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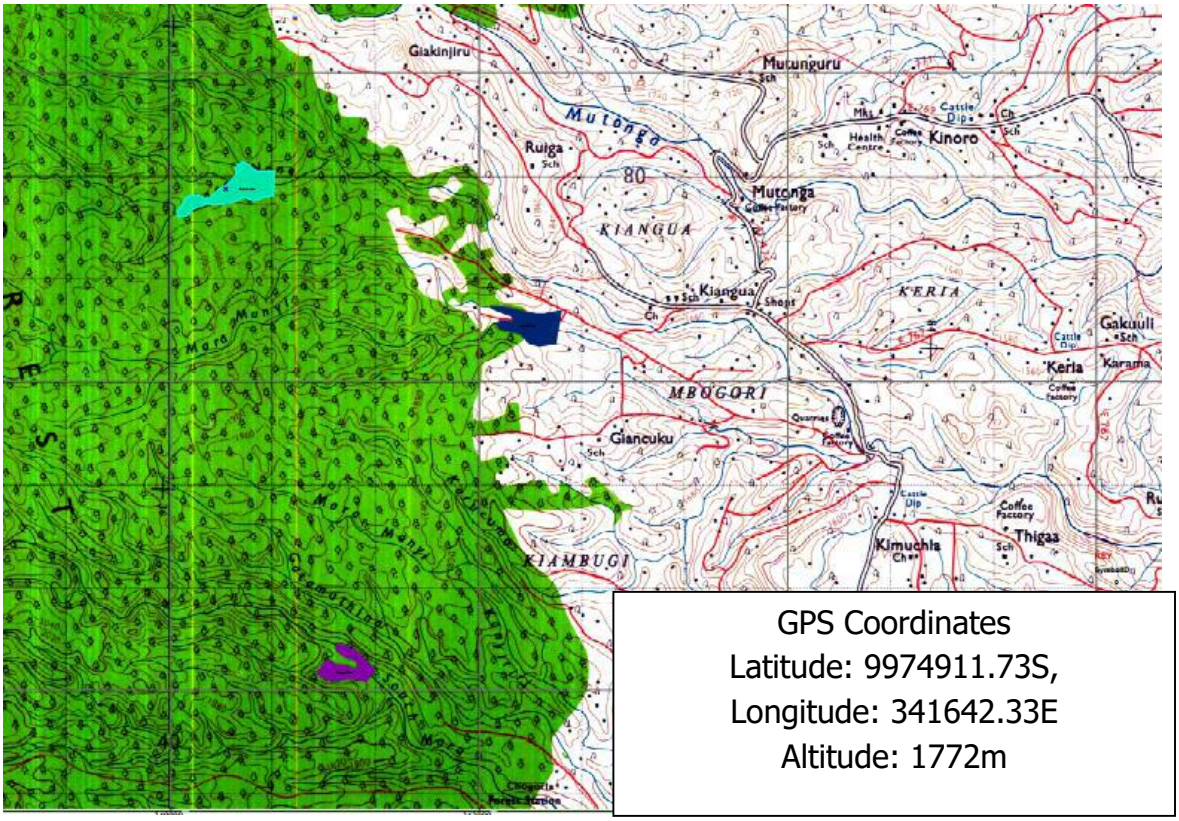
ENVIRONMENTAL AND SOCIAL IMPACT ASSESSMENT PROJECT REPORT

FOR THE PROPOSED KANJOGU DAM



GPS Coordinates
Latitude: 9974911.73S,
Longitude: 341642.33E
Altitude: 1772m

IN
SOUTH MAARA RIVER
MAARA SUB COUNTY
THARAKA NITHI COUNTY

TANA WATER WORKS DEVELOPMENT AGENCY

CERTIFICATION

This ESIA project report for the proposed Kanjogu Dam in South Maara River in Maara Sub County Tharaka Nithi County is prepared in accordance with Environmental Management and Coordination Act (EMCA) Cap 387 and the Environmental (Impact Assessment and Audit) (amended) Regulations, 2019.

We, the undersigned confirm that the contents of this report are a true representation of the construction and operations of the proposed dam project.

PROJECT PROPONENT	**CHIEF EXECUTIVE OFFICER** **TANA WATER WORKS DEVELOPMENT AGENCY** **P.0 Box 1292-10100** **NYERI**
Signature	_____
Consultants	**HABITAT PLANNERS** **NEMA Reg. No. 0465** **Email: info@habitatplanners.com**
Lead Consultant	**Lincoln Kivuti Karingi** **Lead Expert NEMA Reg. No. 0320**
Signature	_____
Date	_____

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ACRONYMS/ABBREVIATIONS

EA	Environmental Audit
EHS	Environmental Health and Safety
EIA	Environmental Impact assessment
EMCA	Environment Management and Coordination Act
EMP	Environmental Management plan
EMS	Environmental Management systems
ERS	Economic Recovery Strategy
IRRI	International Rice Research Institute
Km	Kilometres
M^2	Meter squared
M^3	Meters Cubic
Masl	Meters above Sea Level
TNCG	Tharaka Nithi County Government
MDG	Millennium Development Goals
MEAs	Multilateral Environmental Agreements
NEC	National Environmental Council
NEMA	National Environment Management Authority
TWWDA	Tana Water Works Development Agency
SRA	Strategy for Revitalization of Agriculture
ToR	Terms of Reference
WRA	Water Resources Authority

EXECUTIVE SUMMARY

Tana Water Works Development Agency (TWWDA) through financing from the National Government proposes to develop Kanjogu dam with an estimated volume of 900,000 M^3. The proposed Kanjogu dam lies on the upper reaches of South Maara River in Mara Sub County of Tharaka Nithi County at an elevation of 1772 Metres above sea level (Masl) and GPS coordinates Latitude:341642.33E, Longitude: 9974911.73S and about 3km inside Mt. Kenya Forest Reserve.

Development of water storage facilities to harvest the flood water and store it for use during the critical dry season is a crucial development that will spur the growth of water dependent enterprises. The approximate dam area is approximately twenty (20) hectares with an estimated dam capacity of 900,000 M^3 at a water level of 20m. The construction of the dam is estimated to affect 4150 stems of mixed indigenous trees.

TWWDA has contracted Habitat Planners- a NEMA registered and a practicing firm of Experts - Registration Number 0465 to undertake an Environmental and Social Impact Assessment (ESIA) of the proposed development and prepare a project report for submission to NEMA for review. The dam construction activities will include but not limited to among others: -

Land clearing, stripping of top soil, excavation of soil (both spoil and borrow material), installation of Filter Blanket and Toe drain, placement and compaction of borrow material and excavation of spillway.

Some of the perceived negative impacts of the dam during construction phase include:

- Removal of soil and vegetation impacting on habitats, current productive uses of the land, archaeological or cultural sites and artifacts
- Displacement of wildlife
- Change in the natural hydrological pattern which may impact on floods and low flow conditions downstream

- Degradation of water quality due to erosion, excessive storm water and discharge of contaminated effluent
- Generation of wastes/debris/litter from site clearance waste, construction materials such as metal, concrete, cement bags, and domestic waste associated with the workforce
- Increase in dust and noise
- Safety of workers and other people
- Increase in traffic and risk of accidents
- Influx of immigrant workers
- Conflicts between project proponent, regulators, service providers and public

The environmental concerns during the operational phase of the dam relate to increased risk of drowning, downstream flow and water quality issues attributed to the dam, pests attributed to the expanded water habitat such as water rats, snakes, geese, mosquitos, liver fluke, snails, invasive water plants and possible dam failure.

These concerns will be continually addressed by dam management team through measures such as complaints handling mechanisms, pest monitoring and control, dam monitoring and risk reduction activities. Additionally, the dam owner/management will carry out dam inspection by a qualified water professional as required.

An environmental management and monitoring plan (EMMP) has been developed for the dam project which will be implemented and monitored from time to time via Annual Environmental Audits to be submitted to NEMA by the dam owners. In addition, dam safety plan and dam inspection regime will be adhered to.

1.0 INTRODUCTION, TERMS OF REFERENCE & METHODOLOGY OF THE STUDY

1.1 Introduction

Design and construction of water storage structures is primarily informed by the opportunities for benefits associated with such a structures. But like any other infrastructure project, water storage structure projects also have the potential to trigger negative social and bio-physical impacts. Environmental and Social Impact Assessment (ESIA) is thus a project planning process that identifies, predicts and assesses the type and scale of potential social and bio-physical impacts and opportunities for benefits associated with the proposed water storage project.

