projects over the years. Adding onto the effects from the construction of Thika Dam, Ruiru I dam, Theta Dam as well all the water transmission pipelines including the northern collector corridor are is significant. Associated impacts include;

(i) The overall number of people being replaced rises with population,
(ii) The land area taken for projects is also increasing,
(iii) Losses from developments taken over by projects are also increasing including agricultural based, public amenities, etc.
(iv) Institutional disruptions in terms of land take, disturbance on amenities and access roads as well as services provision
(v) Separate pipelines from sources are particularly causing notable social disruptions that can be avoided through integrated water transmission pipeline corridor.

Mitigation Measures

- ✓ Undertake a comprehensive and all-inclusive RAP study to provide guidelines for the land acquisition and compensations thereof. All compensations shall be completed before commencement of the project construction,
- ✓ Quantification of assets and losses as well as the population to be displaced (Project Affected Persons (PAPs)) should be done to the satisfaction of the affected before commencement of the project works,
- ✓ Adequate and timely compensate for lost assets and damages to be undertaken before project commencement,
- ✓ The PAPs should be trained on financial management and investments as a way of preserving family interests from the loss of land.
- ✓ Initiate a programme to sensitize people in the entire region on the appreciation of the many projects that seem to affect their lives and how to cope with the merging challenges. This include handling social stress and objections especially y the aged people,
- ✓ Athi Water Services Board may consider initiating a process for integrated water transmission pipeline corridors in the region to avoid social disruptions from the scattered pipeline.

Figure 38: Sample Disruption Features



The Elderly — Housing Structures (along the dam crest)



Infrastructure (Bridges and Access Roads)



Power Transmission Lines — Public Institutions



Environmental Features (Water Falls, Vegetation Cover, Aquatic Systems)



Agricultural Land

8.4.4 Safety Impacts

Construction Impacts

The construction will involve heavy machinery and excavation areas. Among the safety risks to the people will include;

(i) Safety risks from construction machinery,
(ii) Public safety risks from construction trucks ferrying materials into and out of the site
(iii) Potential safety risks at steep excavations and cuttings (dam excavations and pipeline channels. Access roads and public passages are at higher risks especially for the elderly, the sick and children,
(iv) The water treatment works is not expected to pose notable safety impacts since it is located away from public access,
(v) Pipeline routes will be have excavated channels with some sections notably deep. There is therefore potential risk to public safety, especially along the road crossings. Most affected include children, women and the elderly.

Post-Construction Impacts

(i) Possible human wildlife conflicts from possible migration from Aberdares forest and other conservation areas in proximity of the dam among others elephants, hippos, crocodiles and snakes. Chances, however, are low due to the high population density,
(ii) Higher risks of drowning of livestock and people especially minors, elderly and the drunk persons into the dam,
(iii) Risks of dam break mainly as a result of design challenges, weakness of embankment walls and malfunctioning of the spill way. The risks are however remote. The Dam interference with the natural river is changing the intensity of a flood peak in the safe way. In this matter, the dam has a real positive impact on the safety downstream of the dam. Moreover, installation of metrological sensors and alarm in the catchment area of the dam will permit to reduce the potential consequence of an important flow by warning locals in advance
(iv) Risk of the transmission pipeline bursts with damages to land, crops, housing structures and risks to safety,
(v) All pipeline sections should be backfilled to the original land surface to ensure no safety risks to the residents.

Cumulative Impacts

Attractions of wildlife (including hippos, crocodiles and snakes) into the area arising from the number of water bodies (dams) are potentially a safety risk to the residents of the wider project region. This is particularly associated with the possibility of migration from one body of water to the other and the Aberdares,

Mitigation Measures

- ✓ Putting up a perimeter fence surrounding the dam area,
- ✓ Provision of simple infrastructures (e.g. guard rails) at critical places along the dam reservoir to reduce chances of drowning,
- ✓ Creation of awareness to the community on the co-existence with the dam project,
- ✓ Provide safe access to watering points for the communities to water their livestock and

fetch water,

- ✓ Provide safety information and signage around the dam and its components,
- ✓ Undertake a comprehensive dam safety audit on the design reports and drawing for appropriate interventions before implementation. Main focus should be on immediate zones upstream and downstream of the dam as well as around the dam and its components,
- ✓ It will be necessary to engage the Kenya Wildlife Services in monitoring and training the communities on coexistence with wildlife. They will also be asked to establish control mechanisms for migrating wildlife species into the area,
- ✓ Among the dam safety interventions should include;
  - Review the Dam design and Dam Construction by independent panel of experts
  - Prepare relevant plans (Plan for construction supervision and quality assurance, an instrumentation plan, an operation and maintenance plan),
  - Prepare an emergency preparedness plan
  - Install proper instrumentation in the dam,
  - Ensure frequent maintenance of the dam structures,
  - Ensure use of high quality standard materials during construction phase,

8.4.5 Health Impacts

Construction Impacts

Dam construction involves important workers and machineries. According to the dam high, we can assume that more than 100 workers can work at the same time in the dam construction site. Traffic of earthworks machineries and concrete tools auditioned to common construction workers accident (slips and falls, injuries of hand, eye infections, etc.) make the dam site unsafe;

(i) Workers injuries from accidental falls, use of faulty equipment during construction,
(ii) Respiratory problems from dust from earth moving and construction materials, emissions from the equipments,
(iii) Environmental pollution from disposal of solid waste materials (excavated materials from pit latrines and other residues from construction activities)
(iv) Potential health problems from pressure on housing, sanitation and hygiene facilities,
(v) Increase of HIV AIDs from interaction of workers, local communities and migrant influx,
(vi) Landslide during earthwork.
(vii) Local resident injuries due to traffic or water access.
(viii) Occupational injuries from accidental falls, use of faulty equipment during construction,
(ix) Respiratory problems from dust from earth moving and construction materials, emissions from the equipments,
(x) Environmental pollution from disposal of solid waste materials (excavated materials from pit latrines and other residues from construction activities)
(xi) Potential health problems from pressure on housing, sanitation and hygiene facilities,

Post Construction Impacts

(i) Dam construction will encourage new agricultural activities and promote use of chemical pesticides and fertilizer which will contaminate the waters hence a health risk to the people.

(ii) Dam reservoir provides habitat for waterborne diseases as well as parasite thrive (mosquito, snails). Mosquitoes are carriers of malaria, there is also the likelihood of snails breeding which are carriers of schistosomiasis other water borne diseases cholera and dysentery.

(iii) HIV/AIDs may also increase from interaction of the workers, local communities and migrant influx.

Cumulative Impacts

(i) There are notable of projects running together in Kiambu County, specifically on water projects for local use and extension to Nairobi City. There is, therefore, possibility of an influx of construction workers and other services providers into the area leading to potential introduction of diseases and infections including HIV/AIDS and other STIs,

(ii) Disease vectors are common with wet and humid conditions. Mosquitoes and snails (potential widespread of malaria and schistosomiasis) and other carriers of Typhoid, dysentery, etc. are likely to increase in the County,

Mitigation Measures

- ✓ Organize an epidemic base survey in the affected area and periodic evaluation
- ✓ Implement measures to assess the presence of vectors and control its and potential diseases. This include focus on the entire Kiambu County where a majority of these projects are located,
- ✓ Creation of awareness, prevention and monitoring programs,
- ✓ Wellness centres and awareness campaigns on the sexually transmitted diseases and HIV/AIDs. This should be integrated in all the projects as well as being an integral policy of Athi Water Services Board,
- ✓ Adequate provision of personal protective equipment to the workers,
- ✓ Provide sanitation facilities in all work areas,
- ✓ Waste generated (sanitary, rehabilitation and proper hazard waste storage) during the construction phase should be carefully disposed of in an environmentally safe manner
- ✓ Implementation of a Hygiene and Safety Management Plan according to international standards including adequate provision of PPEs to the workers,
- ✓ Adequate diversion of the river and protection of the site during construction,
- ✓ Management of earthwork be taking care of excavation and slope stability
- ✓ Presence of a nursery in the worker camp,
- ✓ Frequent maintenance of the machineries used,
- ✓ Creation of awareness to the community,
- ✓ Provide safe access point to the water for the local residents and livestock to enhance safety.

8.4.6 Potential Cultural Disruption

Overall Impacts

(i) Involvement of foreign construction workers (non-residents of Kiambu County) may contribute to local culture erosion, e.g. Moral standing,

(ii) Potential for relocation of graves touches on cultural values, though the local community claims that relocation of graves was never in their traditions,

(iii) Displacement of people from their family land may face cultural challenges, especially from the elderly PAPs,
(iv) There is potential for resistance and shock related to displacement of people from their ancestral land,
(v) There are no cultural features established within the project area. However, there are chances to find during the construction phase.

Cumulative Impacts

While appreciating that Kiambu County is highly habited and no immediate sign of cultural sites where the projects are located, there are increasingly emerging issues that the community never practiced before. These include;

(i) Relocation of graves
(ii) Decommissioning of pit latrines,
(iii) Discussing moral issues in public, e.g. sexual behaviors,

Mitigation Measures

- ✓ Engage the community members through the Leaders and Church in handling cultural resistance for the benefit of the project
- ✓ Relocation of the graves be handled in collaboration with the Elders, the affected families, Local Leaders, the Administration and the Public Health during the RAP process,
- ✓ Engage appropriate cancelling experts to deal with stress related cases arising from shock of displacements during the RAP process.
- ✓ On the chance to find situations, the procedures below are to be followed;
  - If the Contractor discovers archeological sites, historical sites, remains and objects, including graveyards and/or individual graves during excavation or construction, the Contractor shall;
    - Stop the construction activities in the area of the chance find;
    - Delineate the discovered site or area;
    - Secure the site to prevent any damage or loss of removable objects. In cases of removable antiquities or sensitive remains, a night guard shall be arranged until the responsible local authorities or the Ministry in charge of managing cultural heritage and related resources in the country (responsible ministry) take over;
    - Notify the supervisory Project Environmental Officer and Project Engineer who in turn will notify the responsible local authorities and the responsible ministry immediately (within 24 hours or less)
  - Responsible local authorities and the responsible ministry would then be in charge of protecting and preserving the site before deciding on subsequent appropriate procedures. This would require a preliminary evaluation of the findings to be performed by the archaeologists assigned by the government. The significance and importance of the findings should be assessed according to the various criteria relevant to cultural heritage, namely the aesthetic, historic, scientific or research, social and economic values.
  - Decisions on how to handle the finding shall be taken by the responsible authorities and/or ministry. This could include changes in the layout (such as when finding irremovable remains of cultural or archeological importance)

conservation, preservation, restoration and salvage.

- Implementation for the authority decision concerning the management of the finding shall be communicated in writing by relevant local authorities.
- Construction work may resume only after permission is given from the responsible local authorities or the responsible ministry concerning safeguard of the heritage.

8.4.7 Livelihood Impacts

Construction / Post construction

There are numerous potential beneficial impacts associated with the scheme. These include:

(i) Stimulation of the local economy

(ii) The construction phase of the projects will stimulate local economic activities through procurement of construction materials and creation of job opportunities for the construction workers. This will have spiral effect on the demand for goods and services as result of increased capital inflow. Those employed will have a chance to train on the job and/or gain experience that subsequently may enable them to secure more lucrative jobs.

(iii) Temporary and/or permanent direct increases in employment arising from construction activities and operation;

(iv) Education Benefits as increased access to water will remove the burden of collecting water from the girl child. Academic pursuit of the girl child at early stage leads to further education and competitiveness in the job market which is an exit route from poverty. Those employed as casual workers will benefit from on-the-job skill training.

There are a number of potential adverse impacts arising from the proposed Dam in respect of socio-economic considerations. These include:

(i) Loss of fields, agro-forestry and natural vegetation

(ii) The possible loss of community facilities as a result of temporary or permanent land take for the project (e.g. temporary loss of recreational space for a construction site or permanent loss of a community facility through demolition);

(iii) Reduced access to water in the rivers

Cumulative Impacts

(i) Improved water supply within and outside Kiambu County from all the water projects in the area has an overall positive impact to the economy.

(ii) Increasing social disruptions from resettlements for water projects (dams, transmission pipelines and water treatment works) is increasingly affecting stabilized land based livelihoods.

Mitigation Measures

(i) Involve local labour to the extent possible to ensure for the construction and operation of the dam facility, clauses should be integrated in contractor's contract

(ii) Apply the AWSB CSR policy in economic welfare support for the local community. Part of this may include erection of water kiosks and pay sanitation facilities along the pipeline corridor. However, this be limited since the people live in their own homes,

(iii) Compensate loss of agriculture opportunities
(iv) Strategy of resettlement.

8.4.8 Impacts on Livestock Farming

Construction
From field visit interview, an important integration between crops agriculture and livestock keeping has been noticed. Major part of the animals' food comes from agriculture of the nearest land. In the farming scale, a balance between the land owned and the animal's number insure the income of the farm. The loss of agricultural land will have an indirect impact of the livestock activities. This issue will be deeply assessed during the Resettlement Action Plan.

Post Construction
The dam is located in a steep valley where the water is accessible through direct abstraction and pumping. The dam will disrupt the access points and displace some of the pump house. :

Mitigation Measures

- ✓ The linkage between the agriculture activities and livestocks activities should be consider in the RAP
- ✓ A safe and easy public access to the water should be provided.

8.4.9 Dam Safety

WB Dam Safety
The proposed dam is a 40m high. According to the World Bank Operational Manual OP 4.37 - Safety of Dams, Kariminu Dam is a Large Dam. The World Bank requirements on Dam Safety are summarized in the following table:

Table 15: Dam Safety Criteria

World Bank Requirements	Comments
For the life of any dam, the owner is responsible for ensuring that appropriate measures are taken and sufficient resources provided for the dam safety	Under AWSB responsibility.
It requires that the dam be designed and its construction supervised by experienced and competent professionals.	The supervision company will be chosen according to its experience on similar project and the resources involved will have to be competent.
Reviews by an independent panel of experts for the investigation, design, and construction of the dam and the start of operations	Large Dams (>15m high) requires an independent panel of expert to validate the different steps of the Dam project implementation. The cost of panel of experts will be integrated into the global environmental costs of the dam project implementation
Plan for construction supervision and quality assurance, an instrumentation plan, an operation and maintenance plan, and an emergency preparedness plan	These plans will be prepare during design phase of the project and will insure the management of Dam Safety. The plan should be extended to the dam

World Bank Requirements	Comments
Prequalification of bidders during procurement and bid tendering	This phase is undergoing and a proper Tender documents have been prepared
Periodic safety inspections of the dam after completion.	Under Athi Water Service Board responsibility.

Dam Safety under Construction

Any dam site inside a river valley where the river has to be diverted through a channel need to keep the construction site dry. In case of rains and flooding, the construction site could become unsafe in terms of high flows. In the conceptual design, the return period used for the construction flood flow is 50 years which is safe for a 2 – 3 years construction period. The concrete gallery pre-design for this purpose has a 3.6m diameter. A 10m high upstream cofferdam will protect the site against flood and a downstream coffer dam will prevent any water return on the dam site in case of flood. A partial water sensor system coupling with alarm will alert any workers in the dam construction site to quite the place.

Dam Safety under Operation

Two main events during the dam operation could impact the safety of people around the dam namely event of important flood and event of dam break. The proposed dam is classified as a large dam being >15m high and, therefore, safety precautions during operations should apply.

Flood

The dam interference with the natural river is changing the intensity of a flood peak in the safe way. In this matter, the dam has a real positive impact on the safety downstream of the dam. Moreover, installation of metrological sensors and alarm in the catchment area of the dam will permit to reduce the potential consequence of an important flow by warning locals in advance.

Dam Break

The potential dam failure can result of fault in the design, use of sub-standard material during construction, deliberate sabotage, and landslide in the reservoir. According to the design, the dam is design for the Probable Maximum Flood. This flood flow is 2 times bigger than the flood with a return period of 10,000 years. According to the design life of the dam, which can be assumed between 50 – 100 years, the design flood chosen make the dam safe against flood.

Mitigation Measures

- ✓ Adequate diversion of the river and protection of the site during construction,
- ✓ Review the Dam design and Dam Construction by independent panel of experts
- ✓ Design and install metrological sensors and alarm during the construction to alert workers in case of risk of flood
- ✓ Review the Dam design and Dam Construction by independent panel of experts
- ✓ Prepare relevant plans (Plan for construction supervision and quality assurance, an instrumentation plan, an operation and maintenance plan),
- ✓ Prepare an emergency preparedness plan
- ✓ Install proper instrumentation in the dam,
- ✓ Ensure frequent maintenance of the dam structures,
- ✓ Ensure use of high quality standard materials during construction phase,

CHAPTER 9: ENVIRONMENTAL AND SOCIAL MANAGEMENT PLAN

9.1 Management Plan Principles

The project is geared towards enhancing social and economic benefits through sustainable water supply. Development of the Kariminu dam project would be expected to comply with the environmental conservation requirements in accordance with the established Kenyan laws and regulations. To realize these goals, acceptability by a majority of the stakeholders and minimal effects to the physical environment will require to be ensured through participation in the project and continuous consultations, evaluations and review of the design aspects throughout project implementation cycles.

It is also recommended that the environmental management guiding principles specific to this project improvement and water resources management be established to allow integration of environmental management considerations during construction and operations. Among the factors that need to be considered in this particular project implementation will include;

(i) Ensure control of soil erosion and siltation of the water sources(rivers and the streams),Incorporation of dam safety provisions and the associated components,
(ii) Enhancing integration of environmental, social and economic functions in the project implementation,
(iii) Compensation of any land or property that may be affected by the project in accordance to the laid down regulations,
(iv) The contractors and other players in the project activities be prevailed upon to implement the EMP through a sustained supervision and continuous consultations

9.2 Management Responsibilities

In order to implement the management plan, it is recommended that an expert be identified to oversee the environmental and social management aspects including the dam conservation, soil erosion control, re-vegetation whenever appropriate, water conservation and equity in distribution, enhanced sanitation and hygiene measures throughout project area. The expert would also be required to coordinate and monitor environmental management activities during construction and post monitoring audits. Other recommended participants include;

(i) Athi Water Service Board will be responsible for coordination of all the activities and liaisons, particularly in regard to the quality control of the works and social issues.
(ii) Water Service providers, in this case Gatundu Water and Sewerage Company) who have the responsibility to enforce water quality monitoring and efficient maintenance systems, procedures to minimize interruptions to water supply and ensure accessibility by all consumers,
(iii) National Environmental Management authority (NEMA) through the county directors office shall be responsible of surveillance of environmental and social aspects of the project implementation,
(iv) Kariminu Water Community Association Committee

9.3 Environmental Management Guidelines

The guidelines will include among other areas environmental management programmes, standard operation procedures, compliance monitoring schedules and environmental audit schedules as required by the law. Social harmony of the dam and associated component will be achieved through the collaborations with the stakeholders or community management committees introduced at various water consumption points

9.4 Institutional Framework Management

The National Policy on Water Resources Management and Development and the Water Act 2002 are the guiding tools on water resources management. The policy goal is to facilitate the provision of water in sufficient quantity and quality and within a reasonable distance to meet all competing uses in a sustainable, rational and economical way. It also separates policy formulation, regulation and services provision and defines clear roles for sector actors within a decentralized institutional framework and includes private sector participation and increased community development. The Ministry in-charge of Water is responsible for policy development, sector co-ordination, monitoring and supervision to ensure effective Water and Sewerage Services in the Country, sustainability of Water Resources and development of Water resources for irrigation, commercial, industrial, power generation and other uses. The Ministry executes its mandate through the following sector institutions:

(i) Water Services Regulatory Board (WASREB)
(ii) Water Resources Management Authority (WRMA)
(iii) Water Services Trust Fund (WSTF)
(iv) Water Services Boards (WSBs)
(v) Water Services Providers

This integration encourages provision of sustainable development and a healthy environment to all Kenyans. The key functions of NEMA through the NEC include policy direction, setting national goals and objectives and determining policies and priorities for the protection of the environment, promotion of cooperation among public departments, local authorities, private sector, non-governmental organizations and such other organizations engaged in environmental protection programmes and performing such other functions as contained in the act. Other stakeholders include Kiambu County Government, Ministry of Environment, Water and Natural Resources, Ministry of Agriculture and Livestock and Fisheries, The Local Community and Kariminu Cam Committee.

9.5 Environmental Education and Awareness Raising

Athi Water Service Board and the water consumers and beneficiaries need to understand the basic environmental, water use sanitation and hygiene principles. In this regard therefore the following steps may be considered;

(i) Creation of liaisons on all matters related to environment, health and safety,
(ii) Encourage contribution of improvement ideas on specific issues related to the management of the facilities,
(iii) Establish initiatives that would instill a sense of ownership of the facilities and related

components to all beneficiaries,

9.6 HIV/AIDS Issues

The contractor would be expected to incorporate HIV/AIDS programmes during construction phase. Awareness, prevention and training on HIV/AIDS and other social diseases is important during project construction and operation phase. The awareness creation should be improved through putting up of banners, posters and training should be facilitated within the project area to the construction workers and the community.

9.7 The Management Plan Matrix

Complying with the national laws and regulations, the ESMP will include;

(i) The RAP (with separate report) including support to development of affected people;
(ii) The monitoring plan
(iii) The institutional and managerial arrangement for implementation of the full ESMP
(iv) The cost of the implementation programme during pre-construction, construction and post construction if applicable.

In the final ESMP, It is proposed to analyze any measure present in the ESMP according to the following element;

(i) Justification and expected results
(ii) Conditions of eligibility
(iii) Main technical characteristics of the measure
(iv) Activities to carry out to implement the measure
(v) Operating arrangements to implement the measure
(vi) Cost of the measure
(vii) Arrangements for monitoring and evaluation of implementation and impacts of the measure

The ESMP matrix below outlines the action plans and responsibilities on the key negative impacts anticipated from the project activities.

Table 16: ESMP Matrix

Project Activity and Issues	Key Impacts	Areas of Concern	Management Action Plans and Responsibilities	Timeframe and Cost Estimates (KShs.)
Preparatory Activities ✓ Site Surveys ✓ Setting up construction camp site(s) ✓ Setting up materials holding sites	✓ Social conflicts ✓ Loss of ready crops ✓ loss of trees and ground cover	✓ Dam construction site and riverine zone and adjoining slopes (Buchana, Gathanji and Kanyoni village) and surrounding areas, ✓ Water Treatment Works Area ✓ Water transmission Corridor ✓ Camp site location ✓ Access passages	✓ Give prior notification to the community on expected activities related to the project ✓ Involvement of local authorities, project liaison committees, in the project ✓ Allow the ;land owners harvest ready crops and trees, **Responsibilities** ▪ AWSB, ▪ Contractor, ▪ Supervision Consultant	Pre-construction No direct costs anticipated (cost integrated in the construction costs)
General preliminary Construction Activities ✓ Land acquisition and compensation, ✓ Catchment alignment ✓ Setting the embankment base ✓ Relocating landowners and affected structures	✓ Potential displacements of project affected persons, ✓ Change of land use systems, ✓ Potential change in river flow patterns, ✓ Temporary disruption of water access by the residents ✓ People displacements	✓ Project area ✓ Part of affected catchment system under project area, ✓ Water Treatment Works Area ✓ Water transmission Corridors ✓ Bennett's Ridge Storage Tank	✓ Preparation and implementation of the compensation and resettlement action plan ✓ Ensure adequate compensation with current land market value, ✓ Creation of awareness to PAPs on alternative land use practices, **Responsibilities** ▪ AWSB, ▪ Contractor, ▪ Supervision Consultant ▪ Community Representatives ▪ Grievance Redress Committee	Pre-construction No direct costs anticipated (cost integrated in the construction costs)
Site clearing	✓ Loss of riverine vegetation	✓ Dam Construction site ✓ Project Camp sites	✓ Avoid unnecessary vegetation clearing	Pre-construction

Project Activity and Issues	Key Impacts	Areas of Concern	Management Action Plans and Responsibilities	Timeframe and Cost Estimates (KShs.)
✓ Vegetation removal, ✓ Access to the river and livestock watering point ✓ Removal of pit latrines and livestock sheds ✓ Mapping water diversion ✓	✓ Potential riverine bio-diversity degradation ✓ Potential soil erosion on cleared sites ✓ Siltation to the water sources (Kariminu, Gathanji, Gakuru- ini Rivers ✓ Water pollution (increased turbidity) ✓ Degradation of the river banks	✓ River sub – catchments(upstream and downstream of the rivers) ✓ Water Treatment Works Area ✓ Water transmission Corridors ✓ Bennett's Ridge Storage Tank	✓ Watering the construction sites ✓ Ensure proper disposal of waste generated (tea and coffee bushes/pineapple vegetation/trees species) ✓ Ensure minimal interference with watering points **Responsibilities** ▪ AWSB, ▪ Contractor, ▪ Supervision Consultant ▪ Community Representatives	No direct costs anticipated (cost integrated in the construction costs)
Site clearing ✓ Removal of houses where applicable, ✓ Decommissioning of sanitary facilities and cattle pens, ✓ Relocation of graves	✓ Potential water pollution ✓ Cultural issues regarding grave relocation ✓ Social issues, ✓ Health and sanitation issues	✓ Construction sites ✓ All affected settlements ✓ Entire river catchments ✓ Water Treatment Works Area ✓ Water transmission Corridors ✓ Bennett's Ridge Storage Tank	✓ Ensure proper handling and disposal of the waste generated, ✓ All the graves on the project site should be identified and exhumed, ✓ Follow the required cultural procedures in the grave relocations **Responsibilities** ▪ AWSB, ▪ Contractor, ▪ Public Health ▪ County Administration ▪ Supervision Consultant ▪ Community Representatives	Pre-construction No direct costs anticipated (cost integrated in the construction costs
Construction Works and related components Earth moving	✓ Air pollution (exhaust and dust emissions), ✓ Potential soil erosion, ✓ Siltation to downstream	✓ Downstream Kariminu River ✓ Camp site, workshops and service areas,	✓ Construction to be carried out during dry seasons, ✓ Limit construction during daytime, ✓ Sprinkle water on the excavated	During construction

Project Activity and Issues	Key Impacts	Areas of Concern	Management Action Plans and Responsibilities	Timeframe and Cost Estimates (KShs.)
	water, ✓ Noise and vibrations from earth moving, ✓ Oil spills from contractors machinery ✓ Improper disposal of spoil earth materials	✓ Spoil dumping areas,	sections to abate dust emissions, ✓ Practice soil control measures(terracing) ✓ Spoil dumping only in approved locations **Responsibilities** ▪ AWSB, ▪ Contractor, ▪ Supervision Consultant ▪ Community Project Committee	~KShs. 500,000.00 for monitoring
Construction Works and related components Dam formation and excavations (WTW and pipelines channels)	✓ Potential noise and vibration, ✓ Safety risks ✓ Dust emissions ✓ Potential alteration of the water regime ✓ Water pollution ✓ Potential temporary disruption of water flow	✓ Dam construction site, ✓ Material sites and spoil dumping areas ✓ Water Transmission Pipeline Corridors ✓ Bennett's water storage tanks	✓ Limit construction during day time, ✓ Ensure adequate provision of the personal protective equipment, ✓ Ensure regular maintenance of contractors machineries and vehicles, ✓ Provide adequate signage and reflective tapes for restricted zones, ✓ Sprinkling water to reduce dust levels, ✓ Material sites to be fenced up for safety purpose ✓ Implement the rehabilitation plan for material sites **Responsibility** ▪ AWSB, ▪ Contractor ▪ Supervision Consultant ▪ Community Representatives	Throughout the construction phase No direct costs (integrated into the project cost)
Construction Works and related components Machinery, materials and waste management	✓ Air pollution (dust, exhaust emissions) ✓ Oil spillages ✓ Land degradation (material sites) ✓ Public safety risks ✓ Spoil management and conflicts			

Project Activity and Issues	Key Impacts	Areas of Concern	Management Action Plans and Responsibilities	Timeframe and Cost Estimates (KShs.)
Construction Works and related components ✓ Social interactions ✓ Safety Aspects ✓ Health Issues	✓ Potential threat to safety of the workers and adjacent communities, ✓ Possible intrusion to the local communities privacy by construction workers, ✓ Possible immigration into the project area by construction workforce ✓ Safety aspects (public safety, occupational safety)	✓ Entire project area ✓ Neighbouring market centers ✓ Public passages	✓ Provide workers with appropriate personal protective gear and enforce application of the same at all times while at work ✓ Provide an awareness and sensitization forum for the workers as well as the neighboring communities, especially on communicable social infections including HIV/AIDS, ✓ Collaborate with the local leadership on selecting camp site locations. ✓ Provide public safety signage and information appropriately ✓ Create awareness to the public for all construction operations ▪ AWSB, ▪ Contractor, ▪ Supervision Consultant	Through construction period ~KShs. 5M on social awareness and education for health and safety
Construction Works and related components Economic Issues	✓ Lost opportunities for cultivation on the river basin, ✓ Loss of direct water access points	✓ Dam area ✓ Neighbouring market centers ✓ Water Transmission Pipeline Corridors ✓ Bennett's water storage tanks	✓ Provide opportunities for local labour (upto 60%) ✓ Integrate access to water points into the construction ✓ Enhance benefits from materials procurements to the local communities ▪ AWSB, ▪ Contractor, ▪ Supervision Consultant ▪ Community Representatives	Throughout Construction period ~KShs. 3M to boost local economic opportunities

Project Activity and Issues	Key Impacts	Areas of Concern	Management Action Plans and Responsibilities	Timeframe and Cost Estimates (KShs.)
Operations ✓ Water use trends ✓ Accountability ✓ Sustainability and equity	✓ Access of water by the local communities ✓ Potential water wastage and leakage along the transmission lines, ✓ Potential uneven distribution of water, ✓ Illegal water abstraction for illegal connections, ✓ Illegal water vending (especially if obtained from the dam),	✓ Project area ✓ Potential water kiosks ✓ Transmission water pipelines ✓ Water supply areas (Ruiru and Juja) ✓ Other water use areas	✓ Come up with guidelines regarding water abstraction and use, ✓ Support the communities form a WRUA for support in the use of the water resources including the dam ✓ Sensitize the community on sustainable water use, ✓ Collaborate with other players in the region on sanitation, health and hygiene awareness creation. **Responsibility** ▪ WRMA ▪ AWSB ▪ Local community (WRUA) ▪ Gatundu Water and Sewerage Company ▪ RUJWASCO	Initiate action upon commissioning and then continuous **~KShs. 2M**
Operations ✓ Health and Sanitation ✓ Waste Management	✓ Risks from water borne diseases and vectors thrive, ✓ Potential water pollution from surrounding land-use activities (irrigation), ✓ Risk from introduction of impurity to the water reservoir ✓ Potential contamination of water from market centers (wastewater, surface runoff and solid wastes)	✓ Dam Area ✓ Water abstraction points ✓ Water supply areas (Ruiru and Juja) ✓ Other water use areas ✓ Water Treatment Works	✓ Ensuring 24 Hr security to the dam area, ✓ Ensure regular water quality monitoring and maintenance of the water supply system, ✓ Influence the surrounding land-use activities, ✓ Creation of awareness on water resource management and conservation, ✓ Ensure proper water treatment plant installation at the site, ✓ Ensure provision and operational	Continuous process Allow ~KShs. 2M on water quality protection

Project Activity and Issues	Key Impacts	Areas of Concern	Management Action Plans and Responsibilities	Timeframe and Cost Estimates (KShs.)
	✓ Waste disposal from the water treatment works (sludge disposal, filter backwashing water, scrap materials disposal, etc.) ✓ Sewage and wastewater from the operators housing.		sludge drying beds ✓ The water treatment works should be provided with waste collection yard with a removal schedule **Responsibility** ▪ WRMA ▪ AWSB ▪ Gatundu Water and Sewerage company ▪ RUJWASCO ▪ Local community	
Operations User Safety and risks downstream,	✓ Potential injuries to the operators and visitors, ✓ Safety risks of a dam break to downstream aquatic ecosystems, social and economic features. ✓ Safety risks to settlements and farmlands along the transmission pipeline, ✓ Risks of drowning into the dam to children, the aged and livestock ✓ Potential risks of wildlife attacks (hippos and crocodiles)	✓ Project area ✓ Settlements around the project area and transmission pipelines ✓ Water supply areas (Ruiru and Juja) ✓ Other water use areas	✓ Undertake a comprehensive risk assessment study or the dam as part of the pre-commissioning stage. Develop provide clear emergency preparedness strategies ✓ Maintain a fence around the dam with provision for limited and/or controlled access to the dam water, ✓ Enhance close surveillance by the community, especially those living on risk prone areas. Sensitize the communities on dam safety issues associated with the dam. ✓ Create awareness programmes to the communities on dam safety aspects ✓ Provide safe access points to water for the community around the dam, ✓ Consider acquiring the land directly	Continuous process Allow ~KShs. 5M dam safety risks assessments and monitoring

Project Activity and Issues	Key Impacts	Areas of Concern	Management Action Plans and Responsibilities	Timeframe and Cost Estimates (KShs.)
			below the dam wall to avoid safety risks to the affected residents. **Responsibility** ▪ WRMA ▪ AWSB ▪ Gatundu Water and Sewerage company ▪ RUJWASCO	
Operations ✓ Social and economic issues, ✓ Downstream dependants, ✓ Water use trends and accountability, ✓ Facility Ownership	✓ Creation of employment to locals, ✓ Potential change in land-use practices, ✓ Introduction of new economic activities, ✓ Potential improvement of infrastructure ✓ Potential deprivation of sediment load downstream, ✓ Potential illegal water connections, ✓ Vandalism of water pipelines infrastructure, ✓ Wastage of water and leakages at consumer points,	✓ Project area ✓ Pipeline transmission routes ✓ Immediate downstream of the dam	✓ Sensitization on water resource management and conservation ✓ Local communities should also participate in water resource management and planning ✓ Encourage formation of WRUA's for sustainable water utilization, ✓ Heavy penalties on illegal water connection and vandalism ✓ Development of water resources use guidelines for all consumers and beneficiaries ✓ Provide appropriate safe access points of water for the communities. **Responsibility** ▪ WRMA ▪ AWSB ▪ Gatundu Water and Sewerage company ▪ RUJWASCO ▪ Water Users	Continuous process Allow ~KShs. 2M on water quality protection

Project Activity and Issues	Key Impacts	Areas of Concern	Management Action Plans and Responsibilities	Timeframe and Cost Estimates (KShs.)
Operations Institutional Aspects	✓ Non-compliance with water abstraction regulations, ✓ Natural Resources Utilization, ✓ Water use linkages among the beneficiary communities.	✓ Around the dam (applying to surrounding communities) ✓ Ecological resources downstream ✓ Management of irrigation water at farm level	✓ Comply to the provisions of the Water Resources Management Authority, ✓ Comply with sand harvesting regulations, ✓ Organize communities for effective and sustainable utilization of natural resources associated with the dam. ✓ Establish appropriate water user associations in the areas neighbouring the dam, ✓ Establish a specific monitoring system for the dam and its water **Responsibility** ▪ WRMA ▪ AWSB ▪ Gatundu Water and Sewerage company ▪ RUJWASCO	Initiate action upon commencement of construction and enhance during operations **No direct costs estimates**
Operations ✓ Downstream Ecology ✓ Disruption of social income ✓ Downstream hydrology	✓ Changes in hydrological regimes into the aquatic systems ✓ Reduced silt loads into the ecosystem ✓ Effects to aquatic productivity (fish, general biodiversity) ✓ Reduced agricultural productivity from the river flood plain ✓ Reversed nutrient cycling	✓ Kariminu River sub-basin ✓ Chania River downstream ✓	✓ Simulate the dam to allow appropriate artificial flood release to ensure water quality regulation and silt feed into downstream ✓ Liaise with relevant authorities to establish detailed ecological and social characteristics of Kariminu river sub-basin ✓ The flood releases will also replenish silt and nutrients on the flood plains for higher agricultural productivity	Continuous process Allow ~KShs. 3M for ecological sustenance within and around the dam (including buffer zones)n

Project Activity and Issues	Key Impacts	Areas of Concern	Management Action Plans and Responsibilities	Timeframe and Cost Estimates (KShs.)
	and disruption of habitats ✓ Controlled moderated release of flood flows downstream		**Responsibility** ▪ WRMA ▪ AWSB ▪ Gatundu Water and Sewerage company ▪ RUJWASCO	
Catchments' Management ✓ Pollution control from the watershed into the dam, ✓ Enhancing efficient runoff interception into streams, ✓ Soil erosion control and reduced silt transportation ✓ Re-vegetation of the watersheds	✓ Enhanced vegetation cover ✓ Changed land use practices, ✓ Changes agricultural practices, including controlled application of agro-chemicals ✓ Enhanced vegetation, ✓ Influenced sanitation trends in the neighbouring homesteads around the dam site ✓ Silt interception in the catchment	All feeder rivers catchment	✓ Immediate landowners to be motivated into maintaining buffer zones along the river and the dam itself banks, ✓ Guide landowners in the catchment in changing their land use practices including mode of agricultural and irrigation methods as well as application of agrochemicals. ✓ Initiate afforestation programmes of slopes and other steep sections of the watershed area in collaboration with landowners, ✓ Consider sand interception dams along the main tributaries in the catchments for control of silt discharge into the dam, ✓ Undertake a comprehensive catchment management plan for the entire Kariminu River basin and involve landowners and all stakeholders, ✓ Integrate a comprehensive Land Use Management Plan, Pest Control Management Plan and a Water Use Plan.	A continuous activity Allow ~ KShs. 20M mainly for Catchment Management Plan

Project Activity and Issues	Key Impacts	Areas of Concern	Management Action Plans and Responsibilities	Timeframe and Cost Estimates (KShs.)
			Responsibility ▪ WRMA ▪ AWSB ▪ The WRUA	
Decommissioning	✓ Removal of construction sites (housing, toilets, waste dumps, etc.), ✓ Removal of construction residual material holding sites, ✓ Effects of material borrow pits left open ✓ Disposal effects of wastes and debris	✓ Dam construction camp sites ✓ Materials sites ✓ Material holding sites	The contractor to prepare a decommissioning plan of all construction installations and associated sited at least 3 months prior to end of construction. **Responsibilities** ▪ WRMA ▪ AWSB ▪ Gatundu Water and Sewerage company ▪ RUJIWASCO ▪ The WRUA	End of construction Allow KShs. 5M for decommissioning audit
	✓ Removal of part or all of the water treatment plants ✓ Demolition of the water distribution tanks, ✓ Demolition of the dam structure, ✓ Removal of the transmission pipeline	✓ Dam component locations (water pumps, WTP, Power houses, tanks, etc, ✓ The dam itself ✓ Water treatment works ✓ Water transmission pipeline	✓ Notify NEMA at least one year before the intention to decommission ✓ Undertake a decommissioning audit at least six months before the activity and provide a decommissioning plan, ✓ Undertake the decommissioning following the decommissioning plan and under supervision by NEMA, ✓ Rehabilitate the affected locations to the satisfaction of NEMA and other stakeholders. **Responsibility** ▪ WRMA	At decommissioning stage and surveillance thereafter (could be upto 50 years upon commissioning assuming nothing h extraordinary happens to the dam)

Project Activity and Issues	Key Impacts	Areas of Concern	Management Action Plans and Responsibilities	Timeframe and Cost Estimates (KShs.)
			▪ AWSB ▪ Gatundu Water and Sewerage company ▪ RUJWASCO ▪ The WRUA	

Table 17: Conclusions and Recommendations

Conclusion	Recommendation
Kariminu dam is generally acceptable by a majority of the local community, most of whom appreciate the value of the dam locally and the target beneficiary towns where a majority also have interests. However part of the community will be affected through displacement of settlements, agricultural land and public amenities.	Concerns of the community, and especially those directly affected should be addressed effectively during the planning and construction as well as operations of the dam facility. Continuous engagement and involvement should be integrated in the project implementation and dam operations,
✓ Commissioning of Kariminu dam will significantly reduce the deficit in water demand for Ruiru and Juja Towns. ✓ Market centers and communities along the water transmission corridors are potential beneficiaries of the water project.	✓ Appropriate management of the new facility will require keen attention from AWSB and Gatundu Water and Sewerage Company ✓ Athi Water Services Board to provide a parallel service water pipeline to provide the communities along the water transmission pipeline,
✓ Land acquisition for the project will be guided by a comprehensive Resettlement Action Plan (RAP) to be developed under the project. The Plan will also provide a clear complaints redress mechanism to ensure fairness and value to the affected landowners. ✓ A majority of the PAPs might be at risk of losing their compensation earnings from lack of knowledge and skills.	✓ A comprehensive Resettlement Action Plan (RAP) should be commissioned. The process should be all inclusive and within the law. Effective complaint redress systems should be integrated. ✓ Compensation for loss of land, settlements and restoration of livelihoods should be realized before the project implementation commences. ✓ Consider training and awareness raising of the PAPs on investment skills for enhanced beneficiates from compensations.
The catchment areas for the dam are increasingly on threat of inappropriate use with vegetation clearing, wrong agricultural practices and increased settlements. This is a potential future risks to the dam storage capacity (siltation) and the quality of the water (pollutant loading).	✓ Initiate intervention measures for sustainable catchment management strategies (if non-exists) in collaboration with the communities and other relevant agencies. ✓ Influence sustainable agricultural practices to reduce discharge of agrochemical residues into the dam, ✓ Integrate a buffer zone around the dam to prevent direct discharge surface runoff and hence pollution control, ✓ Encourage riparian communities to observe appropriate sanitation technologies for the safety of the dam.
The project will also spur socio-economic activities within the project area such as fishing, tourism, controlled irrigation and also boost water supply to the local markets and institutions through appropriate collaborations with AWSB and the	✓ Communities are advised to form Water Resources Users Associations (WRUAs) and obtain water abstraction permits from WRMA to draw water and supply for their members and other potential economic opportunities,

Conclusion	Recommendation
Services provider. These activities will consequentially lead to increased employment and other economic opportunities,	✓ The local community should also participate in water resource management planning, this will empower the local people so that they regard the development project as their own and learn ways to protect the water resource,
The dam development will present certain ecological and social challenges by vegetation cover removal (especially the riverine species) and replacement with new species (plants and animals) in the long run,	✓ Prepare Construction Environment Management Plans (CEMP) based on this report to ensure specific ecological issues are address during the construction period. ✓ Ensure well formulated environmental management plans that will support sustainable biodiversity of the dam for future value addition to the communities,
The project will disrupt public amenities include access roads and power lines as well as water pumps and pipelines. It is, however, noted that the project will provide alternative routes for access roads and collaborate with relevant agencies in the relocation of services where required,	Development of alternative access roads and relocation of service lines including power and water shall be integrated into the project implementation.
As a result of the dam construction the downstream impacts will include species migration to upstream areas, dam safety risk and land use changes due to fluctuation in the water regimes along the river basin,	Full dam risk assessment study should be undertaken after the project completion to identify the precautionary measures to be undertaken for the safety of the affected areas,
The dam will also provide a flow balancing effect downstream such that high storm water will not cause excessive flooding of the flood plain during the heavy rains. Effectively, the productivity of the cultivation on the flood plain will not be significantly affected,	Sensitize riparian communities to utilize the opportunity wisely to avoid destruction of Kariminu River flood plain.
It is also noted that the dam will control the level of siltation of Kariminu River and other points downstream through retention of the same. The intermittent release of silt during the scouring flush-out may be less damaging to the river downstream,	Monitor the silt build-up of the dam and develop a scouring schedule in line with the flood regimes downstream.
The Treated water rising main will is planned to link to the Northern Collector and onward run along the western edge to Ngewa Junction. From Ngewa Junction, the pipeline is to run along the road reserve to the Bennett's Ridge Reserve Tank Location	The additional pipeline will need to be delineated and necessary land acquisition process undertaken for compensation purposes. The associated RAP studies were undertaken along this ESIA Study.

ANNEXES

ANNEX I: Terms of Reference

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nema

NATIONAL ENVIRONMENT MANAGEMENT AUTHORITY

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ATHI WATER SERVICES BOARD RECEIVED 16 JAN 2015 TEL: 6724322 / 3 P.O. Box 45283 - 00100 NAIROBI

REF: NEMA/PR/5/2/12885

5th November, 2014

Athi Water Services Board
P.O. Box 45283 – 00100
NAIROBI

RE: ENVIRONMENTAL IMPACT ASSESSMENT (EIA) STUDY REQUIREMENT FOR THE PROPOSED CONSTRUCTION OF KARIMENU DAM, KIRIKO TOWNSHIP, IN GUTUNDU SUB-COUNTY, KIAMBU COUNTY

Initial review of the Project Report for the subject development has revealed that the magnitude and the risks associated with the project demands a wider public consultation and in-depth coverage of the foreseen impacts and mitigation measures.

Pursuant to Section 58 of the Environment Management and Coordination Act, 1999 and Regulation 10 of the Environmental (Impact Assessment and Audit) Regulations, 2003 Legal Notice No. 101, you are hereby asked to initiate an Environmental Impact Assessment Study to facilitate in-depth evaluation of potential impacts associated with the proposed project and to materialize harmony with the effected and interested stakeholders.

Please liaise with your EIA experts for further guidance on the same and develop Terms of Reference for approval by the Authority.

SALOME MACHUA
FOR: DIRECTOR GENERAL

Our Environment, Our life, Our Responsibility

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The Project

Project Background

Athi Water Services Board is a state corporation established under the Water Act 2002 vides Gazette Notice No.1775 of 21st March 2003 and licensed by the Water Services Regulatory Board (WSRB) on 5th April 2004. The principal mandate of the board is to ensure efficient and sustainable provision of quality and affordable water and sewerage services in its area of jurisdiction. The responsibilities of Athi Water Services Board include:

(i) Ownership and Holding of water and sewerage Assets/Infrastructure.
(ii) Planning, development and expansion of water and sewerage services Infrastructure
(iii) Contracting out water and sewerage services provision to water service providers
(iv) Monitoring and supervision of water and Sewerage services provision by water service providers.

The main existing infrastructure serving Nairobi City and its Satellites towns were built between 1900 and 1994 and are undersized to insure the actual and future water demand of Nairobi including among others Kikuyu Springs, Ruiru Dam, Sasumua Dam, Thika Dam – Mwagu Intake System. Water from the above sources is treated at 23No. Water Treatment Plants namely:

(i) Ngethu Treatment Works with a capacity of 460,000m^3/day
(ii) Sasumua Treatment Works with a capacity of 63,700m^3/day
(iii) Kabete Treatment Works with and a capacity of 20,000m^3/day

The Water Master Plan Study commissioned by Athi Water Services Board in 2011 identified a priority strategy to meet the 2017 water demand for Nairobi and also prepare a master plan for the year 2035 water needs for Nairobi and Satellite towns. The Master Plan identifies the towns of Thika, Kikuyu, Ruiru – Juja, Kiambu, Karuri, Mavoko, Ngong Township and Ongata Rongai as “the Effective Envelope” of Nairobi Water Demand. From this envelope, Thika, Ruiru-Juja, Kiambu and Karuri are some of the towns that the proposed dams in this study are targeting. The findings of the Water Master Plan, therefore, are the main guiding baseline information during the establishment and development of the water supplies to these towns.

The proposed project site is located in Gatundu North District of Kiambu County approximately 75km north of Nairobi city. The dam location is just upstream of the main bridge linking Buchana to Kariko and Gituamba Markets about 6 km from Kanyoni market on the Thika – Gituamba road. The proposed Karimenu Dam will be constructed across Karimenu River downstream of its confluence with its tributaries including Gathanje, Kagundu and Githanga. Karimenu dam with an estimated yield of approximately 103,000m^3/d in the master plan provided the most suitable source that can supply the towns of Ruiru and Juja with an initial surplus to Nairobi. This yield compares well with the confirmed mean annual flow of 100,224m^3/day.

The dam is being designed and constructed to supplement water supply for Ruiru and Juja Satellite Towns as envisaged in the Water Master Plan for Nairobi. The dam inundation area is estimated at 1,350,000m^2 such as to attain a dam height of 40m for a maximum gross storage capacity of 18.9mm^3. It is estimated maximum daily yield of 129,500m^3 (about a discharge of 1,200m^3/sec). The dam size is expected to impart socio-economic impacts such as the potential relocation of people and economic activities as well as potential disruption of the residual residents and land use features along the transmission corridor.

Project Justification

The capacity of water resources in the Aberdare slopes has been declining with time due to a number of factors including catchment degradation from competition of land use requirements and reduced rainfall to recharge the sources as well as increasing water demand for domestic, commercial and also irrigation purposes for the urban and rural users. This situation is overstretching the available water for domestic supply in urban areas including to the City of Nairobi (which is the major consumer of water from the Aberdare catchment) and now being felt in Ruiru, Juja and Thika Towns. The resources require progressive augmentation to meet the present and future water demand.