ESIA documents the baseline condition and how this is likely to change during construction, operation and decommissioning phases of a project. It explores alternatives and provides an environmental monitoring and mitigation plan. The process is multi-disciplinary in nature and requires disclosure and consultation with stakeholders.

ESIA is a planning process that has become common practice for water storage infrastructure projects. Additionally, ESIA being a legal requirement, past experience has proven that proper public consultation and analysis of potential environmental and social impacts improves the likelihood of sustainable benefits from the project to a wider body of stakeholders. Further it reduces the likelihood of negative impacts of the project on the social and bio-physical environment.

The construction of small dams, pans and other small scale water storage structures poses low risk of adverse social and environmental impacts than the construction of large-scale dams and reservoirs. The ESIA process is normally scaled to suit the magnitude and nature of the project in question. However, it remains an important component of project development particularly where fragile environment and vulnerable people are involved.

Exploitation of (surface) water resources by the creation of an artificial reservoir, however limited in size, still constitutes an intervention in the hydrological cycle. This therefore calls for ESIA to be taken into consideration during the planning process.

The Kenya government policy on all new projects requires that an ESIA study is carried out at the project planning stages to ensure that significant impacts on the environment are taken into consideration. Large dams are some of the projects listed under the second schedule of the Environmental Management and Coordination Act (EMCA) cap 387 that should undergo an ESIA.

It is a legal requirement that an ESIA is conducted on all development projects that require one before implementation. The intention of National Environment Management Authority (NEMA) is to approve and license projects that take into consideration all the aspects of concern to the public as they impact on health and the quality of the environment.

To meet environmental statutory requirements set out by EMCA, the proponent contracted Habitat Planners - a firm of experts registered with NEMA (Registration no. #0465 to undertake an Environmental and Social Impact Assessment (ESIA) of the proposed Kanjogu dam development and prepare a project report.

1.1.1 Tana Water Works Development Agency (TWWDA)

The promulgation of the new constitutional order introduced the devolved governments. The water Act 2016 created Water Works Development Agencies among them is Tana Water Works Development Agency (TWWDA). TWWDA has now been mandated to serve five counties, namely; Meru, Nyeri, Tharaka-Nithi, Kirinyaga and Embu.

In this regard, deliberate efforts aimed at realizing the objectives as stipulated in the Agency's Mission and Vision are being done to propagate and facilitate the provision of adequate water and sanitation services for the communities within these areas.

Over the recent past, the Agency, through financing from development partners, has undertaken major infrastructural works in particular areas falling within these counties. These works range from bulk conventional water supply systems to small water projects such as water pans and small dams.

In cognizant of the Government of Kenya's major efforts and interests in undertaking massive water harvesting and storage programs with construction of dams in several parts of this country, the Agency has identified dam locations in Tharaka Nithi County which it intends to develop in order to provide reliable water sources to the target areas as well as conserving the much needed water resource. Among the dams identified is the proposed Kanjogu dam with an estimated volume at 900,000 M^3

1.1.2 Kanjugu Dam Project

The proposed dam lies on the upper reaches of South Maara River in Mara Sub County of Tharaka Nithi County at an elevation of 1772 Metres above sea level (Masl) and GPS coordinates Latitude:341642.33E, Longitude: 9974911.73S and about 3km inside Mt. Kenya Forest Reserve. The approximate dam area is approximately twenty (20) hectares with an estimated dam capacity of 900,000 M^3 at a water level of 20M.

Kanjogu Dam whose major use is the domestic water and minor irrigation water storage and supply is expected to benefit residents of Mitheru, Ganga, Chogoria and Muthambi wards of Maara Sub-County in Tharaka-Nithi County.

The highest percentage of the population in the area constitutes subsistent farmers who live on small demarcated plots and shambas where they undertake small irrigation for their farm produce and animal production. These are the communities that extract the bulk of the water from the existing water facilities. In order to increase the availability of water resource within Maara South River, the Agency has identified Kanjogu Dam site strategically located at a higher zone purposed for increasing the water availability as well as improving the livelihood of the residents

1.2 TOR for Kanjogu Dam ESIA

In realizing the objectives as stipulated in the TWWDA's Mission and Vision provision of adequate water and sanitation services for the communities; the agency proposes to construct Kanjogu dam in Tharaka Nithi County. Kanjogu Dam project is intended to impound flood flow from the South Maara River. The stored water will ensure continuous river flow for South Maara River and improve water supply in parts of Chogoria, Mitheru, Ganga, Chogoria and Muthambi wards of Maara sub-County in Tharaka-Nithi County.

Potential environmental impacts associated with implementation activities of the project during construction and operation phases must be analyzed carefully and adequate and effective mitigation measures formulated. The mitigation measures, including the socio-economic benefits to the community should be considered and an Environmental Management and Monitoring Plan formulated to guide the proponent and NEMA in future audits.

TWWDA has contracted Habitat Planners- a NEMA registered and a practicing Firm of Experts (**Registration number 0465**) to undertake an Environmental and Social Impact Assessment (ESIA) of the proposed dam project development and prepare a report for submission to NEMA for review.

1.3 Scope of the ESIA Work

- Systematically examine if the proposed project has any adverse impacts on the environment
- Prepare a detailed Environmental Impact Assessment (EIA) report
- Submission of the EIA reports to National Environment Management Authority (NEMA) for review, approval and issuance of license.

The expected output is an Environmental Impact Assessment (EIA) license for the proposed Kanjogu dam.

1.4 Methodology of the ESIA Study

The methodology employed by the EIA team was participatory in nature and involved adoption of the following tools to gather and analyze information and data that led to making environmentally, socially and economically sound conclusions and recommendations. These tools included;

- Review of literature and documents
- Discussions with stakeholders and the proponent
- Site visits, observations and interviews
- Analysis of impacts, developing the EMP, discussing the outcomes with the proponent and presenting the report for submission to NEMA for review

The approach and methodology for preparing this report is based on the requirements of the Environmental Management and Coordination Act, (EMCA) Cap 387, the Environmental (Impact Assessment and Audit) (amended) Regulations, 2019, as well as the Environmental Impact Assessment Guidelines and Administrative Procedures published by the NEMA.

1.5 Details of the Environmental Impact Study Report

- Review the project feasibility studies and detailed designs
- Collect, collate and present information on the baseline characteristics of the existing environment within and around the proposed project area
- Highlight major issues and propose mitigation measures that need to be taken during construction, operation and decommissioning phases of the project
- Detailed Environment and Social Management Plan at all phases of the project i.e. Construction, Operations and Decommissioning Phases

Among the issues addressed include but not limited to: -

- Soil erosion and sedimentation in the proposed development area
- Water logging
- Impacts of water abstractions to downstream users
- Water-borne diseases
- Effects of quality of water entering and leaving project area

- Effects of water on the soil condition and sustainability of crop production
- Effects of water quality to irrigated lands and project inhabitants
- Propose mitigation measures of the dam to be incorporated in the design to ensure the above-identified concerns have been addressed in the proposed dam design and implementation of associated infrastructures
- Assess the extent to which the environmental aspects have been taken care of in the proposed dam development
- Study the existing socio-economic situation with a view to integrating the beneficiaries and incorporating a bottom-up approach in the development process.
- Public consultation in accordance with (1) Section 17 of the Environmental (Impact Assessment & Audit) regulations of 2003

The public in this study included, but not limited to:

- Local people likely to be affected by the proposed project sites
- Local farmers and other business in the areas to be upgraded as well as the new area to be brought under irrigation
- Farmers and other business likely to be affected by the dam, as well as the access and feeder roads to the dam
- Downstream users of the river within the project area
- Relevant Government departments both represented in County Government and National Government in the project area among others
- Community-based NGOs specialized in the relevant fields, such as environment and social issues; and
- Vulnerable groups such as the elderly, women, widows, youth, the poor and indigenous people, if any

The views of all affected and interested parties were taken into consideration, especially requests and comments regarding environmental issues and reflected in this ESIA report and documentary evidence of this such as the list of participants, the minutes of meetings are provided in the report.