The towns around the City of Nairobi that shares water resources from the Aberdare's catchment are among the worst hit by water scarcity resulting from the increasing demand of rising population and expanding social and economic activities. Water sources supplying the City (Sasumua dam, Thika dam, Ruiru dam and Kikuyu Springs), all outside the Nairobi area are increasingly under pressure to satisfy the city needs as well as towns local requirements, including the outlying towns of Ruiru, Juja and Thika . The production capacity is related to inadequate ability of the available sources to generate in addition to transmission losses, excessive abstraction along the transmission pipelines, pressure losses and illegal connections as well as other unaccounted for water.

In order to reverse this situation, Athi Water Services Board has proposed to construct additional dams to serve Juja and Ruiru towns that are presently inadequately served from inadequate water supplies from Ndarugu and Ruiru Rivers respectively. This intervention will also enable the surplus water be made available to supply the communities along the pipeline corridor for enhanced revenue generation for the Water Services Providers and Athi Water Services Board. Kariminu II Dam was among those proposed in the Water Master Plan for Developing New Water Sources for Ruiru and Juja Towns that also covered the analysis of water needs and infrastructure development.

Proposed Project Location

The Dam

The proposed Karimenu Dam is located in Kiambu County (Gitwamba ward, Gatundu North District, Mangu Division, Gathaite Location). Among the villages in the neighbourhood include; Buchana, Kiriko, Gathanji and Kanyoni. The dam locally referred to as Buchana Dam, will be constructed across Kariminu River downstream of the confluence with Gathanje, Kiangundu and Gitanga Rivers.

Water Treatment Works

The Treatment works has been located approximately 3km downstream of the dam to the South of Karimenu River to avoid a river crossing. The raw water main has been kept short to minimise operational problems caused by suspended solids or internal sliming. In addition, the location of the treatment works represents a break in pressure along the pipeline and therefore it has been located as close as possible to the dam site.

Water Transmission Pipeline

The pipeline will branch close Ngewa Market just before crossing the road to Ruiru town to transmit water to Ruiru – Juja towns before proceeding to Gigiri Reservoirs in Nairobi City. The pipeline branching at Ngewa will graviate water to a new reservoir next to Bennett's Ridge Road approximately 6.5km from the Ngewa junction. From the reservoir the pipeline will go along the road to Ruiru town before proceeding to Juja town. A new 3km way leave will be required from the treatment works to the point where the pipeline intercepts the Ngethu way leave to Gigiri Reservoirs. The existing Ngethu way leave is already congested with 4 to 5 pipelines and might need to be expanded. The Pipeline from Ngewa junction to Ruiru and Juja towns can utilise the existing road reserves.

Water Reservoirs

A new Service Reservoir site will be required to serve Ruiru and Juja towns. The reservoir will play the role of a Break Pressure Tank and will also serve as a Balancing Tank to Ruiru and Juja towns. The Reservoir will need provide atleast half-day storage of the total daily treated water inflows. Enroute demands are expected to be served along the pipeline route from the reservoir due to the mushrooming developments within the coffee estates and Thika Highway. The capacity of the pipeline from the reservoir to Ruiru and Juja towns has been increased by 1.5 times to cater for peak demands.

Project Activities

Construction Phase

During the construction phase of a dam there are several significant features to be observed they include;

(i) The process of land acquisition and appropriate compensation will be completed before the actual dam construction commences. Details of this process will be covered under an independent RAP study process for the site.

(ii) Vegetation clearing of the area covered to pave way for campsites establishment, parking yards for the contractors machineries and the construction site of for the proposed dam. In the proposed location the predominant vegetation is plantations of tea, coffee and pineapples. There are also a significant number of trees mainly *Eucalyptus ssp*., Graveria, wattle tree as well as fruit trees and a large of volume of ground covering shrubs and grasses.

(iii) In addition to the clearance of vegetation, there site clearance will generate huge volumes of top soil rich in organic and humic content for disposal. This materials management may be used for reclamation of wastelands or other safe disposal mechanism.

(iv) It is suspected that there are graves and pit toilets in some parts of the areas targeted for inundation. These features will not be buried under the water due to water quality as well as cultural reasons. For this reason, any graves and pit latrines will be decommissioned and removed under supervision in collaboration with the landowners, local leaders and the security agents.

(v) Disruption of access roads, power lines and water abstraction points are likely to be disrupted during the construction process. The project will be responsible of services relocation, provision for alternative amenities (access roads, bridges/crossings), public water access points (water pumps, transmission pipelines and public abstraction points).

(vi) It is expected that materials will be obtained from within such as to include gravel and hard stone quarries. Ideally, the entire earth fill should be drawn from within the reservoir area and, if required, from the cut spillway area. Therefore borrow areas within the reservoir area should be given first preference, followed by those located on the valley sides close to the proposed embankment.

(vii) Upon completion of the project, it will be necessary to restore all sections damaged by the construction activities including surface destruction, access roads, river banks and downstream flood plains.

Operations

(i) This will be the formal hand-over and operationalization of the dam upon completion. Among other activities, the contractor and the client will ensure there are no unresolved social concerns, the facility has been completed to the design details, affected sites have been well rehabilitated and that all components are operational.

(ii) In addition to the paper work, there will be a physical evaluation of the facility that will involve the contractor, AWSB, relevant Government departments and the design consultant. The inspection of the dam will ensure all the issues of dam safety are adequately considered and all the structures are operationally ready and approved to function as planned.

(iii) The initial stage of the operation will be to ensure it is relieving water from the catchment through the rivers and runoff during the rains. This could take up to one year during which there will be strict management of flows in the river to ensure dependants and ecosystems downstream are sustained.

(iv) Development a management plan for the entire water supply system to ensure optimum utilisation of the water resource.

Design Features

Basic Consideration

The basic principle of design was to produce a satisfactory, functional structure at a minimum total cost. Consideration was given to maintenance requirements so that savings achieved in the initial cost of construction do not result in excessive maintenance costs. Maintenance costs vary with the provisions of upstream and downstream slope protection, drainage features, and the type of appurtenant structures and mechanical equipment. To achieve minimum cost, the dam was designed for maximum use of the most economical materials available, including materials excavated for its foundations and for appurtenant structures.

A dam must be safe and stable during all phases of the construction and the operation of the reservoir. To accomplish this, the following design criterion was met:

(i) The embankment, foundation, abutments, and reservoir rim must be stable and must not develop unacceptable deformations under all loading conditions brought about by construction of the embankment, reservoir operation, and earthquake.

(ii) Seepage flow through the embankment, foundation, abutments, and reservoir rim must be controlled to prevent excessive uplift pressures, piping, instability, sloughing, and removal of material by erosion of material into cracks, joints, or cavities. The amount of water lost through seepage must be controlled so that it does not interfere with planned project functions.

(iii) The reservoir rim must be stable under all operating conditions to prevent the triggering of a landslide into the reservoir that could cause a large wave to overtop the dam.

(iv) The embankment must be safe against overtopping or encroachment of freeboard during occurrence of the IDF (inflow design flood), (Probable Maximum Flood, PMF) by the provision of sufficient spillway and outlet works capacity.

Dam Components

The Embankments

The embankment will have a slope of 1:2.5 on the upstream side. There will be a 15 m high cofferdam near the dam heel with a 4 m crest/bench. The downstream slope will be 1:3 with a berm at 1,835m a.m.s.l. The core top will be 1,858m a.m.s.l. and 10m wide. The core slopes at 1:0.5 giving a bottom width of 49 m that will be excavated to 7 m depth. On either side of the core are 2.4 m thick filters. The downstream filter extends along the embankment bottom all the way up to the dam toe where there will be a toe drain.

A toe drain will be provided on the downstream side of the dam. Its materials can be developed from the

rock deposits within the potential cuts or potential borrow areas. Rip- rap erosion protection is required. A source of rip-rap will be identified within the site and therefore rip-rap will be from the reservoir area or very near the reservoir area. It is also recommended that additional rip-rap material be sourced in the vicinity of the dam site because more quantities of coarse boulders that could serve as rip-rap will be needed. It will be necessary to provide a grout curtain under the core trench depending on results obtained from the drilling and permeability testing. The purpose of this grout curtain would primarily be to address the potential for seepage through fractured zones oriented roughly parallel to the valley wall along with zones oriented roughly parallel to bedding if any.

Depending on the effectiveness of the seepage cut-off efforts, it may also be necessary to install drainage tunnels below the spillway structure and within the left abutment upstream of the diversion channel excavation. An estimate of the cost of these tunnels has been included in the overall estimate developed for this study, however, the actual location and configuration of these tunnels should be determined during subsequent stages of the design.

The Diversion Culverts

The diversion culvert is required to pass diversion flow during construction, to regulate flood flows, to empty reservoir in case of emergency, to allow for reservoir lowering for inspection and repairs and to allow for routine de-sludging of reservoir bottom. The approach channel will be aligned straight to the diversion culvert to allow equal distribution of flow though it and in a way to avoid excavation, thus lowering the cost.

The diversion culvert will be 373m long and mostly straight in alignment with a gentle bend at about 115 m from the downstream end. An adequate slope for drainage will be ensured. At win rectangular cross-section for the culvert with a top semi - circular dome will be adopted. One of the culverts will be blocked at the upstream side of the tower to form a dry culvert where the supply pipe size dn 1,200 mm will pass and will also be the access to the intake tower. The second culvert will be closed at the tower and incorporate a gate to control the release of some of the flood waters through it and flushing of the bottom of the reservoir during flooding period. The control gate chamber for this second culvert will be located at the tower. The control valve for the supply pipe will be located at the downstream end of the first culvert to enable dewatering of the conduit for inspection purposes.

A cut and cover construction in concrete will be preferred to a tunnel cutting for ease of construction and topographical considerations which would otherwise require a much longer tunnel. The culvert will be placed on the rock bed to the right of the river channel facing downstream. The proposed diversion culvert will be twin culverts square in cross-section of 2x4m wide x 4m high with a semi-circular dome on top. The walling will be reinforced concrete of 1.0 m thickness to resist the heavy embankment loads as per preliminary design.

The Spillway

A spillway is a structure used to provide the controlled release of flows from a dam or levee into a downstream area, typically being the river that was dammed. Spillways may also be known as overflow channels. Spillways release floods so that the water does not overtop and damage or even destroy the dam. Except during flood periods, water does not normally flow over a spillway. Floodgates and fuse plugs may be designed into spillways to regulate water flow and dam height. Other uses of the term "spillway" include bypasses of dams or outlets of a channels used during high-water, and outlet channels carved through natural dams such as moraines.

Off-Take Tower

An off-take tower structure is preferred to a central control shaft. The of-take tower has a long downstream conduit thus higher frictional losses and lower possibilities of cavitation. With gates at the

upstream end of the diversion culvert for the tower, danger from leakage into or out of the abutment is reduced and it is possible to dewater the culvert for inspection.

The of-take tower will be a 46 m high free standing circular tower in concrete. A free standing structure will allow flexibility in locating on site. It is easier to construct and allows better arrangement of conduits, openings, access structures and instruments as opposed to an inclined tower. The circular shape is to take advantage of its superior hydraulic characteristics. The internal diameter will be 10 m with a wall thickness of 1.0 m at the bottom.

Water Treatment Works

The proposed water treatment process comprises of the following:

(i) Cascade Aeration
(ii) Pre-chlorination
(iii) Dosing with Sodium Carbonate
(iv) Dosing with aluminium sulphate
(v) Dosing with Polyelectrolyte,
(vi) Clarification
(vii) Rapid Gravity Filtration
(viii) Disinfection with Chlorine

Sludge Treatment and Disposal process comprises of Sludge Drying Beds to receive Sludge from Clarifiers and Backwash Water Lagoons, a good Environmental Practice to recycle backwash water from the filters. The following Structures and Building are required according to the treatment process outlined above:

(i) Inlet Works
(ii) Flash Mixer
(iii) Distribution Chamber to Clarifiers
(iv) Centrifloc Type Clarifiers
(v) Rapid Gravity Sand Filters
(vi) Treated Water Tank
(vii) Chemicals and Plant Buildings
(viii) Sludge Disposal and Treatment Facilities
(ix) Staff Houses and Retail Shops

Water Use Options

Water Supply

The Kariminu II Dam source (optimum yield of 103,000m^3 per day) is expected to supply Ruiru with ultimate demand (Year 2035) of 114,198m^3 per day and Juja with 38,066m^3 per day respectively. The Kariminu II Dam source is expected to be supplemented by Gatamaiyu dam (optimum yield of 47,124m^3 per day). The Master Plan proposes that the bulk supplies from each of the sources will be combined for strategic reasons before distribution to each of the two water demand centers.

Although the design of the water treatment plant is outside the scope of the assignment, it is assumed that the design of the treatment plant will consider the optimum yield throughput from the dam of103,000m^3 per day and the basis of sizing of the intake structures.

Irrigation

The dam is being developed to supply domestic water and not for irrigation purposes. However, the local

communities may directly abstract for limited irrigation if issued with appropriate permits. Piped water will not be used for irrigation.

Other Benefits

The local residents expect they would benefit from the dam project. Some of the benefits expected include;

(i) Create source of employment during and after construction of the project to the local community hence improvement of living standards,
(ii) Provision of local water supply,
(iii) Introduction and commercialization of fishing activities for economic gain as alternative for other income generating activities like tea farming, coffee farming and pineapple farming which may be affected by the dam.

Preliminary Study Findings

Overview

Dam construction and operations of associated water supply systems have notable local implications to the environmental and social settings of the project areas. These linkages are to be analyzed through this ESIA Study process as well as the RAP study process and other activities associated with socio-economic interactions. Among the key linkages include the following;

(i) Land-take is perhaps the one linkage with the highest social impacts especially to the affected land owners and the immediate surrounding communities. The linkage has potential for displacement of people and their livelihoods as well as loss of agricultural crops,
(ii) Loss of vegetation land covers including agricultural crops, tree cover and under cover (shrubs and grass). This will have effects on local climatic conditions as well as climate change aspects at the global levels. Retention of flood flow, however, is a mitigation measure for flush-flooding downstream associated with climate change scenarios,
(iii) Water quality of Kariminu River and tributaries downstream could get affected temporarily during the construction period. This will arise from earth moving and fills and also the construction of the dam embankment wall,
(iv) Presence of the dam will change the general life of the community in respect to access to water, safety risks, potential water related health issues and security consciousness, especially on terrorism and criminal acts targeting public water,

Dam Stability Factors

Preliminary geotechnical observations at Kariminu dam site shows the following:-

(i) There is resistance variation in the dam area related to the geology of the subsurface that reveals the stratigraphic layering and the rock characteristics in terms of weathering.
(ii) The slightly weathered or un-weathered rock on the hillsides is relatively shallow (<10m). However, within the valley the un-weathered rock is relatively deep (>20m).
(iii) From the results of trial pits and the associated soil tests shows that the permeability of the soil material at the site is sufficiently impermeable.

General Environmental Features

Environment

The area is characterized by a mixed social setting hot and wet climatic conditions, agro-farming (mixture of agriculture and forest) and medium to high poverty levels. The physiography of the area is undulating landscape, with steep valleys where the rivers cross. Specific observations include the following;

(i) The project area is generally hilly with steep slopes and deep valleys in most locations. The surface physiography is influenced by the Aberdares to the North West and western direction that also constitutes the main water catchment. The slope is generally to the southeast and eastern direction getting gentle further East influenced by the flat low lying Yatta plains.

(ii) The project area is well drained both horizontally because of the horizontal valleys, vertical slopes and loamy red volcanic soils which are porous and allow for all infiltration, the ranges are covered by tea zones. Due to this, cases of flooding are not likely to happen. Clearing of vegetation on the steep slopes is strictly discouraged as flush surface runoff is likely to dominate the region. The catchments are constituted by lower Aberdare ranges feeding to the numerous rivers and streams around.

(iii) The Karimenu River system is located on the southern slopes of the Aberdare ranges. The river system originates from the lush forest of the kikuyu escarpment forest and flows on a south-easterly direction through the forest and settled areas to join the Chania River near Thika Town. Chania River then discharges into Thika River downstream of Thika town flowing into Masinga Dam.

(iv) Kiambu County is generally endowed with numerous springs, streams that constitute one major Karimenu River that serves the project area. The river provides the main source of water to the residents of Karimenu area who use the water either directly or through water schemes such as Karimenu Water Scheme. But due to costs of harnessing water resources most of the resource is under-utilized.

(v) The Project area ecological status has been degraded over the decades from agriculture and settlements, production of coffee, tea, pineapples vegetation and food crops demanding more land with rising population. There is no indication that species of unique or special biodiversity value occur at the site or in its environs. The Project site is therefore deemed to have very limited biodiversity value.

(vi) The general area is mainly covered by Tertiary to Quaternary volcanic material overlying the Basement System rocks at a relatively greater depth. The volcanic suite comprises of pyroclastic tuffaceous and aggromelitic rocks intercalated with basalts which overlie the basement.

(vii) The presence of sediments in rivers has its origin in soil erosion, where the erosion is a result of series of complex and interrelated natural processes which would loosen and move away the soil and rock materials under the action of water, wind and other geological factors. The most important factors which influence the erosion from any area are rainfall regime, vegetal cover, soil type, land slope and land use. For the Karimenu River sub-catchment, a major transformation of the middle catchment from forest and bush land into agricultural land has been observed. Land use is an important factor that controls the rate of erosion and poor cropping practices and removal of vegetation by fire accelerates soil erosion.

Social

Following are among preliminary observations on social settings;

(i) During the 2009 population centres, the project sub-county was Gatundu while the project area fell within Kiriko and Gituamba sub-locations in Gituamba Location. These administrative areas have since been subdivided where currently, the project falls within two locations and

three sub-locations namely Gathaiti Location (Kanyoni and sub-location) within Mang'u Divison and Gituamba (Gituamba and Kiriko Sub-locations),

(ii) Settlement patterns are influenced by ecological and climatic factors including land fertility, rainfall amount and type of farming practiced and crops grown as well as number and intensity of economic activities and access to services (administrative, health and education). For example, cash crops such as tea and coffee attract a high population because residents have a higher preference for cash crops farming compared to food crops. Another reason for clustered settlement is the growth of market centres including Kamwangi, Kanyoni, Kiriko and Gituamba among others.

(iii) Land within the project area and its immediate neighbourhood is privately and publicly owned with the former accounting for over 90%. The publicly and government owned land in the area include the 30 meter Karimenu riverine reserve, land constructed with roads and institutional land (schools, health centres and market areas). Privately owned land was historically owned through clans. However, this has been replaced with individual land ownership vested to individuals where land changes ownership through inheritance or purchase.

(iv) Kiambu County has high literacy level which stands at 90.1%. The project area is thus characterized with high literacy levels. There are a number of ECD centres, primary and schools as well as tertiary institutions notably private colleges.

(v) There is no formal water supply reticulation in the project area. Observed access to water practices included the following;

- ✓ The communities, therefore, obtain water for their domestic and livestock requirements directly from the rivers (surface water sources) in the absence of formal water supply reticulation. This practice also applies to the transmission pipeline corridor.
- ✓ Institutions and factories have invested in pumping water from the river, part of which will be disrupted by this project.
- ✓ Among the homesteads were also observed to obtain their water from shallow wells whose water quality could not be established.

(vi) Gatundu north sub-county is currently served by Igegania sub-district hospital which offers out patient, maternity laboratory and pharmacy services. It also has six health centres, six being government funded and two faith based and three dispensaries. The main health facilities in the project area include Kanyoni level 2, Gituamba community dispensary, Gituamba medical clinic and other four private clinics

(vii) Agriculture is predominantly the main economic activity and main source of livelihood for the majority of the population. It is the leading sector employing over 80% of the population directly and indirectly. The agricultural sector in the area is faced with many challenges that include erratic weather, fluctuating commodity prices, high cost of inputs and unexploited potential in trade and industry

(viii) Land is the primary natural resource in the area seconded by surface and sub –surface water. Though the area does have Permanent Rivers a large number of populations of the residents depend on raw water from rivers such as Karimenu River and boreholes. In addition, the project area has forest resources which are natural and also manmade which provide fuel, raw materials for wood products, soil conservation and prevention of water catchment areas

Features along the treated water transmission pipeline corridor, the treated water storage tank and the supply areas will be established during the study.

Potential Impacts

General Overview

Construction of dams and water supply systems is beneficial to the stakeholders and the country in

general. However, it has its fair share of ecological as well as social challenges. Impoundment of large volumes of water has implications on the upstream systems through shifting of ecosystem boundaries upstream as a result of changes in flood regimes. At the dam site itself and the inundated areas, implications ranges from slowed silt, nutrients and pollutant transportation rate to downstream zones, potential loss and/or introduction of species (both plants and animals), displacement of social and economic features and land use changes for the residual riparian landowners.

Abstraction and transmission of water has got direct and indirect interactions with the environmental and social setting of the affected areas and downstream of the source streams. Among the broad linkages include the following,

(i) Abstractions reduces the flows in the target rivers and streams effectively denying the ecosystems and social requirements downstream the opportunity for the associated values,
(ii) On the other hand, transmission involves trenching, physical installations (pipelines, tanks, treatment works and support structures). Transmission of water is perhaps the one with most social linkages including at times limited displacement of people and livelihoods,
(iii) Finally, operations water supply reticulation has attached risks to social aspects such as water accessibility conflicts, wastage of water, economic factors associated with water (e.g. the concepts and modalities of paying for water).

Finally, downstream impacts are associated with regulated flows of the affected rivers/streams, shifting of species to upstream areas, safety risks, deprived sediment load and land use changes due to the constant flows trends introduced by the dam.

The above impact concepts guide the identification of the impacts associated with the proposed Kariminu dam such as to focus on the following aspects;

(i) Hydrological patterns of the affected river basin,
(ii) Hydraulic characteristics at the dam site associated with the dam designs,
(iii) Water quality issues with respect to the watershed and catchment land use practices,
(iv) Geological trends studies in regard to physical water retention,
(v) Aquatic ecosystems and habitat requirements,
(vi) Riparian land use trends and natural features,
(vii) Social features (land use, settlements, economic activities, cultural features, etc.).
(viii) Social trends including population and settlement dynamics, social integration and kinship relations, cultural values, displacement and relocation, gender equity and disease prevalence,
(ix) Economic trends namely economic activities, poverty levels and livelihood changes.

Environmental Impacts

The proposed improvements of abstraction and transmission of water could have a direct and indirect impact on the environment and the people in the project area. Among the broad linkages include the following,

(i) Construction of the dam involving notable earth works and may lead to elevated turbidity and pollute the water temporarily for the users downstream.
(ii) Transmission which involves trenching, installation of pipes and tanks will result to displacement of people and loss of livelihoods.
(iii) Removal of vegetation along the transmission line and especially at the intake will result to loss of biodiversity and disruption of the ecosystem in the forest.

(iv) Potential water losses at the intake and transmission pipeline leakages
(v) Linkages with other water users including downstream communities and the ecological requirements
(vi) Potential vegetation removal along the pipeline network.
(vii) On the other hand, transmission involves trenching for physical installations (pipelines, tanks, treatment works and support structures) with potential linkages to roadside social activities, drainage and loss of vegetation,
(viii) Social aspects such as water accessibility conflicts, wastage of water at sources, connectivity, revenue collection, sanitation and hygiene.

Positive Impacts

The general environmental positive impacts associated with the proposed new water supply system will include;

(i) Potential poverty reduction and improvement of livelihoods for the local residents resulting from increased disposable incomes realized from employment of the skilled and unskilled locals for construction, spending by the construction workers. Through services such as catering, housing, transportation, etc.,
(ii) Improved accessibility to acceptable water quality by additional beneficiaries that in turn will reduce potential risks of water borne diseases, improved general hygiene in the area and encourage use of sanitation at household levels,
(iii) Improved revenue for RUJIWASCO and AWSB. Investment on improving the water distribution would be necessary for the Company to meet the operation costs of the network.

Negative Impacts

Though the proposed project has positive impacts, negative impacts should also be identified and possible mitigation measure prescribed to ensure the projects satisfactions. These negative impacts have influence to both the natural and physical environment. Some of these negative impacts include:

(i) Increase in social vices and infectious diseases that may arise during construction from social interactions
(ii) Potential vegetation removal along the work areas
(iii) Increased exposure to limited accidents during construction and operation phases.
(iv) Potential disruption of people and livelihoods, especially along the pipeline corridors and tank locations
(v) Additional wastewater generation in an area not well covered with waterborne sewerage system.
(vi) Land acquisition for the dam and the new pipeline corridors will lead to limited social disruption through land take. This will require a Resettlement Action Plan (RAP) to provide the procedures and compensation schedules.