2.0 PROJECT DESCRIPTION, ACTIVITIES/BASELINE INFORMATION

2.1 Project Site Description and Location

The site for the proposed Kanjogu Dam is located in a restricted area within the Mt. Kenya Forest approximately (2km) two kilometers from the tea zone with its axis lying across South Maara River at elevation 1771masl. The GPS coordinates of the dam axis are 37N, 42195E, 9974638N. The figure 1.1 shows the location of the proposed dam.

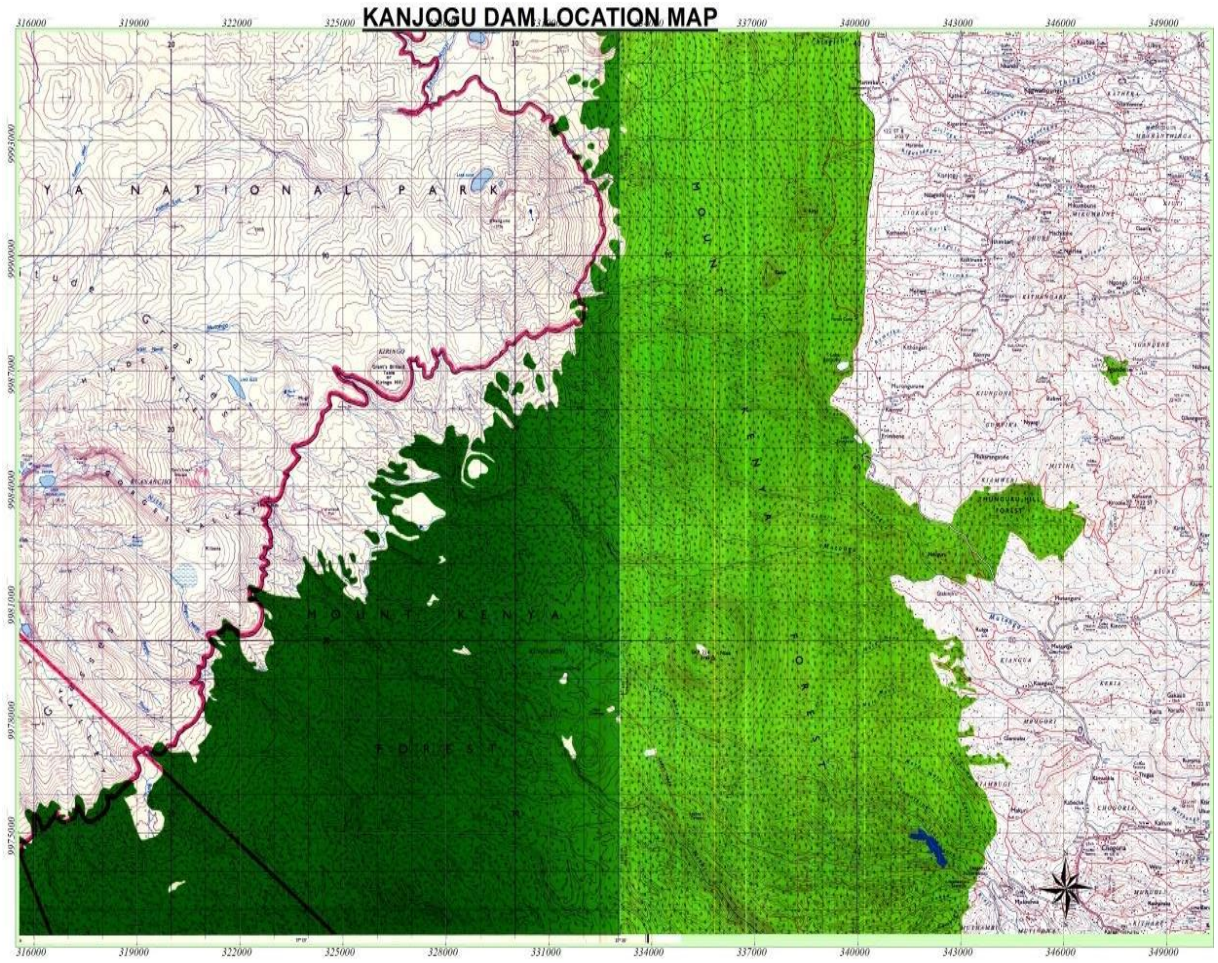

Figure 1.1: Location of the Proposed Dam

2.3 Description of the Project Area

2.3.1. General

The development of Kanjogu Dam is purposed to stabilize the surface water source by impounding the runoff within the South Maara River catchment and supplying it to the target project area for irrigation, livestock and domestic use by the resident communities of Maara Sub-county. Tharaka Nithi County is located on the fringes of Mt Kenya and it neighbors Embu and Meru Counties.

2.3.2 Description of South Maara River

The South Maara River system originates from Mt. Kenya Forest. Maara, then it joins South Maara River to become Maara River which then joins Thuchi and Ruguti Rivers before its confluence with Mutonga River and finally joins the main Tana River which then drains into the Indian Ocean.

Below the mountain peaks, the slopes are highly dissected by radial valleys. The deeply incised valleys in the upper part are U-shaped, and they are formed by glacial erosion and in the lower zones there are the typical V-shaped forms. The foot ridges occur due to the down-cutting of the various rivers. These ridges are situated at over 50m above the surrounding land and slope down to adjacent valleys.

The plateaus are formed in the volcanic formation from lava and have relatively flat surfaces. The entire upper and middle catchment have a rather steep gradient as it falls from the top of Mt. Kenya (5200masl) to the Tana River, representing a fall of over 4000m within a straight-line distance of less than 100 km which translates to a longitudinal slope of 0.25.

2.3.2 Climate

The climate of Mt. Kenya region is largely determined by altitude, with marked differentiation of agro-climatic zones within short distances. The Maara South River sub-

catchment lies within the humid to semi-arid zones on the eastern slopes of Mt. Kenya from where it assumes its sources. The temperatures in the project area vary with altitude. In the Tea-Dairy zones whose altitude varies from 1830masl to 2200 Masl, the annual mean temperatures vary from 15^0 C to 17^0 C.

In the Coffee-Tea Zones with altitude varying from 1520 Masl to 1800masl, the annual mean temperatures vary from 17^0 C to 19^0 C. In the main Coffee Zone with altitude varying from 1280 to 1800masl, the annual mean temperatures vary from 18^0 C to 21^0C. In the marginal Coffee Zone, the altitude of which varies from 1280masl to 1520masl, the annual mean temperatures vary from 19^0 C to 21^0 C.

2.3.4 Rainfall

The rainfall pattern in the project area is bi-modal, with the long rains occurring from March to May and the short rains from October to December. Depending on the altitude, the annual rainfall ranges from between 1600 – 2000 mm in the higher eastern slopes of Mt. Kenya where the river originates. The rainfall distribution in the upper Tharaka Nithi County including the dam project area is presented through the analysis of rainfall data from the following three stations table 2.1;

Table 2.1: Selected rainfall stations in the upper Mutonga/Maara River system

No	Name	Location		
		Longitude	Latitude	Altitude
9037034	Chuka Council Farm	E037.6333	S00.3333	1494
9037150	Igoji TTC	E037.6666	S00.50	1420
9037123	Chogoria Forest Stn	E037.5930	S00.2370	1744

Analysis of rainfall data from the three stations indicates that there is very little rainfall during the months of June to September across the catchment. This is the period when farmers in the lower agricultural zones need water supplies for their crops. The mean monthly rainfall pattern across the catchment is shown in Table 2.2 and graphically presented in figure 2.2. The mean monthly rainfall in the project area is depicted in

Table 2.2 and graphically shown in figure 2.2. The project area experiences an annual average rainfall of 1730mm.