Management Issues

The project is designed for enhancing social and economic benefits through sustainable water supply and sanitation services. The Project would be expected to comply with the environmental conservation requirements in accordance with the established Kenyan laws and regulations. To realize these goals, acceptability by a majority of the beneficiaries and stakeholders as well as ensuring minimal effects to the physical environment will require to be ensured through participation in the project and continuous consultations, evaluations and review of the design aspects throughout project implementation cycles.

It is also recommended that the environmental management guiding principles specific to this project

improvement and water resources management be established to allow integration of environmental management considerations during construction and operations. In order to implement the management plan, it is recommended that an expert be identified to oversee the environmental and social management aspects including the water source conservation, soil erosion control, re-vegetation whenever appropriate, water conservation and equity in distribution, enhanced sanitation and hygiene measures throughout project area to match the water supply initiative. The expert would also be required to coordinate and monitor environmental management activities during construction and post-monitoring audits.

General ESIA and RAP Study Approach

ESIA Study

Due to environmental and social challenges associated with dam construction activities, a comprehensive environmental and social impact assessment study (ESIA) is necessary for every new project to evaluating the current environmental and social status (baseline conditions), establish potential impacts, establish the potential for social and economic benefits and estimate the project cost, obtain opinion of the local communities and develop appropriate mitigation and remedial actions for integration in the project design and implementation. According to the Environmental Management and Coordination Act (EMCA), 1999, section 58 requires that all new projects falling under the second schedule of the Act must undergo comprehensive environmental and social impact assessment studies. ESIA study should also comply with the EIA Regulations of 2003 on the minimum and other convectional Environmental Guidelines

ESIA Objectives and Scope

Objectives

In accordance to the Terms of Reference, the objectives of the study will be;

(i) Predict the anticipated environmental and social impacts.
(ii) Recommend feasible and cost-effective measures to prevent or reduce negative impacts to acceptable levels and enhance positive impacts of the project.
(iii) Estimate the impacts and costs of those measures, and of the institutional and training requirements to implement them.
(iv) Prepare an environmental impact assessment report to include an Environmental and Social Management Plan (ESMP) including proposed work programs, budget estimates, schedules, staffing and training requirements, and other necessary support services to implement the mitigating measures.
(v) Explain how the project would comply with the Kenyan guidelines together with international best practices.

The ESIA report should be informed by the opinions collected during Public Consultations. The public consultations will be conducted such as to share initial findings with project stakeholders.

ESIA Scope

The environmental and social aspects that could be associated with the construction of the dams and associated components include,

(i) Impacts on water resources and water quality and future scenarios predictions,
(ii) Impacts on biodiversity and predictions based on the changing and balanced flow trends,
(iii) Impacts on land and soil,

(iv) Impacts on hydrology and drainage with focus on the river sub-basin and social and economic dependants,
(v) impacts on air quality including relative humidity
(vi) impacts on climatic conditions of the area
(vii) land requirements and associated social disruptions

The project also has the potential to transform environmental linkages as well as social and economic setting in the area in terms of land use practices, human settlements and demographic trends, economic activities, institutional development and, therefore, the need to establish the baseline conditions by generating fresh data and information as well as gather information from existing sources for effective identification of related impacts and appropriate mitigation measures.

ESIA Study Approach

In accordance to the Kenyan EIA regulations (Kenya Gazette Notice No. 56 of 13 June 2003), following are the key issues expected of a full environmental impact assessment study;

(i) A comprehensive description of the proposed project including its objectives, preliminary designs (to be availed by the Client), proposed implementation (from the feasibility or other reports) and anticipated by-products among others,
(ii) Description of the project area such as to cover the location, environmental setting, social and economic issues, development strategies as well as national development plans, etc. linkages will be established between the information so gained and the role of the proposed project,
(iii) Key social linkages including land ownership, access to water, disruption to access roads, potential displacements and compensation issues as well as social disruptions in terms of accessibility of common resources and amenities,
(iv) Policy, legal and institutional framework within which the proposed project will operate that will also include the corporate policy and strategic planning,
(v) An overview of the anticipated impacts from the project to physical environment, social status and general benefits to the national economy. Appropriate mitigation measures and plans would also be suggested,

Following on the above, emphasis on the environmental and social assessment for project will be laid on the following key areas;

(i) Updating the environmental and social baseline conditions in and around Kiambu County and the dam location, water transmission corridor and the user areas,
(ii) Evaluating the land use patterns within the project areas and the larger Kiambu County in general with respect to influence from the dam construction and use thereafter,
(iii) Reviewing the environmental impacts with particular focus on physical environment, social and economic issues as well as natural resources aspects within the project areas,
(iv) Reviewing the social implications of the project to be gathered through structured public participation and interviews of the public officials, community groups, farmers, land owners, public institutions, opinion leaders, etc.,
(v) Reviewing the mitigation measures and an environmental management plan outline,

An Environmental and Social Impact Study Report on the dam project will be developed on the basis of available information and a report will be prepared for submission to the National Environmental Management Authority (NEMA) in accordance to the legislation. In addition to the physical environmental assessment, the communities (Farmers, business people, landowners, institutional heads, residents, etc.) within the project area will be involved through interviews and consultation forums to give their views and

opinions as beneficiaries. Liaison with the local leadership and the administration is expected to facilitate this process while the presence of the Client's representative at this stage would be necessary in order to clarify certain policy issues that may arise during the meetings.

The ultimate goal will be to identify the anticipated impacts resulting from the proposed project that is determined on the basis of the baseline conditions established during the field work and information obtained from the documents reviewed.

RAP Study Approach

Principle

Resettlement Action Plan (RAP) is gradually being introduced in projects in Kenya to ensure appropriate due diligence in the relocation of people and economic features from project target areas. It involves overlaying the project layout on the target land to confirm the social and economic features affected by the project. The inventory of the affected person is updated and the related costs quantified for appropriate compensation through established policies. Any project with the potential to displace up to 200 PAPs undergoes an Abbreviated RAP while where over 200 PAPs are to be involved. A full RAP will be undertaken for Kariminu II Dam Project.

Involuntary resettlement is an integral part of the overall project formulation and needs to be dealt with from the earliest stages of the project. This would help to explore alternatives and minimize the un-necessary displacement of population. In principle, development partners emphasizes that where displacement is unavoidable, the project should assist with all means to improve the former living standards, income generating capacities, production levels or at least maintain the previous standards of living of those displaced. This requires a thorough understanding of social, economic and cultural conditions of the area and its people and the factors, which influence the lives of those affected. This can only be achieved through detailed socio-economic survey among the project affected persons (PAPs). Such a survey becomes the basis for propositions of measures to mitigate the impacts on the PAPs which would be included in a Resettlement Action Plan (RAP).

RAP Objective

The basic objective of the entire exercise is to carry out a Socio-Economic Survey (SES) among PAPs falling within the project area so as to collect information and generate data which are necessary for preparation of an appropriate RAP report. The activities below will be undertaken,

(i) PAPs identification and asset inventory to establish all affected parcel owners and quantifiable developments on the land,
(ii) Rapid PAPs Census will be an enumeration of the nature and status of affected people in regard to households compositions, leadership, livelihoods, health aspects, housing and other socio-economic factors,
(iii) Consultations with PAPs to explain the project and seek their opinions and suggestions on how the resettlements should be undertaken,
(iv) Compensation Assessments will be undertaken to estimate values and entitlements to the land owners as the preliminary stages of the compensation process,
(v) RAP Implementation schedules will be a tool to ensure order and known timeframes desired for the compensation of the PAPs,

(vi) Complaints redress mechanism will be a tool to moderate extreme differences in terms of valuation, compensation factors and impacts generated by the project.

RAP Scope

Resettlement Action Resettlement report will detail the existing land ownership, household setting, livelihoods and physical developments as they will be at the cut-off date. The report will present a detailed inventory of the project affected persons (PAPs) and a schedule of land acquisition and displacements alongside appropriate compensation factors including relocation destinations. Opinions and views of the PAPs will be presented from consultation forums held during the RAP process such as to inform key concerns for consideration in the implementation process. Other issues to be covered will include RAP implementation plan and monitoring guidelines for adoption. Specifically, the report will address the following;

(i) RAP guiding principles
(ii) RAP activities
(iii) Cost estimates
(iv) Institutional arrangements for the RAP implementation
(v) Project impact on human settlements including historical and cultural sites
(vi) RAP Implementation schedule
(vii) Internal and external monitoring and evaluation mechanisms

At this stage, the affected community seems to be agitating for land-for-land form of compensation despite the potential challenges involved including land availability. An intensive discussion including intervention by the Client in this particular regard will be considered. A resettlement statement would also be prepared to provide an outline of necessary indications towards land acquisition and compensation as a basis for a detailed resettlement action plan.

Study Activities

The preliminary ESIA study for the proposed study has already been undertaken and an ESIA Project Report submitted to NEMA. The activities of this assignment, therefore, involves review of the baseline studies, integrate the status along the water transmission pipeline corridor and the treated water tank location as well as updating the impact/mitigation and the environmental management plan (ESMP). However, the Resettlement Action Plan (RAP) is being undertaken right from the scratch. The following study activities will be undertaken for both ESIA and RAP Study Teams concurrently.

Consultations

Commencement Meetings

Following mobilization of the study team, the commencement meeting with the Client took place on the 16th March 2016 followed by a combined reconnaissance site visit on the 6th April 2016. The joint site visit, attended by all the Consultant Team, The Client Representatives and The Managing Director for Gatundu Water Sewerage Company as well as Community Representatives, was meant to provide a common appreciation of the project location characteristics.

In order to ensure harmonized procedure for desk and fieldwork, information gathering and reporting, the Team Leader called a meeting of all the participating experts to discuss and agree on the approach and thereafter engage them in frequent consultative sessions throughout the study. The team deliberated on among other issues among them being;

(i) The diversity on physical environment, climatic conditions, demographic trends as well as the hydrology and geological patterns (geotechnical characteristics) in the project area,
(ii) Discuss the design criteria as a basis for identifying the impacts and necessary amendment recommendations,
(iii) Appreciate the analysis of the social setting and related linkages to enable identify relevant implications and preventive measures,
(iv) Policy, legal and regulatory requirements, particularly governing the water sector,
(v) Share experiences on environmental resources and social issues in that region, and in particular with regard to water resources management and exploitation,
(vi) Report the coverage structure, terms of reference, procedure and an overview on the timeframes.

Stakeholder Selection Criteria

The project area comprises various categories of stakeholders who should be consulted and involved in the study process. The Stakeholders categories considered and relevance are as follows;

(i) The Community Project Committee representing the landowners will be engaged as a supplementary forum following the comprehensive stakeholders and public consultations during the preliminary assessment of the dam areas,
(ii) The landowners around the dam and its immediate neighbourhoods (Kanyoni, Gituamba, kiriko, Kamwangi and sample institutions) who will be engaged on a Focus-Group Discussions basis. Representatives will be selected in consultation with the County Commissioner's Office, Sub-County Administrator and the Community Project Committee,
(iii) Landowners, Institutions and Leaders along the treated water transmission pipeline corridor will be identified and engaged on rapid interviews followed by a structured public consultation meeting at venues to be jointly determined in collaboration with the County Commissioner's Office and the Sub-County Administrator,
(iv) For purposes of land acquisition (RAP), the specific landowners will be identified and engaged as Project Affected People (PAPs) to obtain their opinions and suggestions on mode of compensation,
(v) There will also be a briefing of the County Government and County Commissioner in Kiambu on a day and venue to be determined.

Stakeholders and Public Consultation Meetings

Rapid and structures stakeholders and public consultations were undertaken for the dam areas during the preliminary assessments. Stakeholders and Public Consultation public meetings will be conducted at in collaboration with the Client and the local administration to provide forums for the stakeholders to present and express their opinions and suggestions on the proposed project. The forums will also provide the Client with an opportunity to explain the project to the stakeholders. While the ESIA Study will address the wider population, RAP process will focus on the PAPs, i.e. residents directly affected by the project both at the dam and along the treated water transmission pipelines corridor. During the ESIA Study phase, the following consultation meetings will be convened;

(i) Supplementary meetings around the dam to include Focus Group Discussions. The Community Dam Committee will also be engaged to clarify certain issues of interest to the community,
(ii) Stakeholders and public along the treated water transmission pipeline corridor, including those along the target Northern Collectors corridor, will be engaged through a rapid interview session as well as a structured meeting at a venue to be identified,
(iii) There will also be a meeting at the treated water storage tank at Jacaranda along Ruiru – Githunguri road,

(iv) The Consultant will also hold consultative meetings with the County Government of Kiambu (County Secretary in-charge of water resources)

(v) The Project Affected Persons (PAPs) will also be engaged through the RAP process. The PAPs and the Stakeholders Meetings, however, might overlap and hence possibility of sharing the outcomes.

Presentations to the Client

Presentations of the draft ESIA Study Report and RAP Report to the Client will also constitute a forum for consultations where the comments and sentiments received will go into improving the content of the final reports.

Documentary Review

Various relevant documents will be reviewed for an understanding of the terms of reference, environmental status, data on demographic characteristics of the project area, land use practices, development strategies and plans (local and national) as well as the policy and legal documents. In summary, among the documents to be reviewed will include;

(i) The Terms of Reference,
(ii) ESIA Project Report as submitted to NEMA,
(iii) All relevant project documents (feasibility study reports, design reports and drawings, hydrology reports, socio-economic reports, etc.),
(iv) Nairobi Water Master Plan
(v) Kiambu County Integrated Development Plans,
(vi) Policy documents and legal statutes governing the water sector,
(vii) Selected literature in management practices in the water sector,
(viii) The Constitution of Kenya
(ix) The Kenya Vision 2030
(x) National population census and economic reports (2009),
(xi) National Economic strategy
(xii) Other ESIA and RAP Report water projects in the area
(xiii) Other documents as may be identified.

Field Assessments

A comprehensive physical evaluation of the project area will be undertaken taking into consideration physical and biological environmental status, human settlement and socio-economic activities. Field visits will also involve interviews of selected persons, groups of persons or institutional officials. Interviews will be arranged in collaboration with the and /or other person as will be assigned by the Client at pre-determined locations and time schedules. A questionnaire and other information collection tools will be prepared and distributed to the stakeholders prior to the meetings.

The proposed project site is a well defined feature defined on the ground and this will enable determination of the exact physical environmental features to be affected. However, the effects may be felt on a wider area covering up to a radius of 3km from the project area. The fieldwork session will, therefore, be designed to establish the anticipated positive and negative impacts over each impact zone in terms of physical environment, social and economic trends, population trends, hydrology and climatic patterns. Among the objectives of the detailed fieldwork will be to;

(i) Obtain any available information and data from the local public offices including environment, water, lands, tourism, Forest Department and Agriculture. Interviews will also be organized

with focus group members of the communities in the dam area since a comprehensive meeting had already been undertaken through the ESIA project preparation,

(ii) Full interviews and consultation meetings will be undertaken along the water transmission corridor where there are no previous interactions,
(iii) Interactions with the County Government Offices of Kiambu County,
(iv) Visiting potential construction material sites with respect to land use and loss, proximity to human settlements, relationship with the hydrology and drainage, potential health and safety of the residents, size and ownership among other issues,
(v) Evaluate proposed construction camp site and their effects to the surrounding social and economic conditions (if any has been identified),
(vi) Physical observations will be focused on the topography, land use trends, surface water sources, public amenities, wetlands, settlements, forests, soils, etc.,
(vii) Carry out rapid assessments of population densities, human settlement trends, social and economic activities and presence of any important cultural sites within the impact radius,
(viii) Identify climatic and land cover characteristics of the affected areas,

Reporting

The process of report writing will involve participation of the team members through analysis of respective data and information. This will be translated into findings and anticipated impacts. It will also provide a basis for development of mitigation measures and an Environment Monitoring Plan for incorporation into the project implementation and other investigation. The Project Report will be submitted following a timeframe to be agreed in the contract such as to cover the requirements of National Environmental Management Authority (NEMA) guidelines. The reporting outputs will include the following;

(i) Inception Report (this report)
(ii) Terms of Reference on ESIA Study for NEMA approval
(iii) Draft ESIA Study Report
(iv) Final ESIA Report
(v) Draft RAP Report
(vi) Final RAP Report

Work Plan

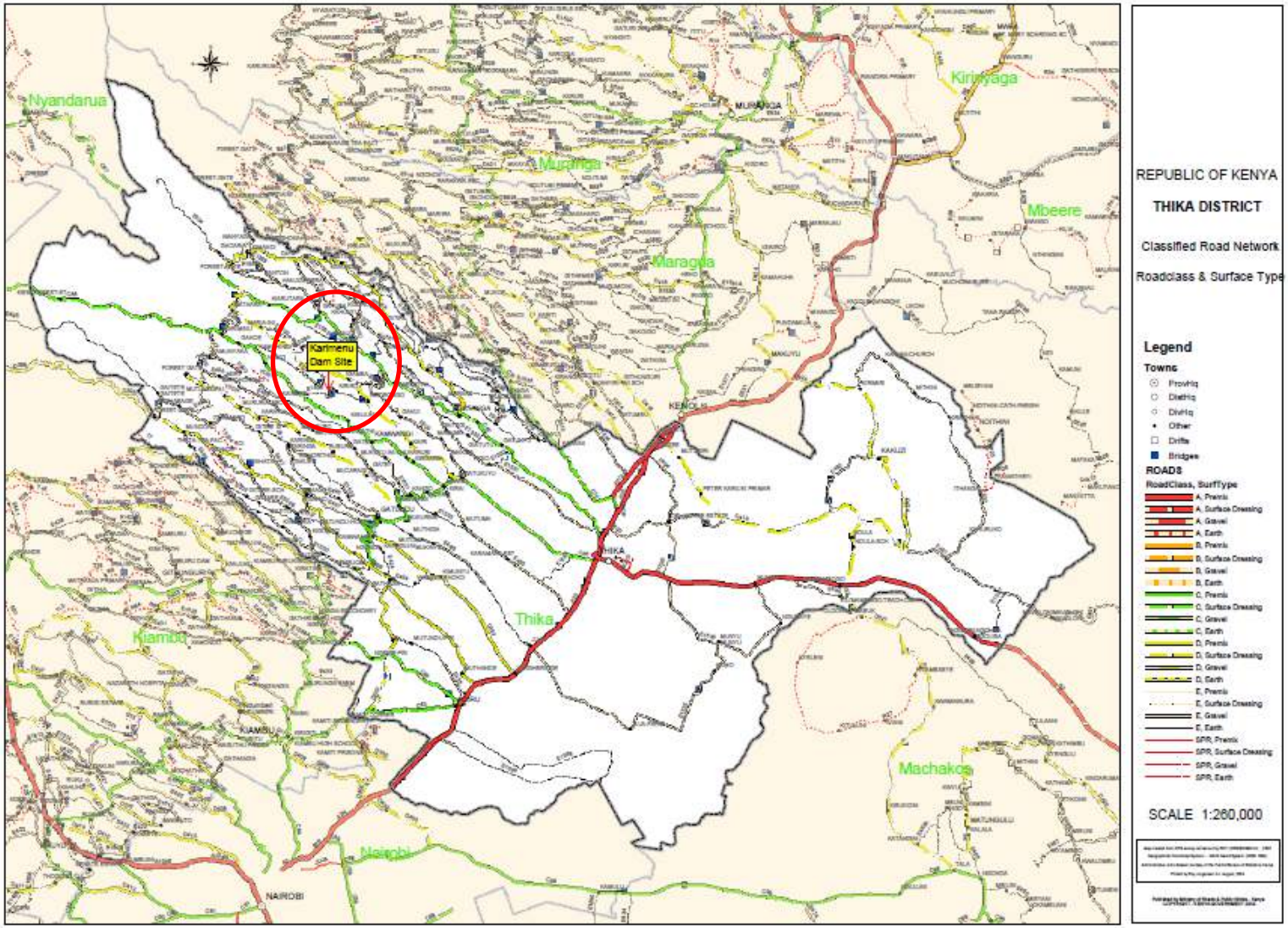
Study Activities

This assignment will involve a series of activities in the sequence listed under the terms of reference. There will be close liaison with relevant county departments, local authorities, community groups and other organizations in the area with a view to sharing their experiences and information with respect to environmental resources and social aspects. Effective evaluation of the baseline status will comprise of interviews (consultative meetings and discussions) and physical inspection of the entire project area. The current status (baseline environmental and social conditions) will provide the starting point for the impacts predictions and benchmark for the mitigation measures.

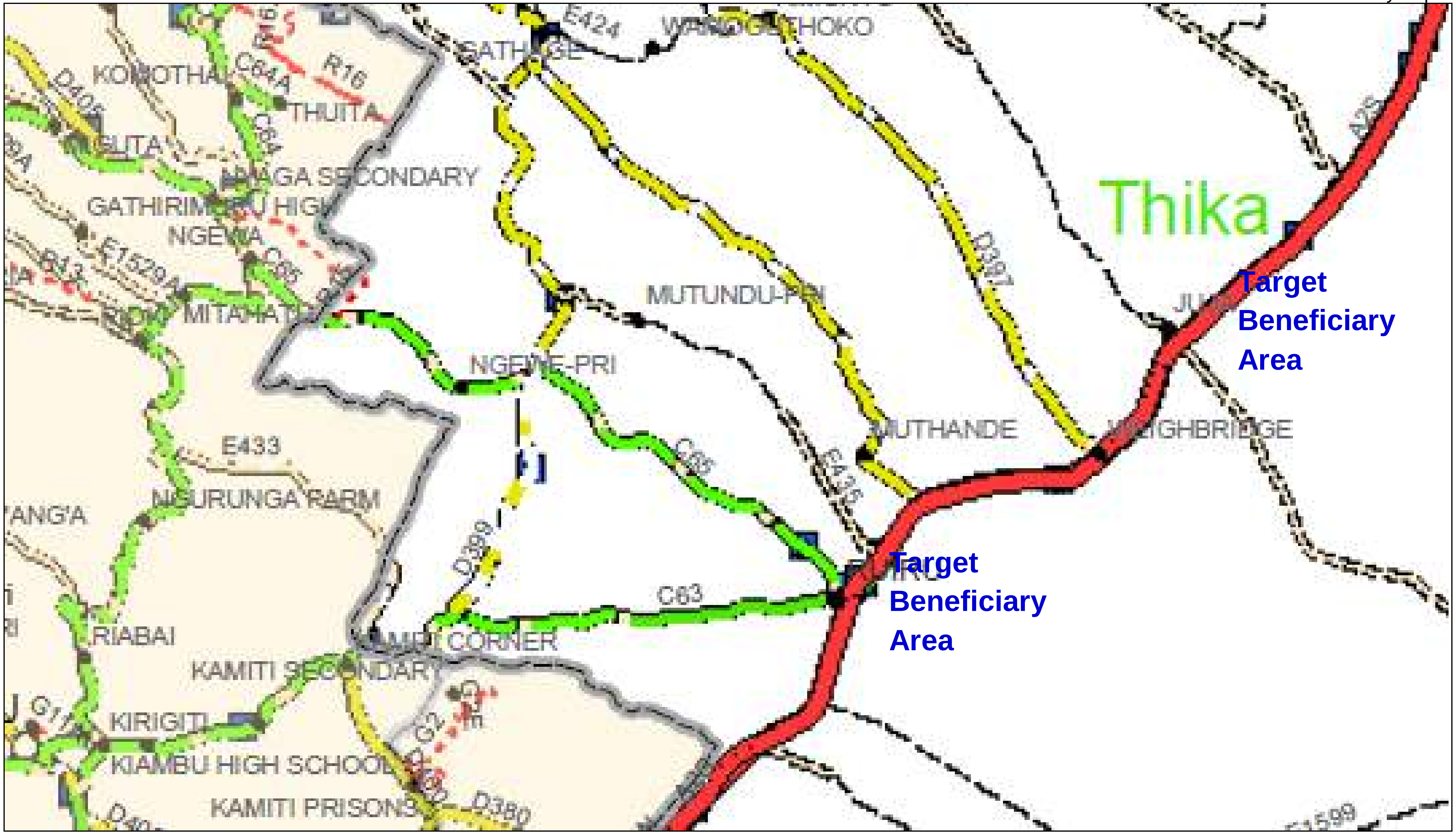
The planning of the assignment will be influenced by the two main outputs, namely the Environment and Social Impact Assessment (ESIA) Study on the one hand and the Resettlement Action Plan (RAP) on the other. The consultant teams for the two studies will overlap on some activities since the two outputs complements each other. The two assignments will, however, run concurrently.