Table 2.2: monthly rainfall distribution in the upper Mutonga/Maara River system (mm)

No.	Name/Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
9037123	Chogoria	73.0	40.1	161.9	466.6	257.4	35.8	49.3	50.5	37.7	306.6	444.4	166.3
9037034	Chuka	52.0	41.4	125.2	403.3	156.4	18.9	35.2	30.5	31.7	249.3	369.0	123.1
9037150	Igoji	44.5	28.1	149.7	313.0	143.2	12.8	17.0	17.0	17.3	235.0	364.5	112.1

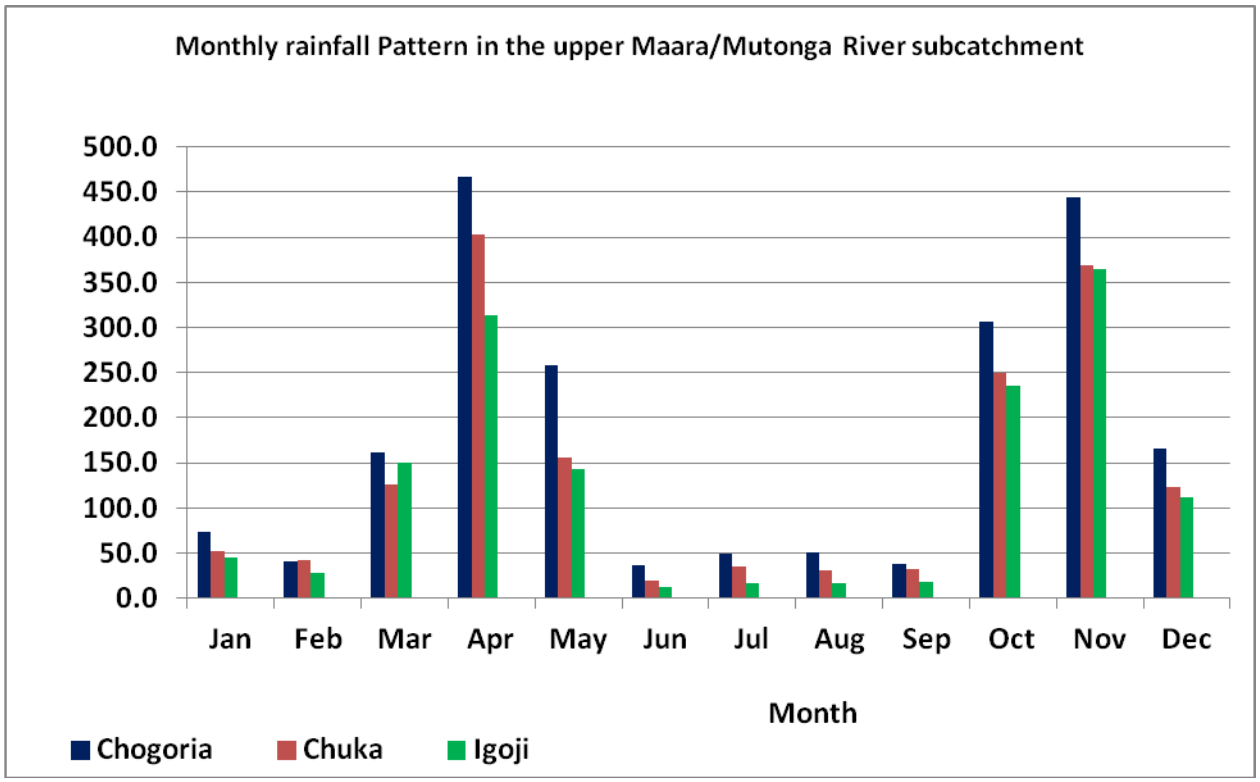

Figure 2.1: Rainfall distribution in the Maara/Mutonga River system

Table 2.3: Mean monthly rainfall in the upper Mutonga/Maara river system

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Rainfall (mm)	56.5	36.6	145.6	394.3	185.7	22.5	33.8	32.7	28.9	263.6	392.6	133.8

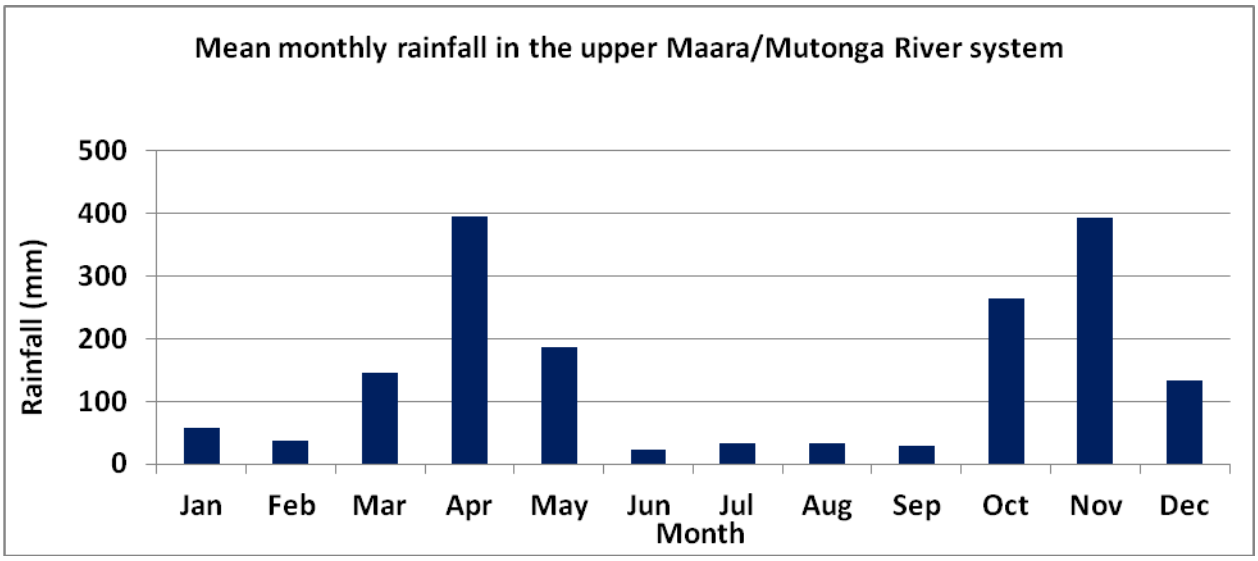

Figure2. 2: Mean monthly rainfall for the upper Maara/Mutonga River system

2.3.5 Evaporation

Evaporation data is basic to estimation of water losses from reservoirs; regrettably, 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 specific regions. The estimation of evaporation rates in the dam project area on South Maara River system is based on evaporation data from Marimba Agriculture Farm station (No.9037102) located to the north of the project area but within the same agro-climatic zone (Tea-Dairy Zone). The mean monthly evaporation rates at the station are depicted in table2.4 and figure 2.4.

Table 2.4: Mean monthly evaporation rates at Marimba Agriculture Farm

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Evaporation (mm)	115	120	135	113	105	90	85	110	128	110	105	105

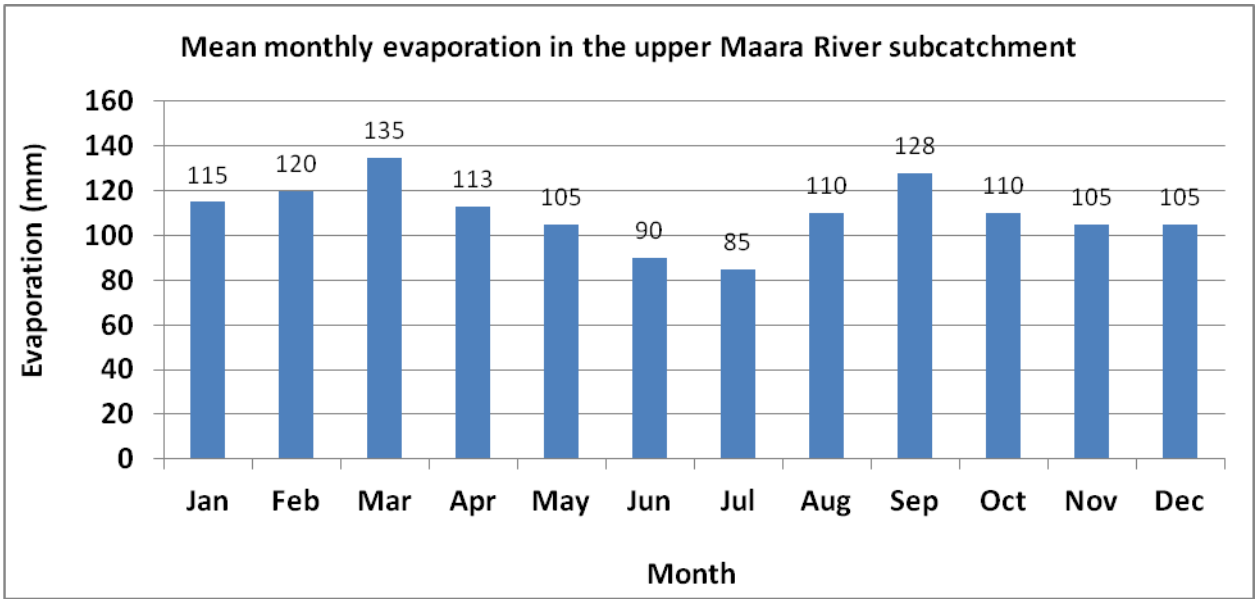

Figure 2.3: Mean monthly evaporation in the upper Maara River sub-catchment

2.3.6 Soils and Land Use

The soils of the South Maara River catchment can be classified into two broad classes, namely:

- Mountain slope soils in the upper reaches of Mt. Kenya. These soils are imperfectly drained, shallow to moderately deep, dark greyish brown, very friable, acid humic to peaty, loam to clay loam, with rock outcrops and ice in the highest parts
- Volcanic foot ridge soils bordering the mountain slope soils. These soils are well drained, extremely deep, dark reddish brown, friable and slightly smeary clay, with acid humic topsoil

The dam project area lies at the boundary of the mountain slope soils and the volcanic foot ridge soils. The land use is basically defined by the agro-climatic zone comprising, the forest zone, the tea/dairy zone, the coffee/ bananas zone, the maize zone, the cotton/ tobacco and livestock/ millet zones. The forest zone comprises the forests under the Mt. Kenya National Reserve, which includes the natural forests and forest plantations. The tea/dairy zone is adjacent to the forest zone and is mainly dominated by small-scale tea farms owned and managed by the local individuals. The Nyayo Tea

Zones- a Government Corporation – also manages a tea estate adjacent to the chogoria Forest Station.

2.3.7 Commercial and Industrial Demand

The commercial activity in the project area is dominated by small scale enterprises in trade and services, especially in the urban centers. These enterprises mainly consist of small shops offering a variety of goods and services for the general needs of the area and peri-urban inhabitants. It is assumed that the future increase in commercial activity is likely to be associated with the growth of population in the Sub-County.

The Project area does not have major industries apart from coffee pulping factories and one Tea factory. The commercial and industrial demand is estimated to be 6% of the overall domestic demand.

2.3.7 Irrigation Water Demand

The project area is within a highly productive agricultural area and it is safe to assume that each household will irrigate at least a quarter acre (0. 101 Ha) of land. Irrigation water will mainly be used to support rain fed agriculture. For average crops requiring an irrigation depth of 0.5litres per sec per hector, it would be safe to assume that the crop will require irrigation for half its maturing period hence 0.25 liters per sec per ha. This will translate to a demand of 2.18 M^3 of water per Household per Day. It has also been assumed that each household has 5 members

The above projections indicate that a mega dam of capacity 3 Million Cubic Meters will be required to meet 90-day storage. The dam under consideration is strategically located inside the forest where the water is relatively clean and this site should be used for domestic water supply as other sites are sought even outside the forest for irrigation purpose. It is therefore necessary to maximize on storage since this is the best site identified so far for this area.

2.3.8 Existing Water Supply Infrastructure

Water infrastructure is largely developed through small community water projects. Water projects emanate from different individual cells/villages groups within the project area who congregate and raise funds to develop their own infrastructure. Some of the water projects that have been developed within proximity and upstream of the proposed Kanjogu dam are as follows;

- Chogoria water project
- Murugi-Mugumango Water Society
- Muwiru water project
- Mwithanga Water project
- Mutindwa West-East Water project
- Chief Mbogori Girls' School Water Project
- Mutindwa farmers' Cooperative Water Project
- Kiroru Water Project
- Kithiru Water Project
- Rwanjege-Kieni Water Project
- Wiru Water Development Project
- Kioru Water Project
- Kiriani Water Project
- Kirigi Water Project

2.3.9 Farming systems

Farmers practice mixed subsistence farming. They grow many crops ranging from maize, beans, sweet potatoes, kales, and tomatoes by rain fed in the upper areas and by irrigation in the valley bottoms.

2.4 Hydrological Study Report for South Maara River

A hydrological Assessment study of South Maara River was carried out in May 2020 by John N Kinyanjui –a registered Hydrologist (report attached). The report indicates that the total annual flow was estimated at 230.8mm^3 with 218.9mm^3 (representing 95% of the total annual flow being the discharge above the normal flow threshold. The abstraction of 900,000 m^3 for storage will represent 6% of the annual flood flow as observed at Q50 threshold which is not expected to have significant impact on the flow of the stream and downstream users of the stream.

2.5 Proposed Kanjogu Dam Design

2.5.1 Design Criteria for the Kanjogu Earth Dam

The design of Kanjogu dam will ensure that a safe and economical structure is constructed. In this regard the following considerations shall be pertinent:

- The foundation, abutments and the embankment should be stable for all conditions of construction and operations
- Seepage through the embankment, foundation and abutment should not result in excess forces and piping of materials is not permitted
- The crest level of the dam must be high enough so as to prevent overtopping and to allow for settlement of embankment and foundation
- The spillways and outlet capacity should be adequately sized to prevent overtopping of the dam
- The slopes of spillway and outlet works must be stable under all operational conditions
- Various literature and experience from other designed dam structures shall be used to define the following dam geometry and the arrangement of available construction materials in the embankment

Some of the factors were considered in design of the proposed dam are as given below.

2.5.2 Physical Characteristics

i. Reservoir capacity and reliability:

The reservoir capacity shall be established from ground survey while the dam reliability shall be established from river flow models simulating different possible flows.

ii. The type of dam(s) possible:

Geotechnical survey established the various materials available on site and at what quantities. Foundation status at that site was also established. From these two investigations, the appropriate dam was established.

iii. Location and the dam wall alignment:

At the pre-investment stage, various locations were suggested and each location's merit has been examined and the best dam location and alignment has been established.

iv. Draw off works and other diversions:

The draw off works and other apartments were established from the volume of water which is possible to store at the current site conditions.

2.5.3 Geotechnical Information

Geotechnical investigation was done to establish the available material for construction both in quality and in quantity and from this the dam details shall be established after all stability checks are satisfied from analysis. The foundation properties of the site both in strength and permeability shall be established so that the size of the dam shall be estimated as well as the necessary foundation treatment to check seepage. This shall be confirmed by geological investigation on the pre-selected sites.

The seismic zone of the site shall establish the expected earthquakes in the area and give rise to the seismic loading necessary to ensure that the dam is safe as far as earthquake is concerned.

2.5.4 Homogeneous Dam Wall

The dam is designed ensuring that the overall structure is safe and economical. Hence the following has been taken into consideration:

- The foundation, abutments and the embankment are stable for all conditions of construction and operations;
- Seepage through the embankment, foundation and abutment should not result in excess forces and piping of materials is not permitted, the phreatic line should be contained within the embankment;
- The spillway and outlet capacity should be adequately sized to prevent overtopping of the dam; and

- The slopes of spillway and outlet works must be stable under all operational conditions

A crest width of 5m was adopted (minimum width of machine compacted embankment). The crest will be provided with 400mm thick murram surfacing with a cross fall of 4% to allow drainage.

Alignment:

The alignment has been selected based on the contour layout to give the shortest crest length and allow for the economical location of spillway route and outlet works. The crest elevation level of the dam is at 2535 masl and the top water level is at 2533 masl a crest length of 237m resulted.

Embankment Slopes

The proposed material resulted to upstream and downstream slopes of 1:3.0 and 1:2.5 respectively. These slopes have been used to determine embankment volumes.

Upstream slope protection:

Rock rip-rap, 1.0m thick has been provided to protect the upstream slope of the earth fill dam against destructive wave action. This is provided up to the lowest draw-off level. Below this, it is proposed to provide dumped rock. Both, rip-rap and dumped rock are to be laid on 1m thick gravel filter encased in a geo-clothe to prevent piping of the sandy silt material in the embankment.

Downstream Slope Protection:

It is proposed that grassing of downstream embankment slopes will be adequate to protect the slopes. However, at the toe, dumped rock will be provided to prevent piping of filter material. A toe drain is also provided to drain any runoff from the downstream face.