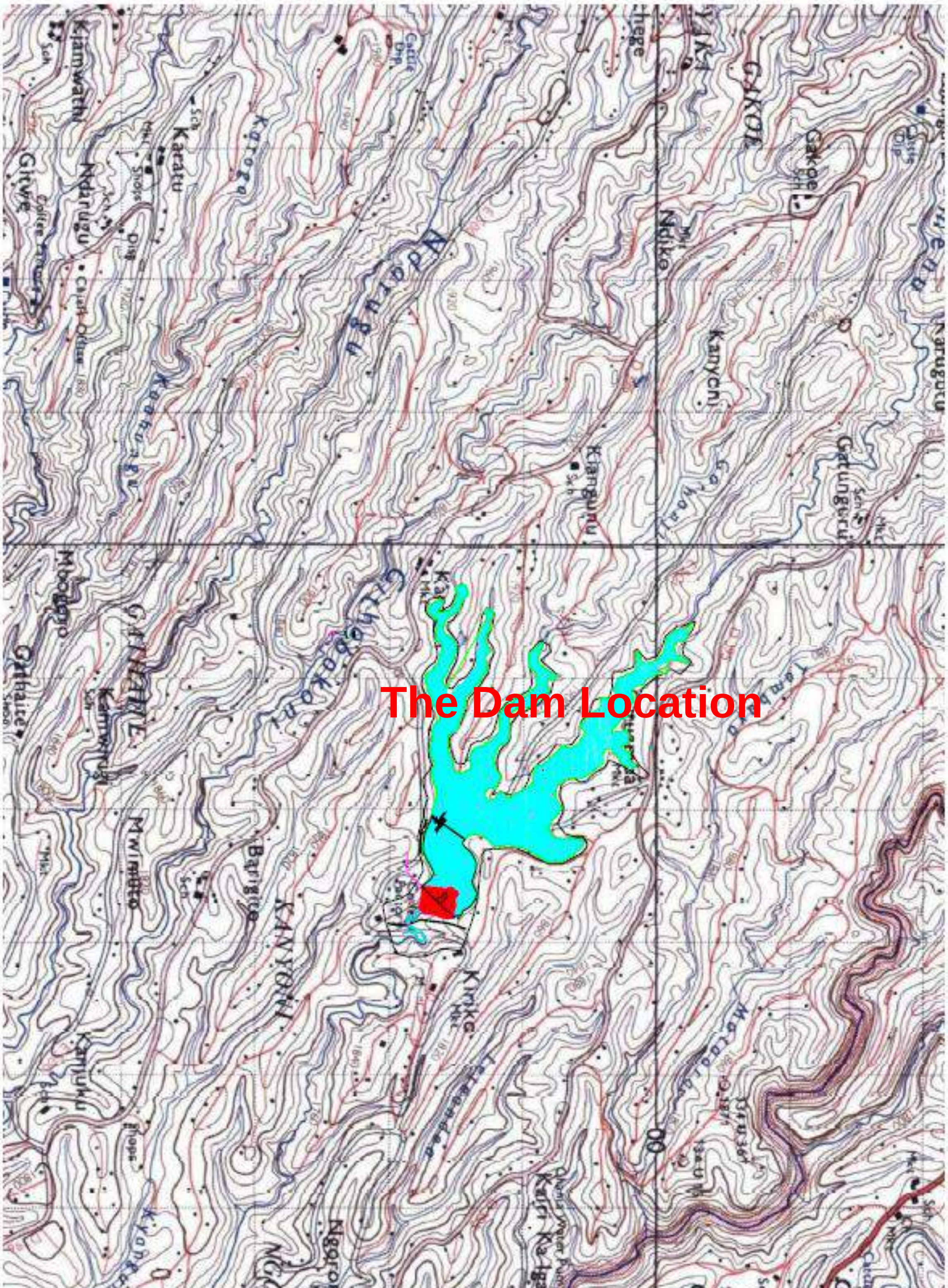
Assignment Phase	Activities	Deliverables
A: Environment and Social Impact Assessment (ESIA)	▪ Initial Consultations ▪ Reconnaissance visits ▪ Inception Report preparation ▪ Submission and presentation of Inception Report	Combined Inception Report (ESIA and RAP)
	▪ Review of original ToR ▪ Review of ESIA Project Report ▪ Prepare ToR for ESIA Study for NEMA approval	Submission and approval Terms of Reference on ESIA Study
	▪ Field assessments ▪ Supplementary environmental assessment ▪ Stakeholders and public consultations. ▪ Cumulative Impacts Assessments	Draft ESIA Study Report for review by the Client
	▪ Review of ESIA Study Report ▪ Presentation to the Client ▪ Integration of Comments (NEMA and Client) ▪ Final ESIA Study Report	ESIA Study Report submission to NEMA
B: Resettlement Action Plan (RAP)	▪ Initial consultations ▪ Reconnaissance sites visits	Combined Inception report (ESIA and RAP) – see ESIA
	▪ Project area delineation and mapping ▪ PAPs identification and mapping ▪ PAPs census and consultations	Draft RAP Report Submission to the Client
	▪ Cut-off date setting ▪ Household survey ▪ PAPs interviews ▪ Compensation factors setting	
	▪ Drawing RAP implementation plan ▪ RAP Disclosure ▪ Integration of comments ▪ Final Reporting.	RAP Report submission to the Client

ANNEX II: Project Location Maps and Layout


Nyandarua
Murang'a
Kirinyaga
Mbeere
Maragwa
Karimenu
Dam Site
Kiambu
Thika
Machakos
Nairobi
NAIROBI
REPUBLIC OF KENYA
THIKA DISTRICT
Classified Road Network
Roadclass & Surface Type
Legend
Towns
ROADS
RoadClass, SurfType
SCALE 1:260,000


Karimenu
Dam Site
KIARUTARA
HANJIGE
KAHUHYU
GITIRI
KAHIGA SCH
MUKOE
THAGARI
GAKOI
KARITI
GATHIGE
KAMAE
KANDARA
ARIMINU
GAKOE
AMUNYAKA
IGAMBA
KIRIKO
NDORONGO
MURURIA
KARATU
GAKUI
KANJUKU
MUNDORO
KAMWANGI
KAIRI
GATEI
GIATUTU
GATUNYU
MUKURWE
MUCARAGI
GIKURE
KARINGA
RUBURI
IGEGANIA
GATUKUYU
KANGO
KIRAI
GATUNDU
MUTUMA
MUTHIGA
GITARE-SCH
MUCHEGE
GATHIRU-INI
MUKINYE


Thika
Target Beneficiary Area
Target Beneficiary Area
MUTUNDU-PRI
NGEWE-PRI
MUTHANDE
E433
NGURUNGA FARM
RIABAI
KAMITI SECONDARY
KIRIGITI
KIAMBU HIGH SCHOOL
KAMITI PRISONS
D380
C63
C65
D397
D399
E424
THUITA
MITAHATI
GATHIRIMU HIGH
NGEWA
E433
A2


The Dam Location

The Water Treatment Works Layout

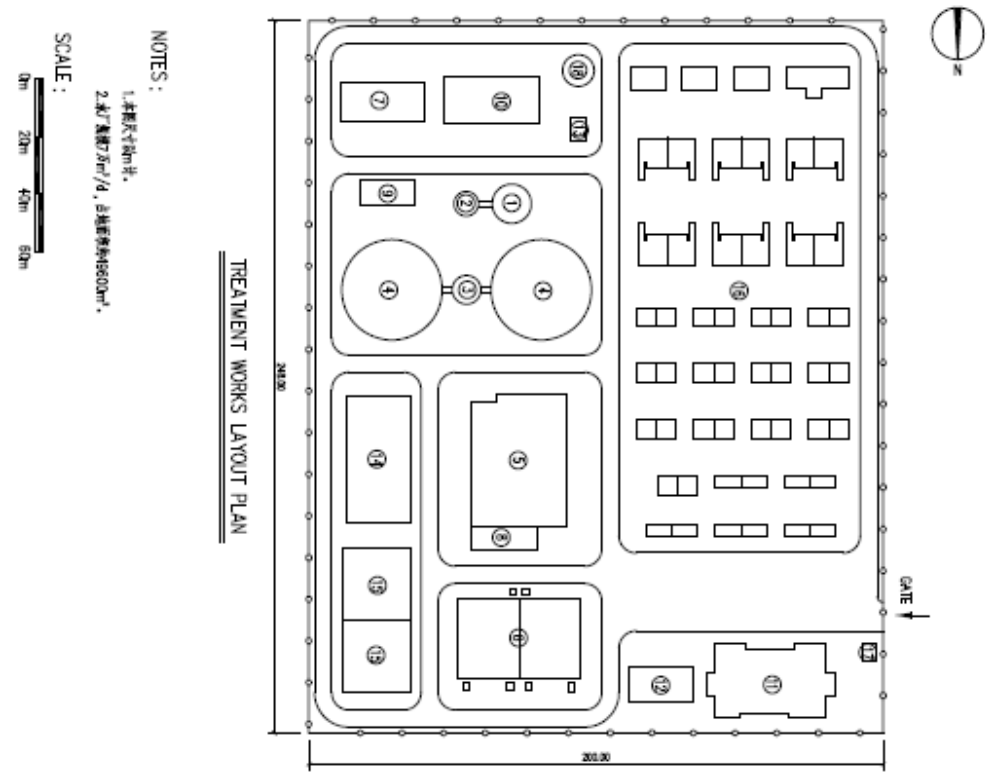
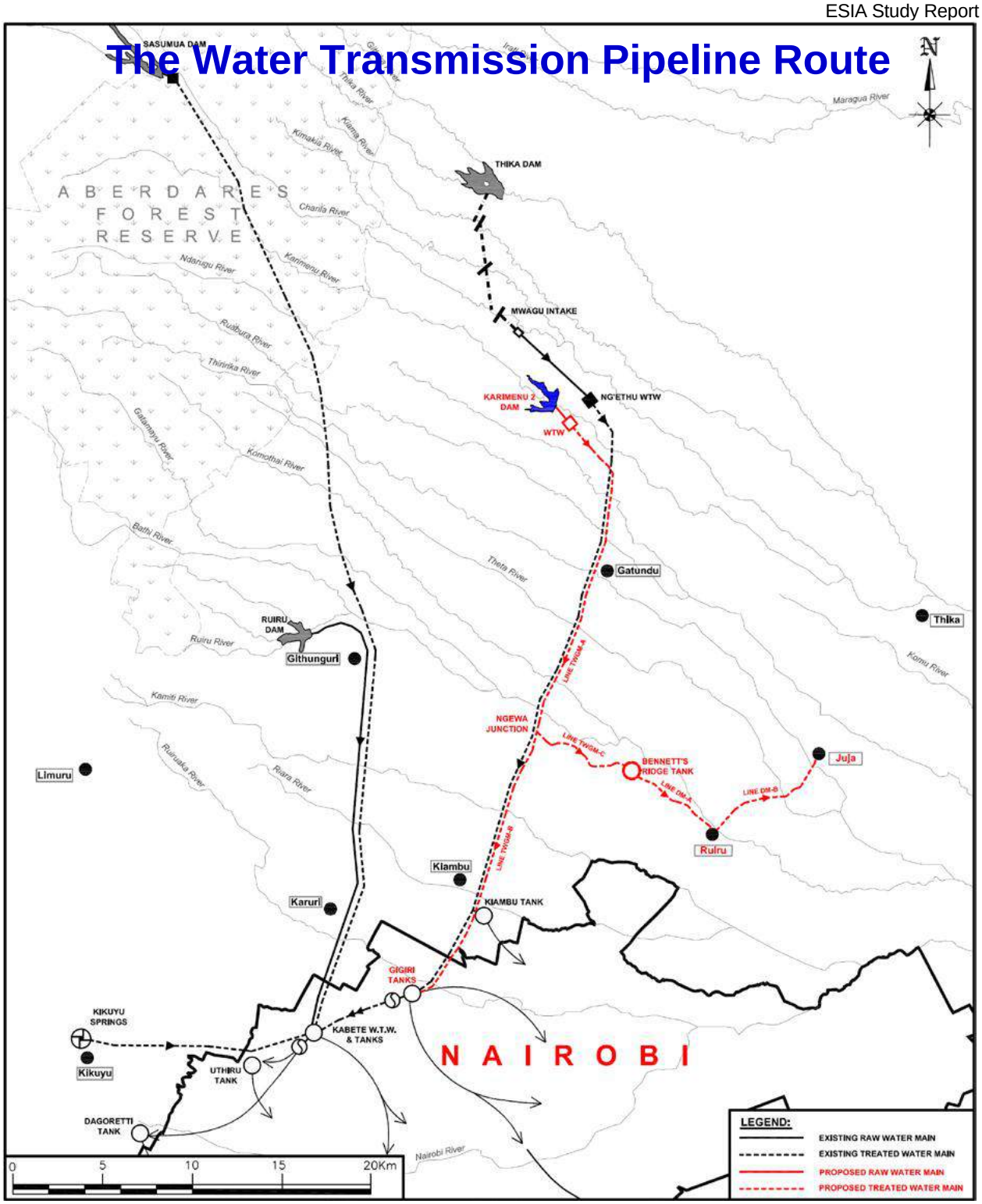


TABLE OF STRUCTURES AND BUILDINGS

No.	Name	Specification	Unit	Quantity	Remarks
①	Inlet Works	70000m³/d	Nr	1	
②	Flash Mixer	Diameter 8.5m	Nr	1	
③	Distribution Chamber to Clarifiers		Nr	1	
④	Clarifiers	Diameter 35m	Nr	2	
⑤	Rapid Gravity Sand Filters	70000m³/d	Nr	1	
⑥	Treated Water Tank	Capacity 5000m³	Nr	1	
⑦	Chemical Mixing and Dosing Building	Construction Area 310m²	Nr	1	
⑧	Pump Room and Air Blower Room	70000m³/d	Nr	1	
⑨	Gas Chlorination Building	Construction Area 150m²	Nr	1	
⑩	Chemical Storage Building	Construction Area 520m²	Nr	1	
⑪	Administration Building	Construction Area 500m²	Nr	1	
⑫	Workshop and Stuff Room	Construction Area 250m²	Nr	1	
⑬	Caretaker and Guards Room	Construction Area 40m²	Nr	1	
⑭	Backwash Water Lagoons	Capacity 2900m³	Nr	1	
⑮	Sludge Drying Beds	Construction Area 600m²	Nr	2	
⑯	Store Houses and Retail Shops	Construction Area 2810m²	Nr	1	
⑰	Gate House	Construction Area 15m²	Nr	1	
⑱	Domestic Water Tank	Capacity 50m³	Nr	1	


The Water Transmission Pipeline Route
SASUMUA DAM
THIKA DAM
MWAGU INTAKE
KARIMENU 2 DAM
NG'ETHU WTW
WTW
A B E R D A R E S
F O R E S T
R E S E R V E
Gatundu
Thika
RUIRU DAM
Githunguri
Limuru
Karuri
Kiambu
KIAMBU TANK
NGEWA JUNCTION
BENNETT'S RIDGE TANK
Juja
Ruiru
GIGIRI TANKS
KIKUYU SPRINGS
KABETE W.T.W. & TANKS
Kikuyu
UTHIRU TANK
DAGORETTI TANK
N A I R O B I
Thika River
Maragua River
Kimakia River
Kiama River
Chania River
Ndarugu River
Karimenu River
Ruabura River
Thiririka River
Gatamayu River
Komothai River
Bathi River
Theta River
Ruiru River
Kamiti River
Ruirutaka River
Riara River
Komu River
Nairobi River
LINE TWGM-A
LINE TWGM-B
LINE TWGM-C
LINE DM-A
LINE DM-B
0 5 10 15 20Km
LEGEND:
EXISTING RAW WATER MAIN
EXISTING TREATED WATER MAIN
PROPOSED RAW WATER MAIN
PROPOSED TREATED WATER MAIN

ANNEX III: Design Concepts Extracts

KARIMENU DAM - PREAMBLE TO THE BILLS OF QUANTITIES

INTRODUCTION

The Project involves funding; design and construction of Karimenu earth fill dam and the associated works as a carryover from the Feasibility Study Report.

PURPOSE OF THE DAM

The dam is proposed to supplement water supply to Juja and Ruiru Demand Centres and cater for the initial, the future and the ultimate water demands, with a surplus supply to Nairobi in the initial years. The sizing of the dam is based on the parameters laid out in the Feasibility Study and Master Plan for Developing New Water Sources for Nairobi and Satellite Towns authored by Egis, BEOM, Mangat I B Patel Consortium dated October 2011.

DAM CHARACTERISTICS

Type of the Dam

The recommended dam is a 40m high earth fill dam with clay core and selected filter material. (Sketches of the dam components are included below).

The dam will strand across the river valley and it will require relocation of a road onto the dam crest, power lines and other private property as set out in the bills of quantities. The earth fill dam embankment will comprise of inner clay core, which will be relatively impervious material to act as cut-off for any water that might be seeping through the body of the dam. The natural materials, red clay soils and gravely soils to be used for the construction of impervious core and the dam embankment respectively are available within the site.Materials for concrete works and rip rap can be sourced from areas like Thika, 35km from the site location.

Spillway
The spillway of the proposed dam is a side channel which is designed to carry the maximum probable run-off of 654m3/s. The length of the spillway crest is 70m spilling onto an open channel of bottom width 33m and 9m high at the dam axis. The channel tapers as the gradient increases downstream.

Diversion Canal

A closed canal of twin culvert measuring 4x4m high each based on Q40 of 20m3/s will be constructed to serve as a diversion canal during construction and for draw-off and scouring during project operation.

Scour and intake works

Scour and intake pipes will be installed in the dry tunnel which is designed for the purpose of diverting river flow during construction. The size of the canal is a twin culvert of 4m by 4m each. The sizes of the scour and intake pipes are 1200 mm diameter each. A dry intake tower is designed to incorporate the intakes for scour and intake pipes.

RESERVOIR CHARACTERISTICS

The following are the key parameters of the reservoir;

- ✓ The maximum area to be submerged - 135×10^4 m2
- ✓ The maximum storage above the lowest river bed level 18.9×10^6 m3
- ✓ The useful storage above the lowest outlet level - 14×10^6 m3
- ✓ The length of the reservoir - 3.5 km
- ✓ The Catchment area contributing runoff to Karimenu reservoir 105 km^2
- ✓ The longest distant point of the catchment from the dam site 40 km
- ✓ The average fall of the main watercourse 2%

WATER SUPPLY INTAKE WORKS

The Intake works consists of a 1200mm diameter gravity ductile iron pipe of length 500m. It is proposed that intake tower incorporate water draw-offs at levels of 1830m, 1835m and 1840m. The dam bottom is at 1815m asl.

WATER DEMAND

The dam and reservoir storage are premised on the water demands parameters in the Master Plan.

ENVIRONMENTAL IMPACT ASSESSMENT REPORT

The environmental impact assessment report and Ressetlement Action Plan will be prepared in accordance with the Environmental Management and Coordination Act 2003 and World Bank Safeguard guidelines under WaSSIP AF as provided for in the procurement plan. This document will be prepared as a separate report by an appointed consultant to be forwarded to National Environmental Management Authority. The Feasibility report has incorporated a preliminary environmental report.

GEOLOGICAL INVESTIGATION

The contractor for geotechnical investigations services for a detailed final design has been mobilised. The pertinent chapter in the feasibility study report is based on the terrametric geophysical investigations conducted on site and will be revisited once the geotechnical investigations are concluded.

KARIMENU 2 DAM – PRELIMINARY DESIGN OF DOWNSTREAM INFRASTRUCTURE

Introduction

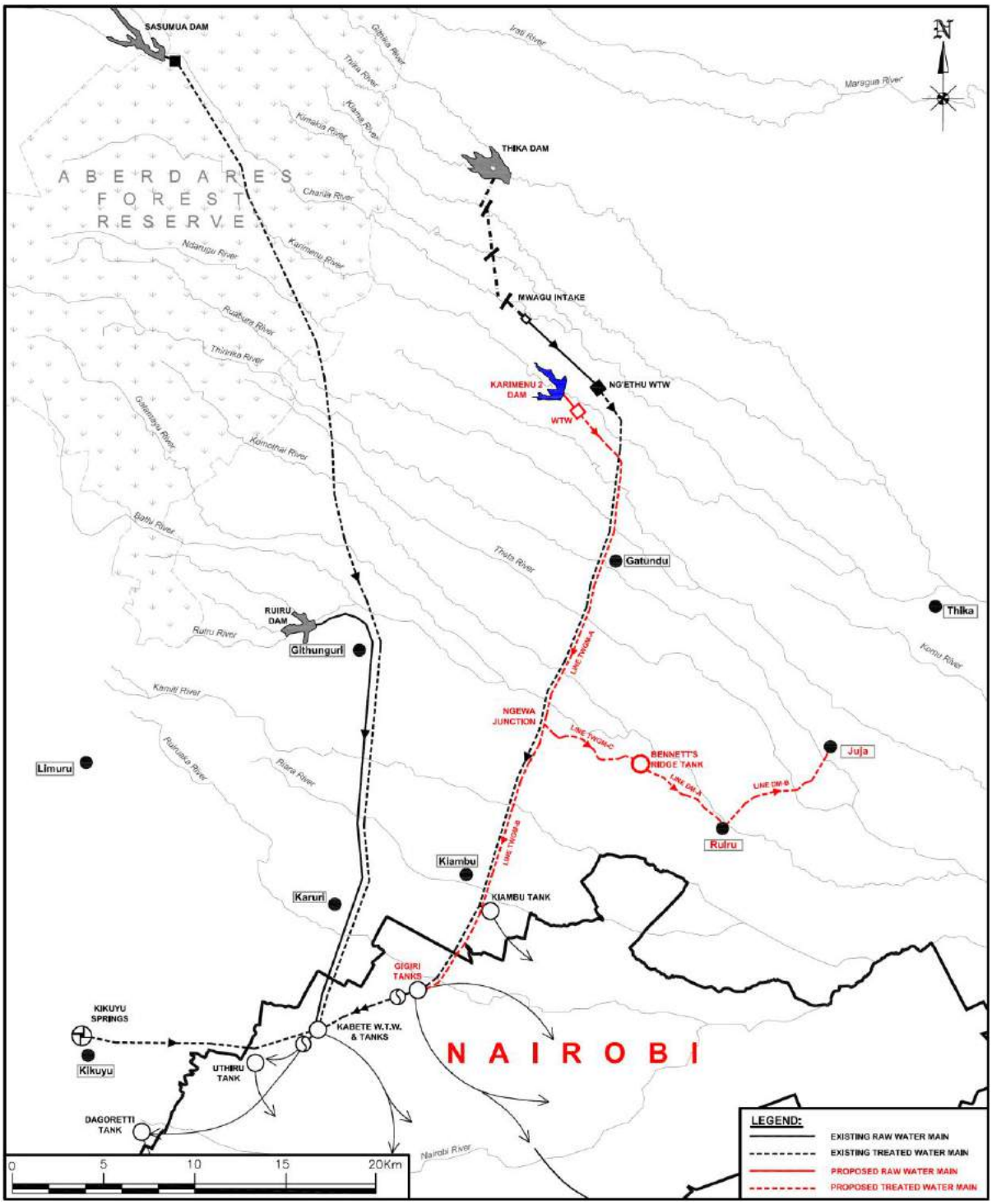
In the Feasibility Study and Master Plan for Developing New Water Sources for Nairobi and Satellite Towns study carried out by egis/MIBP JV (2012), Karimenu 2 Dam with a safe yield of 47,000m^3/d was recommended for development as one of the sources to supply water to Ruiru-Juja towns and the adjoining areas. A recent assessment on the dam yield by Norken (2013) established that the dam could provide a safe yield of 70,000m^3/d.

With this regard, a review of the Master Plan Study has been carried out to incorporate the additional yield from the dam. The dam has therefore been proposed to supply Ruiru-Juja towns at the same capacity of 47,000m^3/d as proposed in the Master Plan to meet the towns' year 2024 water demand with the additional yield being supplied to Nairobi City to ease the current water supply deficit.
In the Master Plan Study, the water demand for Ruiru town and the adjoining areas bordering Nairobi City was found to be approximately 75% of the total water demand for Ruiru-Juja area with Juja having the remaining 25% of the total water demand. This criteria has therefore been used to apportion the supply of 47,00m^3/d to the two towns.