Embankment Volume:

The embankment volume was calculated from embankment sections done at 10m intervals. The embankment rises from a foundation level of 2517masl to 2535masl. The foundation level is 1m deep from the original ground level. From the ground level the embankment is expected to rise 15m. The embankment, spillway plan and the dam cross sections are as shown in the respective drawings.

Dam Construction Materials

Riprap:

The riprap zone 1m thick rock materials would be obtained from the rocks that would be excavated from the dam foundation and spillway areas. The grading of the riprap materials would be based on Ref USBR Table 6.9 or the rocks to be used for riprap should be as per the Kanjogu dam specifications.

Filter:

A horizontal drainage blanket is provided on the downstream side. Filter material should be made of the following specification:

- The D15 size of the filter should not be larger than 5 times the D85 size of the protected soil.
- Thus D15 of filter material/D85 of material ≤5
- The D15 size of the filter material should be at least 5 times the D15 of the protected soil, but it should not be greater than 40 times that size.
- Thus D15 of filter material/D15 of protected material = 5 to 40

- The gradation curve of the filter material should be roughly parallel to that of the protected material.
- If the protected soil contains a large percentage of gravels, the filter should be designed on the basis of the gradation curve of the portion of the protected soil which is finer than 25 mm size.
- The filter material should not contain more than 5% of fines passing 0.075 mm sieve. Moreover, the fines should be cohesion less
- The maximum size of the filter material should not be larger than 75 mm in order to minimize segregation and bridging action of large particles during placement of filter materials

Spillway Design Flood

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.

The catchment area was found to have no useful hydrological data and all information related to points outside the catchment area. The design flood was estimated from the calculated river flood flows and rainfall models relating to rainfall stations outside the catchment area.

The recorded Maara River flows were scaled down to the Kanjogu Dam catchment area and then modeled to suite. The river flows and the rainfall recorded over the years in the catchment was used to derive the probable maximum flood as shown under

hydrological findings. The hydrological studies indicated a pmf of 449m³/sec. For the design of the spillway Q500=126m3/sec has been used.

2.6 Project Activities

2.6.1 Construction Phase

The following activities will be undertaken during the construction phase of the dam:

- Land clearing
- Stripping of top soil
- Excavation of soil (both spoil and borrow material)
- Installation of Filter Blanket and Toe Drain
- Placement and compaction of borrow material
- Excavation of spillway
- Installation of draw off pipe (200mm uPVC Class E in concrete surround)
- Construction of a valve chamber (masonry chamber)
- Installation of water meter and gate valve
- Installation of water pump
- Fencing (Post and wire)
- Installation of staff gauge
- Provision of temporary access road

2.6.2 Operation Phase

There will not much activity in the operational phase apart from monitoring of the dam (water level and safety) and pumping of water. However, the operational phase requires a proper inspection and monitoring plan to mitigate possibility of dam failure.

2.6.3 Materials Inputs during Construction Phase

Various construction materials which meet the KEBS standards for the construction of the dam will be purchased locally.

- Soil- borrow material used in the construction on dam wall
- Stones-Riprap placed on the upstream face of the dam wall to protect it from erosion
- Cement -For the construction of chambers and concrete collars and sill
- Sand- Used as material for filter blanket and in construction of chambers and concrete collars and sill
- Ballast -Used as material for filter blanket and construction of sill
- Reinforcement steel bars – For construction of sill on the spillway
- UPVC Pipe– Used as pipeline for abstracting water from the dam

- Grass-Planted on the downstream phase of the dam to protect it from erosion

2.6.4 Equipment and Tools

The following equipment shall be used:

Table 2.5: Equipment/Machinery to be used

Equipment/Machinery	Function
Bulldozer	Site clearance, excavation, trimming
Excavator	Borrow excavation and loading of tippers
Dam scoops	Borrow excavation and placement
Tippers	Earth movement from borrow area to dam site
Graders	Leveling, trimming placed construction material
Sheep foot roller	Compaction of leveled material
Water Bowser	Applying water to material
Harrow	Turning material to ensure proper mixing with water
Mixer	Mixing concrete
Vibrator	Consolidate fresh concrete by releasing trapped air
Tractor	Water supply, compaction among other uses

3.0 PUBLIC CONSULTATIONS AND PARTICIPATION

3.1 Introduction

Public participation is an important and integral part of the EIA process. It is a requirement and a very important tool for collection of data and especially the baseline/background information. The goal and objective of public participation is to ensure adequate information is provided to all stakeholders in a clear and timely manner and to present sufficient opportunity to these groups to voice their concerns and opinion so that their views can be incorporated into the project design and development as well as augment overall benefits and avoiding potential conflicts.

Further it helps bring out the contentious issues and give a chance to those who may be affected by a proposed project to air their views and any significant issue is addressed at the initiation stage of the project.

TWWDA is committed to pro-active and on-going communication with all parties interested in the development of Kanjogu dam project. Toward this end; TWWDA organized and sponsored a filed mission to visit the site for the proposed dam site. The mission approved itinerary was 10th -21st February 2020. The dam site was visited and assessed jointly with TWWDA, Water Resource Authority (WRA), NEMA and Kenya Forest Services (KFS). The GPS coordinates of the proposed dam were picked and mapped to show the extent of the reservoir area. The proposed Kanjogu Dam reservoir will submerge 11.80 ha of forest land and will affect approximately 4150 stems of mixed indigenous trees as per the report of the mission.

A technical report with recommendations was prepared and presented to CCF for consideration and subsequent submission to the KFS board for consideration and determination. Among the recommendations was for TWWDA to undertake and ESIA for the proposed dam project and get an EIA license.

During our field inspections, we established that the project's stakeholders including individuals and groups had been actively engaged in the consultation process. Public consultations in relation to the ESIA occur at all stages, starting with inception and planning when the potential lands and alternative sites are being considered.

A participatory approach was adopted as an ongoing strategy throughout the entire project cycle. Public participation and consultations were done through individuals, groups and community meetings. Selection of ways to consult, and expand participation by community and other stakeholders took into consideration literacy levels prevalent in affected communities; ethnicity and cultural aspects and practical conditions (like distance). The role of political and cultural leaders including the community elders in the participation strategy was important.

3.2 Stakeholders

During the public consultations, multiple groups of stakeholders were consulted. The stakeholders were those who have an interest in the project development, and who will be involved in the further consultative process. The main groups of stakeholders are:

3.2.1 Directly Affected People

These are the people who reside in the neighborhood of the proposed Kanjogu dam or derive their livelihood from the affected land. Most of the directly affected people were informed and consulted on major issues concerning the proposed project, livelihood enhancement and income generation. These people benefit from water projects originating from South Maara River and were represented by water project leaders who gave their views to the ESIA team. Some of the water projects leaders interviewed include: - Chogoria water project

- Murugi-Mugumango Water Society
- Muwiru water project
- Mwithanga Water project
- Mutindwa West-East Water project
- Chief Mbogori Girls' School Water Project
- Mutindwa farmers' Cooperative Water Project

- Kiroru Water Project
- Kithiru Water Project
- Rwanjege-Kieni Water Project
- Wiru Water Development Project
- Kioru Water Project
- Kiriani Water Project
- Kirigi Water Project

Due to the COVID 19 epidemic, the ESIA team met with some of the water projects leaders and gave them detailed open ended public participation questionnaires which they filed and returned.