This report provides a summary of the results of a preliminary design carried out on the water transmission options to Ruiru-Juja towns and Nairobi City in addition to Bill of Quantities which are appended to this report. Feasible water transmission routes have been established from the 1:50,000 topographical maps published by the Survey of Kenya. The selection of a location for the water treatment works and the general alignment of the transmission mains have been evaluated based on the following criteria:

- ✓ The source should be able to convey water to the water demand areas preferably with minimal pumping requirements. This is to reduce operating costs and to minimise problems experienced with the operation and maintenance of pumping plant,
- ✓ The system should be independent of existing Water Treatment and Transmission Systems,
- ✓ The treatment works should be easily accessible for operational purposes particularly chemical deliveries,
- ✓ The proposed scheme should be economically attractive,

Figure 1: Layout Plan Showing Existing Water Supply and Proposed Karimenu Dam Water Supply



Raw Water Transmission and Treatment

The Treatment works has been located approximately 3km downstream of the dam to the South of Karimenu River to avoid a river crossing. The raw water main has been kept short to minimise operational problems caused by suspended solids or internal sliming. In addition, the location of the treatment works

represents a break in pressure along the pipeline and therefore it has been located as close as possible to the dam site.

Treated Water Transmission and Distribution

The treated water transmission main will convey water from the treatment works site to Gigiri Reservoirs in Nairobi City and to Ruiru-Juja towns. The treated water main will leave the treatment works along a new wayleave, south of Karimenu River, to its intersection with the Ngethu wayleave close to Kamwangi approximately 3km from the new treatment works.

The pipeline will branch close Ngewa Market just before crossing the road to Ruiru town to transmit water to Ruiru-Juja towns before proceeding to Gigiri Reservoirs in Nairobi City. The pipeline branching at Ngewa will graviate water to a new reservoir next to Bennett's Ridge Road approximately 6.5km from the Ngewa junction. From the reservoir the pipeline will go along the road to Ruiru town before proceeding to Juja town.

A new 3km wayleave will be required from the treatment works to the point where the pipeline intercepts the Ngethu wayleave to Gigiri Reservoirs. The existing Ngethu wayleave is already congested with 4 to 5 pipelines and might need to be expanded. The Pipeline from Ngewa junction to Ruiru and Juja towns can utilise the existing road reserves.

Service Reservoir

A new Service Reservoir site will be required to serve Ruiru and Juja towns. The reservoir will play the role of a Break Pressure Tank and will also serve as a Balancing Tank to Ruiru and Juja towns. The Reservoir will need provide atleast half-day storage of the total daily treated water inflows. Enroute demands are expected to be served along the pipeline route from the reservoir due to the mushrooming developments within the coffee estates and Thika Highway. The capacity of the pipeline from the reservoir to Ruiru and Juja towns has been increased by 1.5 times to cater for peak demands.

Water Transmission Infrastructure Required

Table 1: Summary of Water Transmission Infrastructure Required

	Transmission Pipeline Details		
1.	Karimenu 2 Dam to Water Treatment Works		
	Location	Karimenu Dam	Treatment Works
	Approximate Ground Elevation	1820 masl	1800 masl
	Approximate Hydraulic Elevation	1820 masl (Bottom Drawoff)	1810 masl
	Approximate Distance	3.0 Km	
	Design Capacity	70,000 m^3/d	
	Pipeline Diameter	800 mm	
	Norminal Pressure Rating	10 bar	
2.	Water Treatment Works to Ngewa Junction		
	Location	Treatment Works	Ngewa Junction

	Transmission Pipeline Details		
	Approximate Ground Elevation	1785 masl	1675 masl
	Approximate Hydraulic Elevation	1785 masl	1735 masl
	Approximate Distance	19.6 Km	
	Design Capacity	70,000 m^3/d	
	Pipeline Diameter	800 mm	
	Norminal Pressure Rating	16 bar	
3.	Ngewa Junction to Gigiri Reservoirs		
	Location	Ngewa Junction	Gigiri Reservoirs
	Approximate Ground Elevation	1675 masl	1711 masl
	Approximate Hydraulic Elevation	1735 masl	1721 masl
	Approximate Distance	16 Km	
	Design Capacity	23,000 m^3/d	
	Pipeline Diameter	800 mm	
	Norminal Pressure Rating	16 bar	
4.	Ngewa Junction to Bennett's Ridge Reservoir		
	Location	Ngewa Junction	Bennett's Ridge Reservoir
	Approximate Ground Elevation	1675 masl	1580 masl
	Approximate Hydraulic Elevation	1735 masl	1640 masl
	Approximate Distance	6.5 Km	
	Design Capacity	47,000 m^3/d	
	Pipeline Diameter	600 mm	
	Norminal Pressure Rating	16 bar	
5.	Bennett's Ridge Reservoir to Ruiru Town		
	Location	Bennett's Ridge Reservoir	Ruiru Town
	Approximate Ground Elevation	1580 masl	1530 masl
	Approximate Hydraulic Elevation	1580 masl	1550 masl
	Approximate Distance	6.5 Km	
	Design Capacity	(47,000 m^3/d x1.5) peak demand	
	Pipeline Diameter	800 mm	
	Norminal Pressure Rating	10 bar	
6.	Ruiru Town to Juja Town		
	Location	Ruiru Town	Juja Town
	Approximate Ground Elevation	1530 masl	1520 masl
	Approximate Hydraulic Elevation	1550 masl	1530 masl

	Transmission Pipeline Details	
	Approximate Distance	9.0 Km
	Design Capacity	(12,000 m^3/d x1.5) peak demand
	Pipeline Diameter	600 mm
	Norminal Pressure Rating	10 bar

Transmission Route Profiles

Figure 2: Karimenu 2 Dam to Ngewa Junction to Gigiri Reservoirs Transmission Profile

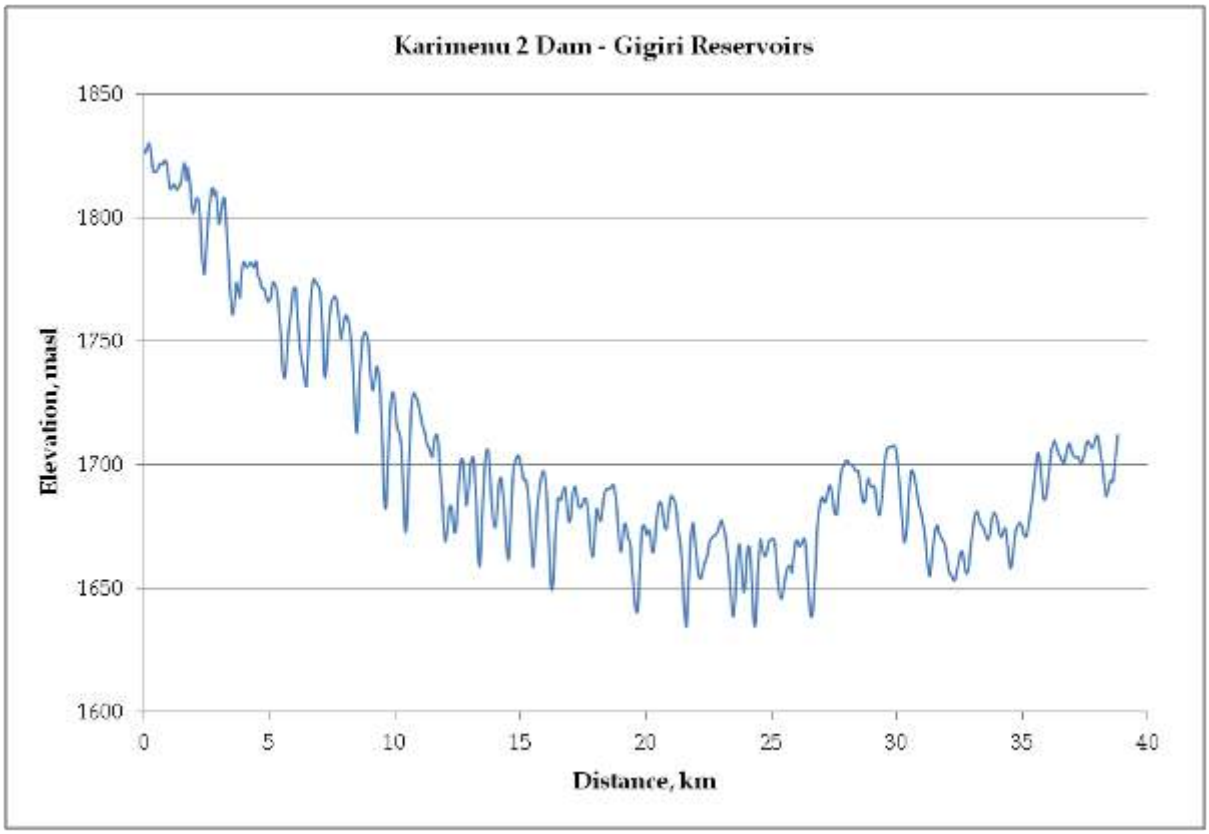
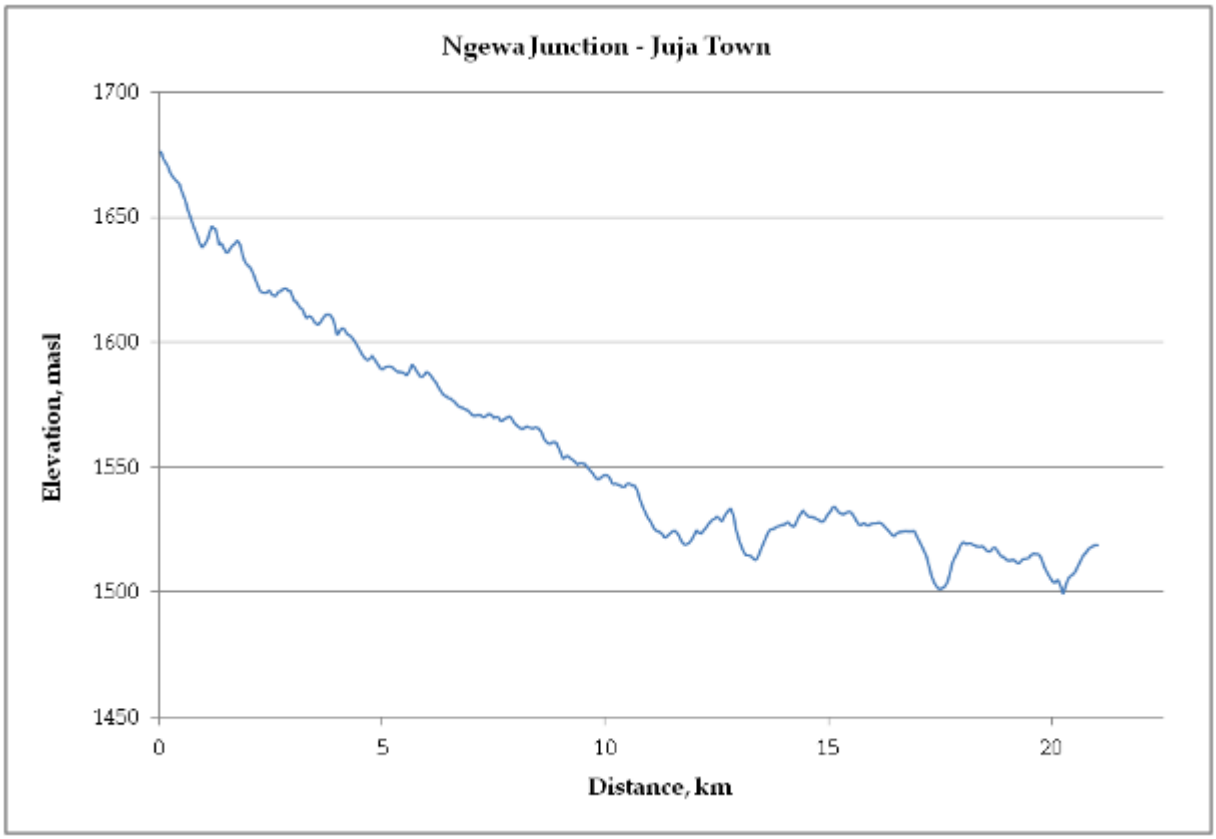


Figure 3: Ngewa Junction to Bennett's Ridge Reservoir, Ruiru and Juja Towns Transmission Profile



Bill of Quantities

- ✓ Bill No. 1 - Raw Water Gravity Main from Karimenu Dam to Water Treatment Works – Line RWGM
- ✓ Bill No. 2 - Treated Water Gravity Main from Water Treatment Works to Ngewa Junction – Line TWGM-A
- ✓ Bill No. 3 - Treated Water Gravity Main from Ngewa Junction to Gigiri Reservoirs – Line TWGM-B
- ✓ Bill No. 4 - Treated Water Gravity Main from Ngewa Junction to Bennett's Ridge Reservoir - Line TWGM-C (incl. Bennett's Ridge Reservoir)
- ✓ Bill No. 5 - Distribution Main from Bennett's Ridge Reservoir to Ruiru Town – Line DM-A
- ✓ Bill No. 6 - Distribution Main from Ruiru Town to Juja Town– Line DM-B

KARIMENU 2 DAM – WATER TREATMENT FACILITIES

Contents

Introduction

The Water Treatment Facilities are expected to cater for raw water flow of 70,000m^3/d (0.81m^3/s) with the construction of Karimenu 2 Dam. It is not possible that the yield of the source will be increased in future, say by raising the dam or diverting other rivers into Karimenu 2 Dam and therefore it might not be necessary to construct the treatment facilities while taking care of future additional capacity. However, adequate space should be provided for the treatment works units and the ancillary facilities required.

Water Treatment Process

The water treatment process comprises of the following:

1. Cascade Aeration
2. Pre-chlorination
3. Dosing with Sodium Carbonate (Soda Ash), to adjust the pH
4. Dosing with aluminium sulphate (alum), as coagulant aid,
5. Dosing with Polyelectrolyte, as coagulant aid (when necessary)
6. Clarification
7. Rapid Gravity Filtration
8. Disinfection with Chlorine
9. Dosing with Sodium Carbonate (Soda Ash), to adjust the pH for corrosion control

Sludge Treatment and Disposal process comprises of the following

1. Sludge Drying Beds – To receive Sludge from Clarifiers
2. Backwash Water Lagoons – Good Environmental Practice to recycle backwash water from the filters.

Structures and Buildings Required

The following Structures and Building are required according to the treatment process outlined above:

- Inlet Works Comprising of:
  - Overflow
  - Cascade Aerator
  - Chlorine, Sodium Carbonate and Alum Dosing Points
  - Flow Measurement
- Flash Mixer
- Distribution Chamber to Clarifiers

- Centrifloc Type Clarifiers
- Rapid Gravity Sand Filters
- Treated Water Tank
- Chemicals and Plant Buildings comprising of:
  - Chemical Mixing and Dosing Building
  - Pump Room and Air Blower Room
  - Gas Chlorination Building
  - Chemical Storage Building
  - Administration Building
  - Workshop and Staff Room
  - Generator and Switch Room
- Sludge Disposal and Treatment Facilities comprising of:
  - Backwash Water Lagoons
  - Sludge Drying Beds
- Staff Houses and Retail Shops

Design Criteria & Key Data

The main Design Criteria and Key Data for the Treatment Works is given in Table 1 given below:

Design Criteria & Key Data for Karimenu 2 Dam Water Treatment Works			
a)	General		
	Treatment Works Design Capacity	:	70,000 m^3/d (0.81m^3/s or 2,916m^3/hr)
Backwash water to be recycled for treatment and made available for distribution			
b)	Aeration		
	Type	:	Cascade Aeration
c)	Raw Water Flow Measurement		
	Type	:	Electromagnetic Flow Meter (size DN 900mm) immediately downstream of Aerators
d)	Pre-Chlorination and pH adjustment		
	Chemicals used:		
	• Chlorine – for precipitating iron and manganese and control of algal problems	:	Average dose – 0.5 mg/l Maximum dose – 1.0 mg/l
	• Soda Ash – for pH adjustment	:	Design dosage – 15 mg/l
e)	Coagulation and Coagulant Aid Dosing		
	Chemicals Used:		
	• Aluminium Sulphate (Alum) – primary coagulant	:	Average dose – 5mg/l Maximum dose – 10mg/l
	• Polyelectrolyte – as a coagulant aid	:	Average dose – 0.05 mg/l Maximum dose –0.3 mg/l
f)	Flash Mixing		
	Type	:	Circular concrete structure, 8.5m diameter, equipped with an electric-motor driven Propeller Mixer

Design Criteria & Key Data for Karimenu 2 Dam Water Treatment Works			
g)	Flocculation & Clarification		
	• Type	:	Circular Centrifloc Clarifiers
	• No. of Units	:	2
	• Diameter of each unit	:	35m
	• Water Depth in each unit	:	5m
	• Flocculation Mechanism	:	Electric-motor driven Flocculators
	• Sludge Removal Mechanism	:	Electric-motor driven Sludge Scrappers and pneumatically controlled sludge draw-off valves
	• Surface Overflow Rate	:	For a design capacity 70,000m^3/d (2,917m^3/hr) SOR = 1.52 m/hr for 2 No. Clarifiers working
	• Detention Time	:	Approx. 3 hours
g)	Filtration		
	• Type	:	Rapid Gravity Sand Filters
	• No. of Units	:	6
	• Area of each Filter Bed	:	11.8m x 7.2m (85m^2)
	• Filtration Rate	:	For a design capacity 70,000m^3/d (2,917m^3/hr) – 5.7 m/hr – all 6 No. Filters working – 6.9 m/hr – 5 No. Filters working
	• Backwash System	:	Air and Water
	• Washwater Rate	:	50 m/hr
	• Air Scour Rate	:	1.5 m/min
	• Backwash Time	:	8 minutes
	• Wash Water discharge to	:	Backwash Water Lagoons
	• Filter Controls	:	Automatically controlled valves with manual overrides
h)	Disinfection		
	• Primary Disinfectant	:	Chlorine Gas
	• Stand-by Disinfection System	:	Stand-by Facilities provided for dosing with Chlorine in Hypochlorite Solution form
	• Design Dosage Rate	:	Post-chlorination - 1 mg/l
	• Storage Period for Chlorine Gas	:	3 Months (at the design output of 70,000m^3/d)
i)	Treated Water Storage Tank		
	• Storage Capacity	:	5,000m^3 – for approx. 1.5 hour storage at design output of 70,000m^3/d
	• Tank Dimensions	:	25m x 40m x 4m deep (1m freeboard)
j)	Sludge Drying Beds		
	• No. of Beds	:	2
	• Surface Area of each bed	:	25m x 24m (600m^2)
	• Supernatant discharge to	:	Backwash Water Lagoons

Design Criteria & Key Data for Karimenu 2 Dam Water Treatment Works			
k)	Backwash Water Lagoons		
	• No. of Lagoons	:	1
	• Size of Lagoon	:	44m x 22m x 3 m deep (volume 2,904m^3)
l)	Chemical Storage Building		
	• Floor Area	:	520m^2
	• Chemicals Stored	:	Alum, Soda Ash, Polyelectrolyte, Hypochlorite
	• Storage Period	:	3 Months storage at the design throughput of 70,000m^3/d.
m)	Chemical Mixing & Dosing Building		
	• Floor Area	:	310m^2
	• Facilities Provided	:	Solution Mixing Tanks, Dosing Pumps& Associated Pipework for Alum, Soda Ash, Polyelectrolyte & Hypochlorite
n)	Gas Chlorination Building		
	• Floor Area	:	150m^2
	• Facilities Provided	:	– Storage Room & Handling facilities for Chlorine Gas Cylinders – Gas Chlorinators
	• Storage Period for Chlorine Gas Drums	:	3 Months (at the design throughput of 70,000m^3/d).
o)	Administration Building		
	• Floor Area	:	500m^2
	• Facilities Provided	:	– Offices for Senior Management & Supervisory Staff – Laboratory – Control Room (Controls &Instrumentation) – Senior Operator's Common Room & Locker Room – Computer / Records Filing Room – Tea Room & Wash Rooms
p)	Workshop, Store & Staff Room		
	• Floor Area	:	250m^2
	• Facilities Provided	:	– Workshop and Store – Staff Room and Locker Room for Treatment Works Operators& Subordinate Staff – Tea Room / Kitchen – Male & Female Wash Rooms including WCs and Showers
q)	Generator House & Switch Room		
	• Floor Area	:	40m^2
	• Facilities Provided	:	– Stand-by Generator Room – Fuel Store – Electric Switchboard / Distribution Panel Room

Staff Housing

Housing for Staff needs to be provided adjacent to the Treatment Works. A schedule of proposed Staff Housing is given in Table 2 below:

Table 2: Schedule of Staff Housing

House Type	No.	Description	Staff
A	1	3 Bedroom; detached; Master en suite; Servants Quarter; Garage. Floor Area 176m^2.	− Works Manager
B	3	3 Bedroom; detached. Floor Area 93m^2	− Treatment Works Coordinator − Maintenance Officer − Chemist
C	12	Bedroom; semi-detached. Floor Area 64m^2	− Treatment Works Supervisors (4 No.) − Mechanical Supervisor (1 No.) − Electrical Supervisor (1 No.) − Security Supervisor (1 No.) − Laboratory Technicians (4 No.) − Stores Supervisor (1 No.)
D	26	1 Bedroom; semi-detached. Floor Area 37.4m^2	− Water Operators (8 No.) − Mechanical Assistants (2 No.) − Electrical Assistants (2 No.) − Laboratory Assistants (4 No.) − Stores Assistant (1 No.) − Security Guards (5 No.) − Hired Armed Guards (Police) - 4 No.
E	10	1 Bedroom; semi-detached. Floor Area 36.5m^2	− Drivers (4 No.) (Vehicles & Forklifts) − Cleaners/ Labourers(6 No.)

A Retail Building to house shops or other required facilities (Floor Area 250m^2) has also been provided for.

ANNEX IV: Minutes on Public Sensitization and Stakeholders Consultations

Minutes of the Public Meeting Held at Kariminu Coffee Factory on 13th November 2014 for Kariminu Dam Project

AGENDA

1. Participants
2. Preliminaries
3. Project briefing
4. Comments and discussion

Participants present

The participants include the following groups (see attached list of attendance)

1. Deputy County Commissioner
2. Assistant County Commissioner
3. Member of County Assembly
4. Minister for Water And Natural Resources
5. Local Administrations
6. Church Officials.
7. Kariminu Dam Committee
8. Norken International

MIN 1: Preliminaries

The meeting started at 11:45am with a word of prayer from Father Kiaminu. The chief proceeded to welcome everyone in attendance and thanked them for their patience. He called upon Mr. John Bosco, (The Dam committee chairman) to introduce the rest of the Dam Committee Members to the people.

Patrick Mwangi (Engineer)

He started by mentioning that he is the head of Gatundu Water and Sanitation Company. He mentioned that the water sector has been devolved for over 10 years and gave a brief history on how it has evolved to what it is now. He introduced his colleagues from his office and proceeded to give a brief description on the steps embarked on to necessitate the development of a dam.

(i) Demand for water.
(ii) The government comes up with a master plan which shows water resources in the country and where to put up dams
(iii) The engineers are tasked with coming up with a conceptual design
(iv) Geo-physical survey is carried out to establish a feasibility study of the dam area
(v) Environmental and Social Impact Assessment (ESIA) issues are established and mitigated
(vi) Resettlement Action Plan (RAP) is carried out for the people displaced and require compensation
(vii) Actual construction starts.

He requested the area MCA to arrange for an office for in the area to enable him serve the people well.

Esther Njuguna (County Minister for Water and Natural Resources)

She mentioned that the water provision in the county is 44% which is lower than expected margin. With over 60% of the population living in the towns, it has increased the demand for the scarce resource.

She pointed out that the dam project development in the area is an opportunity for the youth to get employed and to improve their living standards as well as social economic development for the area.

In her closing remarks she pointed out that there are various small projects underway that are being undertaken by the county government to help those who have no access to water clean water.

Samuel Ng'ang'a Wa Nyambura (Member of County Assembly)

He mentioned that the residents are suffering from problems of dry taps and high water bills which he termed as extortion to the residents. He requested for water projects to be considered in Gituamba area to partially meet the demand for the resource.

He expressed a heartfelt concern for the residents who are suffering psychological because of the long awaited dam construction. It has acted has an impediment for them to do any development since there is fear of been evacuated to pave way for the dam. He requested that the project be fast tracked. He mentioned that in future any meeting should be done formally using a letter rather than word of mouth.

The MCA mentioned that Athi Water Services Board (AWSB) should fulfil the promises they made of provision of water tanks to needy schools. He mentioned that many schools registered for the tanks and they are yet to receive them.

Samuel Kaniu (Deputy County Commissioner)

We've been working hand in hand with the consultant and the administration in making the project a reality for the people. Security in area is ok and during the holidays we should be cautious and be each other's keeper. Nyumba kumi program and community policing are active and any concerns now and in the future should be presented to his office. He urged the members to be patient and wait to hear what the consultant has to say concerning the dam and be ready to ask questions later.

Mr. Musembi Kamau (Area MP Rep.)

Started by apologising for the absence of the area Member of Parliament as he had urgent matters he had to attend to. He acknowledged several roads the proposed project area needs to be improved but the impending issue is the construction of the dam which might interfere. So he requested for a clear documentation to show the area that will not be affected so that they can commence with the rehabilitation of the roads.

MIN 2: Project Briefing

Harrison Ngirigacha (Team Leader)

Site identification was done over 40 years ago and the master plan was developed. We were contracted by AWSB to do an ESIA which is a requirement by EMCA 1999 where all projects must undergo an assessment to determine their anticipated impacts after which Nema issue a licence afterwards to pave way for construction. Currently we are at the stage of applying for the licence. Without the licence World Bank cannot disburse the money for construction of the dam.

Agenda for the day is to inform and consult the locals through a public consultation meeting though a sensitization exercise had been done prior. Part of our study we were able to identify the following concerning the post and pre construction phase of the dam: Our findings on the ground are:

1. Several trees will be cut and the records must be well recorded
2. Safety of the residence
3. Security feature of the dam, like limited access to the dam.

As he concluded he emphasised that during the signing of agreements with the contractor on excavation of materials from their land, there should be a clear clause stating the state at which the open mines should be left. In conclusion he said that once the report is done and approved it will be availed at the DCC office for the people.

Eng. Gitau

The dam will be put up close to the coffee factory and it will incorporate the following:

1. The dam will be 46 metres high

2. A capacity of 18,000,000m^3
3. A spillway will be provided

Some lands will be submerged in water once the dam is constructed but currently we are working with estimates until the rap exercise is carried out.

Julius Ngundo (Sociologist)

The residents as well the administration will be involved accordingly during and after construction of the dam. According to the law 60 percent of the employees should be from the area but urged the residents to be reasonable in approaching the contractor in terms of payment and not to overprice it because he will scorch for cheap labour elsewhere and they will lose on the opportunity. Some of the advantages of the project are:

1. Job opportunities.
2. Appreciation of land in the area
3. Market pool for produce in the area
4. Improvement of transport in the area.

On the flip side the following should be anticipated:

1. Wrecking of marriages
2. Security issues like theft.
3. Communicable diseases like TB,HIV might be on the rise

As he concluded he requested the residents to kindly collaborate with the RAP experts once they are on the ground.

MIN 3: Comments and Discussion

Name	Comment	Response
Pius Ndung'u	✓ Expressed fear of being attacked by their children over inheritance so as to get the money ✓ The joint account with our parents will be an issue because we all live in the same plot	✓ The young people are requested not to attack their parents over inheritance. ✓ You shall have to sit down as a family and discuss the ways or methods you shall use to share the money equally
Lawrence Mwiruri	✓ How will the children be assisted to benefit from the compensation ✓ Requested to know whether there is a place identified for the relocation of the graves	✓ The committee will ensure that children benefit from the compensation ✓ The community members and the committee will find land where they can relocate graves.
Joseph Kinuthia	What will happen to those whose land is acquired and they are left with small pieces of land	If the land left has no value economically then the whole land is acquired and compensated
Lawrence Gakuya	How will you consider the relocation of the graves	When the resettlement begins you shall sit down with the committees and discuss possible land where the remains will be relocated
Kimemia	Let us be informed early about the meetings	Request
Henry Njoroge	When the beacons are put in place when will the initial project begins	We do not have a specific date.
John.B. Ndugu	When will the census begin, the valuation and the total discloser of the	✓ We do not have the exact time frame of when everything will

Name	Comment	Response
	amount of money to be paid	start. ✓ On RAP issues we will have to wait until the exercise is donet.
Joseph Kanyonyi	Let's be given land to land instead of money which may bring a lot of wrangles in our families	Free treaty is the best policy to adopt
Mary Nyokabi	Most of us were treated very badly when some people come to take valuation on our trees and we were conned	There rates for each and every property you have and they have to be valued with the current rate
Ruth Wambui	It the husband died and he left the title deed in his name what will I do	The land is given by the title deed in whom it belongs if the husband died we shall look for the alternative household head at that time and he or she will be taken as the title holder
Samuel Mwangi	Let the committee be transparent to us at all times	Request

A.O.B

Being no other agenda the meeting was closed at 3.33 pm

KARIMINU 2 DAM COMMUNITY BASED ORGANIZATION
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wavally@mail.com

HPE
To be FWA
MP
19/4

THE CEO
ATTHI WATER SERVICES BOARD,
3RD FLOOR AFRICA RE CENTRE,
HOSPITAL RD – UPPER HILL P.O.BOX 45283 001,
NAIROBI.

cc LCM

Dear Sir,

RE: MEMORANDUM BY RESIDENT AFFECTED BY THE PROPOPSED KARIMINU II DAM

Reference is made to the memorandum by the resident which we delivered to your office on 24th February 2015, in view of the above subject matter. This is a follow-up of the meeting with the technical team when they paid us a visit on 6th April 2016.

The Technical team comprised of: consultants; environmentalist; Social Services personnel; KARIWASCO representative; and Ministry officials. In the meeting it was agreed that a follow-up meeting will be held later to discuss and shed light on the way forward.

We understand that the process may involve the following steps:

1. Fixing of bacons;
2. Census;
3. Valuation; and
4. Resettlement

In view of the above steps,we are writing this letter to book an appointment for a meeting with you and your technical team to discuss the way forward. In that meting we are kindly proposing to discuss the following issues:

1. Discuss the Memorandum delivered to your office
2. Appointment of a lawyer to represent the affected residents
3. Time frame for the above steps
4. Facilitation of the Committee ?
5. Any other matter.

We are looking forward to your expeditious consideration of our request.

Yours faithfully

John BoscoNdung'u

Committee Chairman.

ENVIRONMENTAL AND SOCIAL IMPACT ASSESSMENT FOR THE PROPOSED KARIMINU 2 DAM IN KIAMBU COUNTY

MINUTES OF CONSULTATIVE MEETING WITH KARIMINU COMMUNITY REPRESENTATIVES HELD ON 27TH APRIL 2016.

VENUE: Athi Water Service Board Office **TIME: 10.30AM**

PRESENT ***(signed list attached)***

1.	John Bosco Ndungu	Kariminu
2.	Paul Maina Mwangi	Kariminu
3.	Francis Mwenda Kanya	Kariminu
4.	Peter Roope Waweru	Kariminu
5.	Simon Mwaniki	AWSB
6.	Pius Njoroge Mungu	Kariminu
7.	Davidson Muturi	Kariminu
8.	Peter Njoroge	Kariminu
9.	Hon. Kigo Njenga	MP-Gatundu North
10.	Eng. Emily Kilongi	AWSB
11.	Keziah Adhiambo	AWSB
12.	Stephen Rukwaro	Aquaclean
13.	Harrison Ngiringacha	Aquaclean

AGENDA

1. Introduction
2. Project brief
3. MPs presentation
4. ESIA/RAP process
5. Community concerns
   - Memorandum
   - Appointment of community lawyer
   - Compensation modalities
   - Project timeframes
   - Facilitation of Kariminu Dam committee members

	ITEM
1	**INTRODUCTION**
	The meeting started at 10.30am with a round of introductions.
2	**CEOs OPENING REMARKS**
	The CEO –AWSB welcome participants to the meeting and provided a brief background of the Kariminu 2 Dam project. He explained that the project is being implemented using the "design and build" approach. Before construction commences, environmental and social impact assessments are a prerequisite. The ESIA process is currently ongoing, the consultant is on the ground and has met the committee members and other members of the public; a process which will continue throughout the project implementation period.
3	**Area MPs presentation /remarks**
	The area MP Hon. Kigo Njenga stated that the Kariminu community are in support of the project and welcome the development in their area. He told the meeting that the Kariminu 2 dam committee was constituted to represent the community on matters related to the development of the proposed development. The community however had concerns which need to be clarified. The concerns are related to: • Time and modalities of compensation • Mapping of the affected area to identify affected parcels of land in good time • Environmental and social impacts of the project • Appointment of community lawyer • Engagement of community members to create awareness and provide project information **AWSB Response:** • AWSB appreciated the community initiative to organize themselves and keep in touch with AWSB services and noted that community/stakeholders engagement is a key aspect in the Board's project implementation. • All the project affected persons will be consulted in order to obtain their informed consent. • The ESIA/RAP consultant has already started the task of assessing all the possible environmental and social impacts of the project with the aim of proposing adequate mitigation measures for negative impacts, compensation measures for losses and enhancement measures for both the community and the project. • The project will have various benefits to the community, these include other associated projects which may not necessarily be water projects e.g. a ring road around the dam to act as buffer will benefit the community. • AWSB is ready to work together with the community • The ESIA/RAP reports will provide details of all the possible impacts and their mitigations as well as compensation requirement. The public and project affected persons will be fully engaged during this process in order to gather their views and concerns about the proposed project.
4	**ESIA/RAP PROCESS**
	The project ESIA/RAP consultant (Aquaclean Services Limited) gave a brief on the process of conducting the studies and next steps.

	ITEM
	• A scoping was concluded in 2015 giving way for the detailed studies that are currently ongoing • The study is aimed at identifying all the potential impacts, proposing mitigation measures for negative impacts including compensation for losses and enhancement of the project. • Consultations with members of the public will be carried out through focus group discussions and public barazas at different stages of the study. • Survey and mapping will carried out to identify and map the area to be affected and parcels of lands to be taken up by the project • Owners of affected properties will then be consulted and engaged accordingly to explain the outcome of valuation.
5	**MEMORANDUM**
	The chairman of Kariminu dam committee took the meeting through the items of the memorandum residents affected by the proposed Kariminu 2dam submitted to AWSB in Feb 2015. All the items were discussed and agreed upon; a revised memorandum was to be prepared by the committee for submission to AWSB. The AWSB legal officer will finalize in a preferred format for adoption.
6	**APPOINTMENT OF COMMUNITY LAWYER**
	The community requested AWSB to engage a community lawyer for them. AWSB informed the meeting that this could not be possible since there is already existing legal department to handle AWSB legal matters. Therefore it was not possible to engage a community lawyer for Kariminu community. However, AWSB will engage a lawyer for purposes of fast tracking and completing land succession cases during RAP implementation.
7	**COMPENSATION MODALITIES**
	The community stated that they preferred "land for land" compensation mode, and cash for developments such as houses, crops, trees and other structures. They were informed that there was no problem in that arrangement and were urged to scout for land so that by the time all the studies and agreement are completed it would be easy to implement the agreed modality of compensation regarding land. Further details would be provided to the project affected persons during the meetings with the consultant on the ground to clarify different types of compensation modalities and their significance.
8	**PROJECT TIMEFRAMES**
	The community wanted to know the timeframe for implementing the project and specifically when the construction works are expected to commence. The meeting was informed that the project's approval was at an advanced stage of being concluded, the outcome of the ESIA/RAP studies were therefore very important as they are part of the prerequisites before the project can commence.
9	**FACILITATION OF KARIMINU DAM COMMITTEE MEMBERS**
	The committee requested AWSB to consider providing allowances whenever there are committee meetings. They gave an example of a committee where executive receives Ksh. 4000 while members receive Ksh. 3000.

	ITEM
	The matter was to be forwarded to AWSB management for discussion. The following clarifications were also made: • There will be a written agreement between AWSB and the land and property owners • The land owners will not be barred from using their land for cropping after payment, but no crop or structure introduced after the cut-off date will be compensated.
10	**AOB**
	• The community have no objection to the project, social issues should however be given priority and compensations be done in good time because of variation in rates. • AWSB to consider providing refreshments to community members during meetings • ESIA/RAP process is an important decision making tools in project planning. Communities members were therefore urged to participate in the process and provide available information and to honestly share their concerns.
11	**Meeting Closure**
	There being no other business the meeting was closed at 1.45pm with a word of prayer

Signed:-

1. _____ (For AWSB) Date: 9/6/2016

2. _____ (For Kariminu Dam Commitee) Date: 09th JUNE 2016

ATHI WATER

ATTENDANCE LIST

CONSULTATIVE MEETING WITH COMMUNITY REPRESENTATIVES FOR THE PROPOSED KARIMINU 2 DAM IN KIAMBU COUNTY

DATE: 27TH APRIL 2016 **VENUE: AWSB BOARD ROOM** **TIME: 1030HRS**

S/NO.	NAME	ORGANIZATION	TEL. NO.	SIGN	Email
1.	John Bosco Ndungu	Kariminu II Dam	0713374513	[signature]	boscondungu6@.com
2.	Paul Maina Mwangi	Kariminu II D	0721557986	[signature]	wavally@gmail.com
3.	Francis Mwenda Kanya	Kariminu Dam	0720428246	[signature]	Kanyafrancis@yahoo.com
4.	Peter Roope Wawere	Kariminu Dam	0798-790621	[signature]	roopewawere@gmail.com
5.	Simon Mwaniki	AWSB	0723975646	[signature]	Smwaniki@awsboard.go.ke
6.	Pius Njoroge Mutugu	Kariminu Dam	0727268009	[signature]	MutuguPius@gmail.com
7.	Davidson Muturi	Kariminu	0713562806	[signature]	DavidsonMuturi@gmail
8.	Peter Njoroge	Kariminu II	0722-723146	[signature]	Peterirraki@yahoo.com
9.	Hon. Kigo Njenga	Area MP Gatundu North	0722100625	[signature]	
10.	Eng. Emily				
11.	Eng Emily Kilongi	AWSB	0721947853	[signature]	
12.	Keziah Adhiambo	AWSB	0720352697	[signature]	
13.	Stephen Ruewaro	Aquaclean	0723 720 136	[signature]	stevenmk@gmail.com
14	Harrison Ngirigacho	Aquaclean Serv.	0722809026	[signature]	aquaclean2007@gmail.com

PREPARATION OF ENVIRONMENTAL AND SOCIAL IMPACT ASSESSMENT (INCLUDING CUMULATIVE IMPACT ASSESSMENT) AND RESETTLEMENT ACTION PLAN FOR PROPOSED CONSTRUCTION OF KARIMENU II DAM

MINUTES OF INITIAL MEETING HELD ON 16TH MARCH 2016 AT AWSB BOARDROOM

The initial meeting was called on 16th March 2016 to kick off the ESIA and RAP studies process. The meeting commenced at 2.30pm.

Present:

1.	Eng. Joseph Kamau	AWSB
2.	Eunice Jemutai	AWSB (Chairing)
3.	Harrison Ngirigacha	Aquaclean Services (Taking Minutes)
4.	Kefa Mbarine	Aquaclean Services
5.	James Waititu	Aquaclean Services
6.	Stephen Rukwaro	Aquaclean Services
7.	Helen Wanjera	Aquaclean Services
8.	Ephantus Wahome	Aquaclean Services
9.	Li Jiafeng	AVIC/SMEDI (Contractor)

1. Introductions

The meeting was officially opened by Eng. Joseph Kamau. There was a self introduction by all in attendance following a formal presentation of the Consultant Team by the Team Leader, Harrison Ngirigacha

2. The Contractor Briefing

The Contractor representative, Mr. Li Jiafeng was asked to give a brief on the project design and how the Constant will access the concepts for purposes of the ESIA and RAP studies. He undertook to link with the Design Team in China for the necessary assistance. He, however, indicated that a preliminary ESIA Report was required by EXIM Bank for purposes of financing negotiations. He was informed that an ESIA Report could not be ready within the short time but the Consultant Team Leader undertook to prepare something based on the ESIA Project Report submitted to NEMA earlier. This would not, in any way reflect the current works on the ESIA Study and RAP study since the process had not even commenced. The Contractor Representative left the meeting at this stage.

3. Project Scope

The Chair (Eunice Jemutai) informed the meeting that the assignment was designed to upgrade the earlier ESIA Study Report to ESIA Study such as to meet the requirements under EMCA, 1999 and obtain an EIA License from NEMA. The assignment would also generate a RAP for the Dam area as well as the treated water transmission pipeline and other project components that had not be factored in the ESIA project report. She however, stated that the designs for the

project were not ready and that being a design build project, the Contractor would be expected to provide the concepts to the Consultant.

The Chair called upon the Consultant Team Leader to take the meeting through the desired ESIA Study process.

4. ESIA and RAP Studies

The Team Leader (Mr. Ngirigacha) reported that the Study Team was fully mobilized and ready to go after this initial meeting. The studies would commence with the preparation of the ToR for the ESIA Study Report since an ESIA Project had already been submitted for review by NEMA earlier. This would involve assessment of the dam area, upgrading the baseline status and establish the environment and social setting of the treated water transmission pipeline and reservoir. To achieve, this Consultant will need the design reports and associated drawings for the dam, water treatment works, transmission pipelines, the tank and the delivery system of the water to the beneficiaries.

Regarding stakeholders engagement, he indicated that focus group discussions will be held at the dam area to supplement the intensive consultations had already been undertaken during the ESIA project Report stage. However, the communities around the Water Treatment Works, treated water transmission pipelines, the reservoir and other distribution lines will be fully engaged on rapid and structured stakeholders and public consultations meetings. Other interactions will be planned with County Government of Kiambu, Public Health Office, Agriculture Office, WRMA Office, etc.

On the RAP process, it was noted that the only available data is the preliminary Land Acquisition Plan for the dam only that will lay a basis for a detailed RAP study. The Plan comprises in initial serialization of the land parcels, acreage required and number of trees likely to be removed but has no landownership shown on the listing. The water treatment works and the transmission pipeline corridor has not been defined on the ground and therefore, no identification of land parcels affected. The surveyor will be called upon to work with the RAP expert to verify the project extents on the ground with a view to quantifying the land area required and other compensation factors.

The Team Leader also cited the potential challenges facing the study on the ground among them the attitude and demands of the PAPs (including the demand for land-for-land form of compensation). In this regard, he suggested that an urgent meeting with the RAP Office at AWSB to lay appropriate approach strategy that will not raise unnecessary anxiety among the PAPs.

Finally, the Team Leader outlined among the basic documents required from AWSB for the study. Key among them was;

(i) ESMF and RAP Framework for AWSB
(ii) The ESIA Project Report,
(iii) Nairobi Water Master Plan

(iv) Engineering design reports and drawings for the project to provide basic concepts for the study,
(v) Hydrology report
(vi) Geotechnical report
(vii) Socio-economic survey report
(viii) ESIA and RAP for other projects undertaken in the area including the Northern Collector project

The Consultant Team Members confirmed the requests as relevant.

5. Work Plan

The work plan below was agreed upon in principle to drive the process. An inception site visit planned for Monday 18th March 2016, however, could take place to unavoidable circumstances and was rescheduled to Monday 4th April 2016 starting 8am. This affected submission of the inception Report from Friday 1st April to 6th April 2016 in order to reflect inception field observations.

Timeframe from Commencement Date	Deliverables
4th April 2016	Reconnaissance field visits
6th April 2016	Inception Report
8th April 2016	Terms of Reference (ToR)
29th April 2016	Draft ESIA Study Report Submission
13th May 2016	Final ESIA Study Report Submissions
19th May 2016	Draft RAP Report Submission
10th June 2016	Submission of Final RAP Report

The ESIA & RAP Studies were officially commenced.

There being no other business, the meeting closed at 4.15pm

Eunice Jemutai (Chairing) _____

Harrison W. Ngirigacha (Taking Minutes) _____

CONSULTATION PUBLIC MEETING HELD AT BUCHANA CATHOLIC CHURCH ON 27/5/2016 AT 9.30 TO 11.55 PM

Members present

1. Committee members
2. Social and Environmental team
3. Enumerators

MIN 1: INTRODUCTION

Mr. John Bosco – Kariminu Dam Committee Chairman opened the meeting and invited pastor Kimani who opened the meeting with a word of prayer. After prayer, Mr. Chairman introduced Kariminu Dam committee members who introduced themselves, and social and environmental team. He explained that the purpose of the meeting is for the committee members who represent the community to know what's happening and what is likely to happen concerning the proposed Dam construction. He said that community representatives are in the meeting to know and have knowledge of the Dam

MIN 2: Presentations

Environmental Impact Assessment

Mr. .Harrison Ngirigacha explained the importance of Environmental Impact Assessment for the Dam project is to enable approval by NEMA.

He explained that Dam design was explained in stakeholder meeting where the policy makers who included county government were present. He also said that the Dam involves the following reports which will be used as reference

1. Environmental report which is submitted to NEMA
2. Resettlement Action Plan(RAP) Which involves land use survey of the Dam and transition line areas

Temporary beacons will be put to show where the water will be. Residents will be sensitized through the committee members who are in the meeting today and also through churches and schools. He explained that RAP issues will be dealt with by Mr.Mbarine who will educate PAP about land issues for many people think they know land issues and they do not.

Also explained that Environmental issues will be dealt by Mr. Rukwaro Mr. Ngirigacha introduced Sociologist Mr. Julius Ngundo and requested the committee members to sensitize community to cooperate with sociologists who will often be visiting the community for various study activities involving the Dam.

Sociologist Presentations: Mr.Julius Ngundo

He greeted the members and quoted that its not his first time to integrate with Kariminu residents. He said he will be dealing with social issues which will majorly touch life of Kariminu residents around the Dam ,transition line and water treatment works areas. He explained that social issues will also include life of PAP for example; how many members in the households, average level income etc.

He explained that some people will be affected directly and others indirectly. Social impact studies will help evaluate social impact of the project after implementation. He also explained that shared resources and individual resources will be affected. He asked what is likely to be affected socially for example graves and how residents views the issue of the grave relocation and also shrines.

He said the social impact study will also integrate residents to enhance knowing their attitude towards the project. He would also like to know how the project is likely to affect education, number of schools to be affected, number of pupils who will be affected in their gender. He said that already had met with Deputy County Commissioner, MCAs, Chiefs, Ass. Chiefs and they are aware of the team in the Kariminu community.

He said that stakeholders help in policy making but the team will concentrate with locals. He urged residents to participate during household survey and also during the implementation of the project. Failure to participate will have its consequences. Participation will enhance involvement of their grievances in the project. He requested participants of the meeting to sign the attendance list and fill the questionnaire which will be circulated to them. He also explained the terminologies used in the questionnaire. He finally said that the project will have positive and negative impacts. One of the positive impacts is that the youth for example the enumerators present in the meeting will get employments and skills.

RAP Presentation – Mr. Mbarine

He said that his role in the project includes three issues

1. Community issues which includes social issues-Rate of people who will be affected for example the farmers and farming activities
2. Identifying how land is used in Kariminu-this will be through household survey
3. Identify social issues in areas where water will touch, get information about land ownership, tittle deeds(shared tittle deeds, and who owns land and how

He requested the Dam committee to have strategies to deal with land issues and know what will be required in terms of assets. He said that currently the residents to comfortably continue with their activities for land acquisition will follow later. He explained that issues of land will be dealt with by National Land Commission and the official information about land acquisition will come through the District Commissioner and chiefs. He said that not many households will be relocated as the Engineers had estimated.
He also quoted that land will be priced according to the current price per acre by that time.

Compensation exercise will be gazatted and houses will be counted and measured during household survey which will start after pegging and beacons will be put by the contractor to guide the surveyor. He urged residents to kindly reserve the pegging. He explained asset inventory –schools going to be affected and where will they be relocated.

He advised the Dam committee members to discuss after the Dam is filled with water, where will people going to cross over to the other side of the valley. He explained that buffer will be established to control contamination of water. He urged the community to think how to own buffer. The community to discuss with Athi Water about the buffer which (tree planting). He advised the community to think much about compensation whereby the fee comes from the tax payer who is the residents; he urged them to negotiate compensation terms viewing it at its minimal benefits. He insisted that all information relevant to the project is needed to enable good reporting of the project.