3.3.2 Key Issues raised by Leadership of Existing Water Project

The following is a summary of issues raised by the leadership of the some of the existing water project the ESIA team managed to meet:

3.3.2.1 Perceived Benefits of the Proposed Kanjogu Dam Project

- Job opportunities for the local people, especially the youth during the construction phase
- Improved water supplies to institutions, Irrigation project and other domestic water projects
- Potential enhanced pool market for the produce in the area, especially in regard to associated supplies to the dam operations and support services
- Improvement of transport in the area through the development of access road into the dam areas
- Create significant economic and social benefits to the communities and contribute to the attainment of the National priority goals and ongoing National efforts to accelerate economic growth and alleviate poverty
- Contribute to enhanced food security and improved nutrition at the household level
- Alleviate the negative impact of erratic and unreliable rainfall pattern on the community's productive resources

- Supplies of basic necessities to the workers will also lead to more employment opportunities and acquisition of entrepreneurial skills.
- Reduction of idleness particularly amongst the youth due to an increase in income generating activities
- Improve the standard of living of the community especially vulnerable beneficiaries
- Ease the direct resource dependency pressures on forest and forest resources
- Reduced poverty levels through increased incomes and improved livelihoods

3.3.2.2 Issues and Concerns

- The dam is intended to wind up/collapse the existing water projects to create only one
- Those downstream raised concerns that the dam may take too long to be filled up with water thus denying them access to the water for domestic and irrigation within the time before the dam is filled
- 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
- The water projects whose intakes are upwards of the dam site fear that the pipes that run downwards past the dam will be damaged
- Some water projects fear their intakes falls within the dam area and will be demolished
- The existing water projects pipes might be clogged with silt and other debris during the dam construction period
- The infrastructures of the existing water project might be damaged during the establishment of the dam
- Whether the dam water will be treated at the reservoir
- Damage of road infrastructure that is currently being developed during transportation and haulage of construction materials to project sites.
- Clearing of vegetation during construction phase

- The local were concerned about jobs for the locals during construction of the dam project

3.3.2.3 Mitigation measures

The ESIA team responded to the issues as follows:

- The dam is intended to collect flow flood during the rainy season, store it in the reservoir and release it to the river during the dry season to ensure constant water flow in river
- The filling of the dam is not expected to affect the downwards flow of the river as it will be from the flood flow
- The residents will be involved in the dam construction as they will be offered jobs i.e. the contractor will source for labor locally save for the specialized one
- Due care will be taken during the construction of the dam to ensure that existing water projects infrastructures including pipes from the intakes upwards of the dams are not damaged; in events they are damaged, they will be reinstalled to the original state or better
- The water stored in the reservoir will not be treated and will be released back to the river same state
- Due care will be taken by the contractor to minimize soil erosion to the river which may lead to clogging of existing water project pipes
- The contractor will maintain the road infrastructure leading to the project area
- Dust on these roads will be suppressed by continuous sprinkling of water
- Clearing of vegetation will be addressed through reforestation

3.2.2 Indirectly Affected Persons

This group of stakeholders includes all those who reside in areas neighboring the project area or are reliant on resources in the project area and will have no change or the project may not adjust their livelihood e.g. groups such as those residing downstream of the river.

3.2.3 Government Agencies and other Organizations

These included:

- Water Resources Authority (WRA)
- National Environment Management Authority (NEMA)
- Kenya Forestry Services
- Kenya Wildlife Services
- County Government of Tharaka Nithi
- Mara Sub County Offices

3.3. In-depth Discussions with key Informants

3.3.1 National Environment Management Authority

Discussions were held with the Tharaka County Director of Environment Mr. Joseph Kamau. He acknowledged leading a mult1-displinary team to the proposed dam site. He said each represented department/section prepared its findings and as such it was important for the team to visit each of those departments. He further cautioned the consultant that it was important to undertake a full study to be submitted to NEMA Headquarters since the dam is in a protected area.

3.3.2 Kenya Forest Services (KFS)

The ESIA team met the Tharaka Nithi County Ecosystem Conservator Mr. J M Mburu Tel. 0722888489 who affirmed that he was aware of the proposed Kanjogu Dam project. He further acknowledges of a multi-disciplinary visit of the project area organized by TWWDA and led by the Thataka Nithi County Director of Environment Mr. Joseph Kamau. In the team were Water Resource Authority Rep. Madam Jackline, Kenya Wildlife Rep. A report of the findings was compiled.

Mr Mburu informed the team that the position of the KFS on the dam can only be communicated by Mr. Omondi –Head of Water Shed Management at KFS head Office. However, he advised the team to meet Mr. Mwamba tel. 0721860272 at Chogoria Forest Station to get the water projects that draw water from the South Maara River as they will be affected by the proposed dam project.

The team met Mr. Mwamba who provided the water projects that draw water from South Maara River. The ESIA team agreed to visit and meet the executive committees of each of the water project to get their views since it was not possible to have public barazas due to the Covid- 19 pandemic.

3.3.3 Water Resources Authority (WRA)

WRA was among the organization which was in the mission that visited the dam site together with NEMA, KFS and TWWDA on 10th -21st February 2020 and so they are aware of the proposed dam project and will give their comments when called upon.

4.0 PROJECT ALTERNATIVES

4.1 Introduction

This chapter looks at the alternatives to the proposed project in terms of site, technology, design, scale and extent. The comparisons of these with the proposed project give rise to the best project option for adoption.

After the analysis of potential impacts and the identification of mitigation measures, analysis of options and alternative ways to meet the same objectives can be considered with an aim to identify the least damaging option. At this point, comparison of potential impacts and mitigation options can be made against a series of alternative designs, locations, technologies and operation so as to identify the most desirable combination. It is important that the objectives of the proposed project are clearly articulated otherwise the analysis of alternatives can digress into the consideration of irrelevant options.

For most water conservations structures, an analysis of alternatives should include the following considerations:

1. **Different location.** This issue is of particular importance where there are cultural or special habitats that should be protected, where a particular location might increase the likelihood of conflicts (e.g. over pasture or between domestic users and livestock/wildlife) or increase the likelihood of environmental degradation for example by attracting more livestock than the environment can sustain;
2. **Different design.** This might involve considerations of different ways of supplying water from the structure, ways to make the structure safer or to improve water quality, and ways to provide wider public benefit, etc.;
3. **Different way to meet same objective.** This might include a consideration of alternative sources, existing sources or additional infrastructure at existing sources. For example, improved water use efficiency through control of leaks, metered connections and tariffs, control of illegal connections can increase the supply without the need to develop a new source;

4. **No project.** This option essentially provides a basis of comparison with the proposed project and other alternatives. The no-project option is not necessarily a static situation as external factors such as demand for water, employment and livelihoods are dynamic.

4.2 The Proposed Alternative

This report has been prepared based on sound desktop and field studies made by the ESIA team. The findings and recommendations are based on the proposed site, materials and the proposed technologies to be used in implementation of the proposed project.

4.2.1 Project Location Alternatives

The current proposed dam site was arrived at after a number of water resources surveys and a topographical survey.

4.2.2 Analysis of Project Materials Alternatives

There are minimal options in terms of materials for the proposed project. While there are no alternatives to borrow material, filter blanket material, sill and inspection chamber, the draw off pipes can either be of HDPE, Galvanized Steel or UPVC. There is no benefit in replacing the pipe material with any of the alternatives.

4.2.3 The No Project Alternative

The no project alternative implies that the project is not implemented and the status quo is maintained. This would mean that the proponent abandons the planned expansions for which the dam is being constructed to support. This will also mean foregoing of the benefits that would have otherwise been gained by both the proponent and the community if the project is implemented.

While this option has the least or no effect on the environment, such an option would be most suitable in the event of probable extreme negative impacts which is not the case for the proposed project. This alternative therefore is not a viable alternative from a socio-economic and partly environmental perspective.

5: LEGAL, REGULATORY AND INSTITUTIONAL FRAMEWORK

5.1 Overview

The Constitution of Kenya is the supreme law of the republic and binds all persons and all state organs at all levels of government. The Constitution of Kenya, 2010 provides broad frame work regulating all existence and development aspects of interest to the people of Kenya, and along which all national and sectorial legislative documents are drawn.

In relation to the environment, article 42 of chapter four, the Bill of Rights, confers to every person the right to a clean and health environment, which includes the right to have the environment protected for the benefit of present and future generations through legislative measures, particularly those contemplated in article 69, and to have obligations relating to the environment fulfilled under Article 70.

Kenya is a signatory to various international agreements, conventions and treaties that have environmental implications/provisions and as such cannot be contravened during project development phases. In the past, the government had established a number of National policies and Legal Statutes to enhance environmental conservation and sustainable development. Some of the policy and legal provisions are briefly presented in the following sub- sections.

Before enactment of EMCA in 1999; Environmental conservation aspects and pollution control were scattered in the various sectoral pieces of legislation thus making coordination very difficult. However, since it is not possible to capture everything, it is recommended that the proponent acquire copies of the Acts, Regulations and Policy documents for completeness.