He said he always target to cooperate with people and be on their side. He said that the project is for the community. He requested the Dam committee to help identify surveys which may not be seen by normal eyes. Traditions of the community are to be well clarified and observed that Christianity is not a culture but a faith. Finally he insisted that accurate information is needed during household survey. During household survey, clear information about land ownership, sub division and availability of Title Deed should be well shown.

Mr. Ngirigacha

Mr. Ngirigacha urged residents to also look at the long term effects of the project not just the compensations which will come and go. He asked the Dam committee members to discuss issues like mosquito breeding, cases of drowning, safety of water and waste water disposal from homesteads and market centers.

MIN 3 : OPEN DISCUSSION FORUM

Name of participant	Question	Comment	Answers by SEIA Team
Chairman – John Bosco	In the Dam corridor, there is a school, Murata wa Twana primary and a road connecting from Buchana –Gathanje to Gituamba. How will the school be dealt with and how will people and school going children cross over to the other side of the valley Land here is free hold, will the land to where people will be relocated be free hold also		Mr. Mbarine ✓ Relocation has its own problem, basing on the challenges our country has faced on people relocated to public land. ✓ Athi water will investigate the issue of relocation ✓ Injurious affection will also be considered ✓ Household survey will help know how social lif will be affected ✓ The Dam committee to start reviewing infrastructure arrangements basically with county government and ministry of roads

Name of participant	Question	Comment	Answers by SEIA Team
			✓ Grievances redress committee will be formed to address PAPs grievances and guide Athi Water on compensation issues
A lady-committee member	Who will be the appropriate person to give out information during household survey in a case where the owner of the homestead is no present		Mr. Mbarine The person who understands the land well will be the appropriate person to give information during household survey particulary the land owner.
Maina mwangi-Dam committee secretary	Who is the relevant body to talk with the county government concerning the infrastructure ?Is it Athi water or Committee members After the completion of the project who will own it? The community or the county government How will the project generate money Will the community benefit? Who will be the members of the grievances committee In a case where the family has disputes over land issues, how will it be dealt with during compensation? The people who have leased land, how will their issues be delt with?	They will support the project and their grand fathers will be appeased, but if the project will mess up with lives of people it will affect even generations to come Requests cooperation from both parties-Athi water and the community	Mr. Mbarine ✓ Institutional arrangements are in devolved government who prepare county financial bill with local political representation. Consult the same about the Dam ✓ Money will not be paid to land with disputes ✓ Absent land lords-Committee and local leaders to start discussing how people who owns land without tittle deeds will be dealt with to avoid unnecessary delays during compensation ✓ Tenants will be paid for the developments of the land and disturbance fee for the remaining years Ngirigacha ✓ Ownership of the Dam-the Dam will have direct and indirect benefits ✓ The Dam committee to discuss and define the communal benefits not necessarily water but also community social responsibility-How the profit got from the Dam be returned back to community(Direct and indirect) ✓ Grievances redress committee membership will involve ✓ -PAP representative ✓ -Administration representative ✓ -Church representative ✓ The committee will be for legal advice and will be paid by the project, will be formed before compensation

Name of participant	Question	Comment	Answers by SEIA Team
			✓ National Land Commission will deal with land issues ✓ Ripallian land owners will apply for the use of water only for limited irrigation and domestic use
Ass. Chief- Francis Njoroge- Kanyoni location		Educate family members over land ownership issues for it's a big challenge Educate locals the importance of doing search of tittle deeds Kanyoni residents will be highly affected Requests for a seminar for PAPs to educate them on how to deal with land disputes	
Ass. Chief – George Munene – Kamwangi location		Requests seminar for PAPs	

MIN 4: Final remarks

Mr. Ngirigacha

Requested the committee members to kindly let any question from the community concerning the Dam construction to be forwarded to the Chairman. The People to be sensitized as they wait the program of household survey

Pastor closed the meeting with a prayer at 11 50 AM.

REPORT FROM THE OFFICE OF THE COUNTY ADMINISTRATOR GATUNDU NORTH SUB-COUNTY

The county administrator Gatundu North sub-county Mr.Gichogu was out on leave, so we opted to interact with the ward administrators: Ms.Catherine of Chania Ward where the pipeline will pass and Mr. Mungai of Githobokoni (Gituamba) ward, the site of the dam.

INTRODUCTION

The Karimenu dam is a project of Athi Water Services that is funded by Exim bank of China.
The objective of the construction of the dam is to supply water to Ruiru, Juja and partially Thika.
As part of the project it is important to carry out consultations with the local administrators considering there will be disturbance of public utilities and residences of the locals at the site of the dam.

QUESTIONS:

1. How have the residents taken it?

They are happy that the project is finally underway after a long time of waiting. The main issue though is how they will be resettled. The committee prefers land for land, but after our negotiations with them we shall get clearer feedback from those that will be affected.

2. What are our benefits as the locals, now that the dam will be in our area but supplying water elsewhere? Will it be the case as that of Ngethu Treatment where the locals don't benefit?

The residents will be employed for it is a rule that 65% of the employees must be locals.
With feedback from Athi Water Services Board, it is important that there be construction of small water points for the locals.

3. When is the start of the construction?

When we finalize the feasibility study and R.A.P report, Athi Water Services Board will authenticate afterwards NLC, then treasury, so we could say in the next 3months.

4. How will the affected be compensated?

After the household census, the affected will be compensated in the witness of their area chief.

CONCLUSION:

Both Ward Administrators noted that it is important to involve MCAs on a one on one basis to avoid political conflicts.

Persons Consulted

Officer Consulted

Name	Designation/area	Contacts
Mr. Njahi	Unit Manager	721887570
Irine Gathinji	P.A.O	722612441
George Wachira	DEO	0722638585
E. Macharia	RCO	721571943
Ms. Catherine	Ward Administrator, Chania Ward	
Mr. Mungai	Ward Administrator, Githobokoni (Gituamba) ward	

Resident Villagers Interviewed

Name	Village	Occupation
Tea leaves harvesters	Kiriko	
James Kimani	Kiriko	Tea farmer
John mwangi-0712154022	Kiriko	Tea leaves farmer
Ann Njeri	Kiriko	
Raymond Kamau	Iruri	
Martin Garari-0717100105	Iruri	Tree Nursery farmer
Ann Nduta	Iruri	Resident
Mugai Samuel	Gituamba	Elder
Michael Nyanjui	Githanga	Farmer(pinnaples)
Mary Wanjiru	Guru-ini	Farmer-pinapples,tomato fruits
John Chenge-0705972789	Ngurweini	Farmer-cotchets
Charles Lari	Ngurweini	Farmer-tea leaves
Tea harvesters	NGurweini	
Agness Wangeci-0716719279	Gurue-ini	Farmer-tea
Samuel Njenga	Head Teacher Murata Wa Twana primary school	Gathanje

Annex V: Public Submissions

Annex VI: Water Quality Results

UNIVERSITY OF NAIROBI
DEPARTMENT OF CIVIL & CONSTRUCTION ENGINEERING

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P.O. Box 30197-00100
NAIROBI
KENYA

CHEMICAL ANALYSIS FOR WATER SAMPLES

SAMPLE SOURCE & DESCRIPTION: BOREHOLE WATER – AVIC AND SMED COMPANY.

SAMPLED BY: CLIENT **CLIENT:** AVIC AND SMED COMPANY.

PARAMETER	RESULT	REMARK
P^H	6.64	
APPARENT COLOUR ^0H	35	
TRUE COLOUR ^0H	30	
CONDUCTIVITY µS/CM, mg/l	42	
TURBIDITY, F.T.U	3.9	
CALCIUM HARDNESS AS $CaCo_3$, mg/l	4	
TOTAL HARDNESS AS $CaCo_3$, mg/l	10	
TOTAL ALKALINITY AS $CaCo_3$, mg/l	8	
CARBONATE ALKALINITY, mg/l	0	
IRON, mg/l	0.3	
FLUORIDES, mg/l	0	
SULPHATES, mg/l	0	
PHOSPHATES, mg/l	0.02	
SILICA, mg/l	10	
DISSOLVED OXYGEN, p.p.m	6.0	
NITRATES, mg/l	0.6	
MANGANESE, mg/l	0	
CHLORIDES, mg/l	48	
CHROMIUM ,mg/l	-	
COPPER, mg/l	-	
TOTAL COLIFORM/100ml	-	
TOTAL FAECAL COLIFORM/100ml	-	
DISSOLVED SOLIDS, mg/l	40	
SUSPENDED SOLIDS, mg/l	10	
TOTAL SOLIDS, mg/l	50	
BIOCHEMICAL OXYGEN DEMAND, mg/l	-	
CHEMICAL OXYGEN DEMAND, mg/l	-	
RESIDUAL CHLORINE, mg/l	-	

GENERAL REMARKS: Clear and soft water, colour exceeds standards for drinking water.

REMARKS BY: DR P. K. NDIBA **SIGNATURE:** ..... **DATE:** 25/07/2013

APPROVED BY: PROF. S.K. MWEA **SIGNATURE:** ..... **DATE:** 24/7/13
CHAIRMAN, CIVIL & CONSTRUCTION ENGINEERING

KKJ

UNIVERSITY OF NAIROBI

Institute of Nuclear Science & Technology

College of Architecture & Engineering
P.O. Box 30197
Nairobi, KENYA.
Fax. 254-2-245566

Telephone 318262
Exts. 28483/28545/28536
Telegram: Varsity
Telex: 22095 VARSITY KE

26th July 2013

REF: UON/CAE/INST/537

AVIC & SMED Company

RE: Heavy metals analysis in a river water sample - Karumenu

Reference is made concerning the above request.

The result of analysis obtained by **X-ray fluorescence techniques** is attached.

We look forward to continued co-operation.

INSTITUTE OF NUCLEAR SCIENCE & TECHNOLOGY
CAE
UNIVERSITY OF NAIROBI
P.O. Box 30197 - 00100, NAIROBI

D. M. Maina
Director,
Institute of Nuclear Science and Technology

1/2

Concentration results in µg/L (ppb)

Element	Karumenu river water
Potassium (K)	1773 ± 94
Calcium (Ca)	2210 ± 50
Titanium (Ti)	136 ± 10
Vanadium (V)	<40
Chromium (Cr)	<40
Manganese (Mn)	130 ± 3
Iron (Fe)	2779 ± 127
Nickel (Ni)	<30
Copper (Cu)	<30
Zinc (Zn)	85.3 ± 3.0
Arsenic (As)	<20
Bromine (Br)	<20
Rubidium (Rb)	<10
Strontium (Sr)	16.3 ± 0.6
Lead (Pb)	155 ± 4

2/2

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DEPARTMENT OF CIVIL & CONSTRUCTION ENGINEERING

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NAIROBI
KENYA

CHEMICAL ANALYSIS FOR WATER SAMPLES

SAMPLE SOURCE & DESCRIPTION: KARUMENU DAM

SAMPLED BY: CLIENT **CLIENT:** NORKEN (I) LTD.

PARAMETER	RESULT	REMARK
P^H	7.03	
APPARENT COLOUR ^oH	45	
TRUE COLOUR ^oH	40	
CONDUCTIVITY µ/S/CM, mg/l	22	
TURBIDITY, F.T.U	5.9	
CALCIUM HARDNESS AS $CaCo_3$, mg/l	4	
TOTAL HARDNESS AS $CaCo_3$, mg/l	6	
TOTAL ALKALINITY AS $CaCo_3$, mg/l	15	
CARBONATE ALKALINITY, mg/l	0	
IRON, mg/l	0.3	
FLUORIDES, mg/l	0	
SULPHATES, mg/l	5	
PHOSPHATES, mg/l	0.02	
SILICA, mg/l	20	
DISSOLVED OXYGEN, p.p.m	6.5	
NITRATES, mg/l	1.0	
MANGANESE, mg/l	0	
CHLORIDES, mg/l	68	
CHROMIUM ,mg/l	0	
COPPER, mg/l	0	
TOTAL COLIFORM/100ml	-	
TOTAL FAECAL COLIFORM/100ml	-	
DISSOLVED SOLIDS, mg/l	80	
SUSPENDED SOLIDS, mg/l	20	
TOTAL SOLIDS, mg/l	100	
BIOCHEMICAL OXYGEN DEMAND, mg/l	-	
CHEMICAL OXYGEN DEMAND, mg/l	-	
RESIDUAL CHLORINE, mg/l	-	

GENERAL REMARKS: The water meets the standard for development as a source for domestic use.

DEAN
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UNIVERSITY OF NAIROBI
P. O. Box 30197
NAIROBI

REMARKS BY: PROF. P.M.A ODIRA **SIGNATURE:** ..... **DATE:** 04/2/2013

APPROVED BY: PROF. S.K. MWEA **SIGNATURE:** ..... **DATE:** 04/2/13
CHAIRMAN, CIVIL & CONSTRUCTION ENGINEERING

KKI

UNIVERSITY OF NAIROBI
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NAIROBI
KENYA

CHEMICAL ANALYSIS FOR WATER SAMPLES

SAMPLE SOURCE & DESCRIPTION: KAMITI DAM

SAMPLED BY: CLIENT **CLIENT:** NORKEN (I) LTD.

PARAMETER	RESULT	REMARK
pH	7.32	
APPARENT COLOUR °H	85	
TRUE COLOUR °H	80	
CONDUCTIVITY µ/S/CM, mg/l	45	
TURBIDITY, F.T.U	8.3	
CALCIUM HARDNESS AS $CaCo_3$, mg/l	8	
TOTAL HARDNESS AS $CaCo_3$, mg/l	16	
TOTAL ALKALINITY AS $CaCo_3$, mg/l	20	
CARBONATE ALKALINITY, mg/l	0	
IRON, mg/l	0.4	
FLUORIDES, mg/l	0	
SULPHATES, mg/l	5	
PHOSPHATES, mg/l	0.02	
SILICA, mg/l	25	
DISSOLVED OXYGEN, p.p.m	6.1	
NITRATES, mg/l	1.0	
MANGANESE, mg/l	0	
CHLORIDES, mg/l	53	
CHROMIUM ,mg/l	0.01	
COPPER, mg/l	0	
TOTAL COLIFORM/100ml	-	
TOTAL FAECAL COLIFORM/100ml	-	
DISSOLVED SOLIDS, mg/l	110	
SUSPENDED SOLIDS, mg/l	50	
TOTAL SOLIDS, mg/l	160	
BIOCHEMICAL OXYGEN DEMAND, mg/l	-	
CHEMICAL OXYGEN DEMAND, mg/l	-	
RESIDUAL CHLORINE, mg/l	-	

GENERAL REMARKS: The water meets the standard for development as a source for domestic [illegible]

SCHOOL OF ENGINEERING
UNIVERSITY OF NAIROBI
P.O. Box 30197
NAIROBI

REMARKS BY: PROF.P.M.A. ODIRA **SIGNATURE:** ..... **DATE:** 14/2/2013

APPROVED BY: PROF. S.K. MWEA **SIGNATURE:** ..... **DATE:** 13/2/13

CHAIRMAN, CIVIL & CONSTRUCTION ENGINEERING

KKJ

UNIVERSITY OF NAIROBI

DEPARTMENT OF CIVIL & CONSTRUCTION ENGINEERING

PUBLIC HEALTH ENGINEERING LABORATORY

JAR TEST RESULTS

Sample Source and Description: KAMITI DAM (NORKEN (I) LTD.

Date sampled: 01/13. **Date Tested:** 21 /01/2013.

Raw Water Quality:

pH 7.32 Turbidity, F.T.U...8.3 Colour °Hazen: 80

Total Alkalinity mg/l as $CaCO_3$: 20

Coagulant Used: Alum

Stirring Time and Speed:

Flash mixing: 1Minute. Flocculation: 15 Minutes. Setting Time: 60 Minutes.

JAR NO.	ALUM DOSE Mg/l	LIME DOSE Mg/l	pH	TURBIDITY F.T.U.	ALKALINITY Mg/l $CaCO_3$	COLOUR °H
1.	10	0	7.21	1.8	19	30
2.	15	0	7.12	1.8	16	10
3.	20	0	7.09	1.5	15	5
4.	25	0	6.86	1.4	14	5
5.	30	0	6.84	1.4	14	5
6.	35	0	6.64	1.5	14	10
7.	40	0	6.35	1.6	12	10
9.	45	0	6.34	1.7	11	15
10.						

GENERAL REMARKS: With a small dose of lime to increase alkalinity optimum clarification of the water should be achieved with a dose of 20-25 mg/l of alum.

SCHOOL OF ENGINEERING
UNIVERSITY OF NAIROBI

REMARKS BY: PROF.P.M.A. ODIRA **SIGNATURE:** ..... **DATE:** 21/1/2013

APPROVED BY: PROF.S.K.MWEA **SIGNATURE:** 22/1/13

CHAIRMAN, CIVIL & CONSTRUCTION ENGINEERING

DEPARTMENT OF CIVIL AND CONSTRUCTION ENGINEERING
UNIVERSITY OF NAIROBI

KK

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DEPARTMENT OF CIVIL & CONSTRUCTION ENGINEERING

PUBLIC HEALTH ENGINEERING LABORATORY
JAR TEST RESULTS

Sample Source and Description: KARUMENU DAM (NORKEN (I) LTD.

Date sampled: 01/13. **Date Tested:** 21 /01.2013.

Raw Water Quality:

pH 7.32 Turbidity, F.T.U...5.9 Colour °Hazen: 40

Total Alkalinity mg/l as $CaCO_3$: 15

Coagulant Used: Alum

Stirring Time and Speed:

Flash mixing: 1Minute. Flocculation: 15 Minutes. Setting Time: 60 Minutes.

JAR NO.	ALUM DOSE Mg/l	LIME DOSE Mg/l	pH	TURBIDITY F.T.U.	ALKALINITY Mg/l $CaCO_3$	COLOUR °H
1.	10	0	6.89	1.6	11	5
2.	15	0	6.78	1.5	9	5
3.	20	0	6.73	1.4	8	5
4.	25	0	6.70	1.3	8	5
5.	30	0	6.69	1.2	6	5
6.	35	0	6.52	1.5	6	10
7.	40	0	6.20	1.6	5	15
8.	45	0	6.15	5.0	9	30

GENERAL REMARKS: With a small dose of lime to increase alkalinity optimum clarification of the water should be achieved with a dose of 20-25 mg/l of alum.

DEAN SCHOOL OF ENGINEERING UNIVERSITY OF NAIROBI NAIROBI

REMARKS BY: PROF.P.M.A. ODIRA **SIGNATURE:** ..... **DATE:** 14/2/2013

APPROVED BY: PROF.S.K.MWEA **SIGNATURE:** ..... **DATE:** 13/2/13

CHAIRMAN, CIVIL & CONSTRUCTION ENGINEERING

KKJ

Annex VII: ESIA Project Report Submissions

nema

NATIONAL ENVIRONMENT MANAGEMENT AUTHORITY

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Popo Road, off Mombasa Road
P.O. Box 67839 – 00200
Nairobi, Kenya
Website:www.nema.go.ke

NEMA/PR/5/2/..12885.....
OR
NEMA/EIA/5/2/.....

Date..25/09/14.....

Athi water Service Board
Box 45283-00100
NAIROBI.

PSR/2846

RE: ACKNOWLEDGEMENT OF ENVIRONMENTAL IMPACT ASSESSMENT (EIA) PROJECT REPORT OR STUDY REPORT

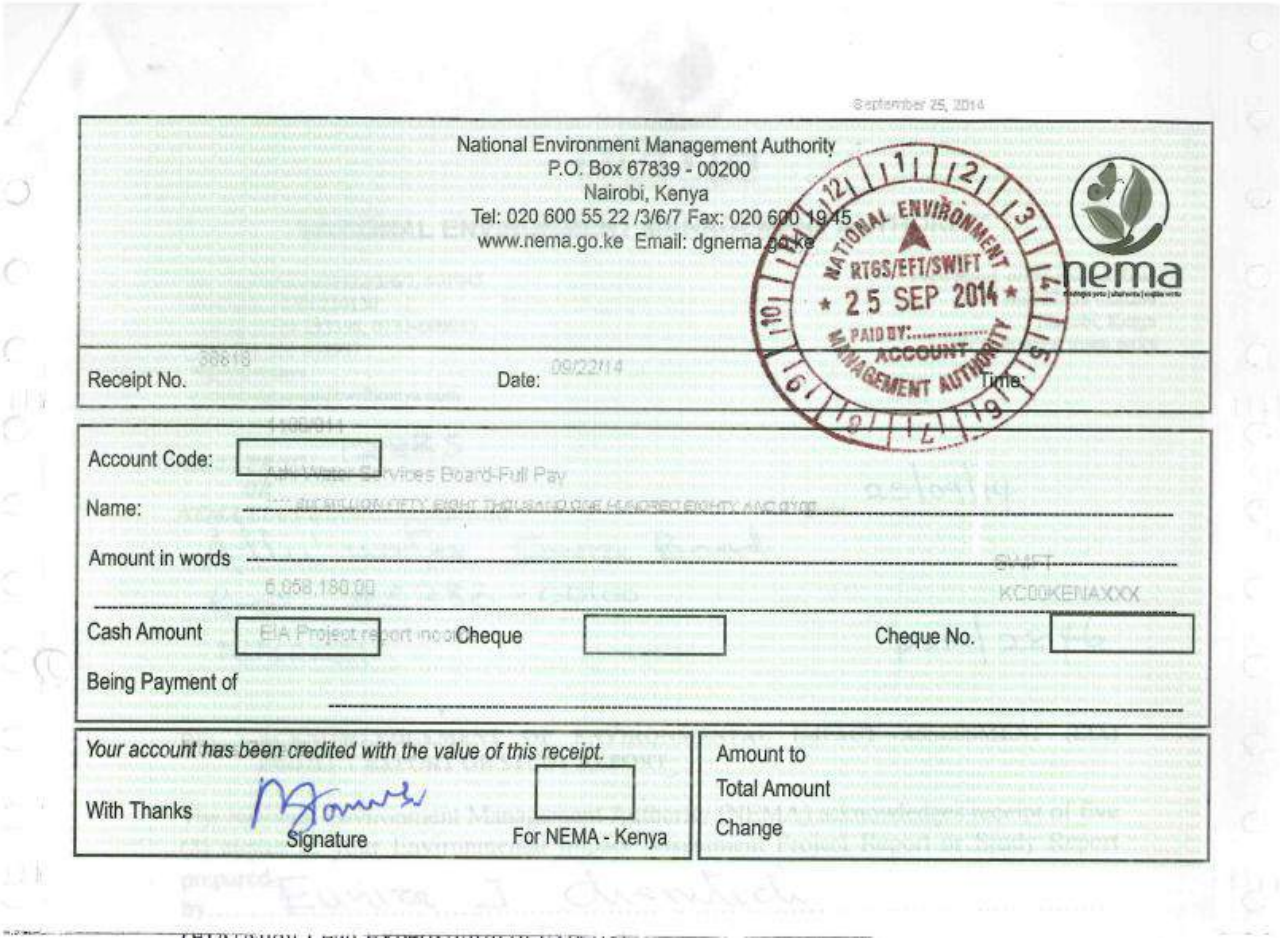
The National Environment Management Authority (NEMA) acknowledges receipt of five (5) copies of your Environmental Impact Assessment Project Report or Study Report prepared by..Eunice J Chemutai.....
(EIA/Audit Lead Experts/Firm of Experts)

We have also received 100%of the 0.1% of EIA Licence fee. The Reference Number for the EIA Project Report or study Report is NEMA/PR/5/2/12885.....for any future correspondence.

The report will be reviewed in accordance with Environmental Impact Assessment and Audit Regulations 2003; and NEMA will communicate its findings within 51 days to 3 months for study reports.

In the interim, please do not commence or proceed with any development of the proposed project until you receive communication from NEMA on the same.

REAGAN AWINO
FOR: DIRECTOR GENERAL



September 25, 2014

National Environment Management Authority
P.O. Box 67839 - 00200
Nairobi, Kenya
Tel: 020 600 55 22 /3/6/7 Fax: 020 600 1945
www.nema.go.ke Email: dgnema.go.ke

NATIONAL ENVIRONMENT MANAGEMENT AUTHORITY
RTGS/EFT/SWIFT
* 25 SEP 2014 *
PAID BY: ACCOUNT

nema

Receipt No. 36818 Date: 09/22/14 Time:

Account Code: Athi Water Services Board-Full Pay

Name:

Amount in words

6,058,180.00 SWIFT KCBKENAXXX

Cash Amount EIA Project report inco Cheque Cheque No.

Being Payment of

Your account has been credited with the value of this receipt.

With Thanks Signature For NEMA - Kenya

Amount to
Total Amount
Change