5.2 Environmental Management Principles and Guidelines

The project proponent is expected under law and set practice to consider and exercise the principles and guidelines of environmental management as follows:

5.2.1 Sustainability

In the course of implementing the proposed project, the project proponent is expected to use resources sustainably and source materials from suppliers that have been identified as practicing sustainable resources use, thereby maintaining the potential of the natural resources to meet the needs and aspirations of present and future generations.

5.2.2 Intergenerational Equity

Operations and activities undertaken at all the stages of the proposed project ought to be designed to comply with the principle of intergeneration equity in resources use of both natural and man-made resources. Additionally, various resource users in the current generation should not have their resource use ability compromised by the proposed project.

5.2.3 Prevention

The project proponent should undertake all the preventive and viable measures to protect the environment in the first place, throughout all the phases of the project (Construction, Operation and Decommissioning) rather than allow damage to take place then take remedial action. Prevention is far less costly than mitigating environmental damage.

5.2.4 Precaution

The project proponent should undertake all the necessary precaution in the making of environmental decisions where there is scientific uncertainty and such uncertainty should not be used as a reason for not taking cost effective measures to prevent environmental harm.

5.2.5 Polluter Pays Principle

Polluters of natural resources are required to bear the full environmental and social costs of their activities. Therefore, should the project proponent cause damage to private properties or public utilities such as roads or public goods such as water bodies, measures to compensate the affected should be instituted immediately.

5.2.6 Public Participation

The project proponent will ensure environmental democracy and involvement of the public, especially local communities in environmental and developmental decisions that it seeks to make, which affect their lives. The public participation process shall be open and transparent, provide valuable information on key impacts, potential mitigation measures and possible alternatives as well as enlightens the community on the opportunities and benefits that could arise from a project.

5.2.7 Cultural & Social Principal

Due consideration shall be made of the local environment management systems in the course of implementing the project and due care shall thus be exercised while introducing technologies that may conflict with the existing environmental management systems.

5.3 Multilateral Environmental Agreements (MEAs)

Kenya as a member of the international family of nations is a signatory to various MEAs whose aim is to ensure global environmental sustainability at national level. Under the old constitution of Kenya, the ratification of treaties was purely within the purview of the executive arm of government, which could determine whether to present a treaty to parliament for operationalization through Kenyan legislation.

In terms of article 2(6) of the Constitution of Kenya, 2010 as read together with section 12(1) of the 2012 Treaty Making and Ratification Act (No. 45 of 2012), Kenya remains a dualist jurisdiction whereby for treaties to take legal effect, it is mandatory for them to be approved both by Cabinet, and by Parliament.

The MEAs which Kenya has ratified and whose obligations are relevant for the construction and independent environmental monitoring of the proposed Kanjogu dam are as below: -

5.3.1 Convention on biological diversity (CBD Secretariat, 1992)

The CBD is also known as the "Omnibus Convention" or the "Convention for all life on the Earth" and is regarded as the over-arching biodiversity convention which deals with many critical issues including access and benefit sharing. Kenya signed the CBD on 11th June 1992 and ratified it on 26th July 1994.

5.3.2 Ramsar Convention (UN, 1971)

The objective of this Convention is to protect important habitats of water birds by controlling the encroachment and loss of wetlands and ensuring their wise use. Kenya signed the Ramsar Convention on 5th October 1990 and ratified it on 5th June 1991

5.3.3 World Heritage Convention (UN, 1972)

The objective of this Convention is to protect important habitats of water birds by controlling the encroachment and loss of wetlands and ensuring their wise use. Kenya signed the Ramsar Convention on 5th October 1990 and ratified it on 5th June 1991

5.3.4 Convention on Migratory Species – Bonn Convention (UN, 1979)

The objective of the convention is to establish an effective system of collective protection of the cultural, historical and natural heritage of outstanding universal value. Kenya signed the World Heritage Convention on 5th June 1991

5.3.5 United Nations Framework Convention on Climate Change, UNFCCC (UN, 1992)

The MEA was established in order to protect wild animals that migrate across national and trans-national boundaries, including migratory land and SESA animals. The aim of the Convention is to ensure that the traditional migration of wildlife through different

regions of the world is sustained through international collaboration. Kenya entered into the agreement of adopting the Convention on Migratory Species on 1st May 1999

5.3.6 Paris Agreement, 2015

An international agreement on climate change concluded under the UNFCCC governing global actions to address climate change, and creating obligations for developing countries through Nationally Determined Contributions (NDC) that specify national commitments to reduced GHG emissions through mitigation and adaptation actions supported by climate finance

5.3.7 United Nations Convention to Combat Desertification, UNCCD (UN, 1994)

The Convention specifically addresses the arid, semi-arid and dry sub-humid areas, known as the dry lands, where some of the most vulnerable ecosystems and peoples can be found. It aims at forging a global partnership to reverse and prevent desertification/land degradation and to mitigate the effects of drought in affected areas in order to support poverty reduction and environmental sustainability Kenya ratified the convention in June, 1997

5.3.8 East African Community (EAC) Protocol on Environment and Natural Resources, 1999, Amendment 2006 (EAC, 1999)

The role of the protocol, although not yet in force, is to govern the partner states in their cooperation in the management of environment and natural resources over areas within their jurisdiction including transboundary environment and natural resources. It is a protocol of general application which applies to all activities, matters and areas of management of the environment and natural resources of the Partner States

5.4 Policy Frameworks

5.4.1 Kenya Vision 2030

The Kenya Vision 2030 is the new county's development blueprint covering the period 2008 to 2030. It aims at making Kenya a newly leading industrializing middle income country providing high quality life for all its citizens by the year 2030. The vision has been developed through an all inclusive stakeholder consulative process, involving Kenyans from all parts of the country. The vision is based on three 'pillars' – Economical, Social and Political.

The environmental sector falls under the social pillar. The vision came after the successful implementation of the Economic Recovery Strategy for Wealth Creation which saw the country's economy back on the path to rapid growth since 2002 when the GDP was at 0.6% rising to 1% in 2006

The long-term success of achieving Vision 2030 targets will largely be dependent on ensuring that environmental management is addressed in medium term plans as an enabler for sustained pro-development rather than as an inhibitor to development. It is therefore critical that all constructions within the country take care of the environment and ensure environmental sustainability in order to help achieve this very important Millenium Development Goal amongst others.

5.4.2 National Environmental Action Plan (NEAP)

According to NEAP 1994, the government recognized the negative impacts on ecosystems emanating from development programmes that disregarded environmental sustainability. Established in 1990, the plan's effort was to integrate environmental considerations into the Country's Economic and Social Development. The integration process was to be achieved through a multi-sectoral approach to develop a comprehensive framework to ensure that environmental management and the conservation of natural resources are an integral part of societal decision-making. Under the NEAP process EIA was introduced.

5.4.3 National Policy on Water Resources Management & Development

It enhances a systematic development of water facilities in all sectors for the promotion of the country's socio-economic progress and recognizes the by-products of these processes as wastewater. It calls for development of appropriate sanitation systems to protect people's health and water resources from pollution.

5.4.4 Policy Guidelines on Environment and Development

Among the key objectives of the policy paper on Environment and Development (Sessional Paper No. 6 of 1999) are to ensure that from the onset, all development policies, programmes and projects take environmental considerations into account and to ensure that an EIA report is prepared for any industrial venture or any other development before implementation among others.

5.4.5 National Environmental Policy (2013)

The National Environmental Policy aims at integrating environmental aspects into national development plans and the broad objectives of policy include:

- Optimal use of natural land and water resources in improving the quality of human environment;
- Sustainable use of natural resources to meet the needs of the present generations while preserving their ability to meet the needs of future generations;
- Integration of environmental conservation and economic activities into the process of sustainable development;
- Meet national goals and international obligations by conserving bio-diversity, arresting desertification, mitigating effects of disasters, protecting the ozone layer and maintaining an ecological balance on earth

Various Acts and Regulations addressing environmental management seek to make provisions that enable the achievement of the National Environmental Policy objectives.

The project proponent will thus endeavour to observe the provisions of the various statutes that are aimed at maintaining a clean and healthy environment.

5.4.6 National Water Policy (2000)

The objective of the National Water Policy is to lay the foundation for the rational and efficient framework for meeting the water needs for national economic development, poverty alleviation, environmental protection and social well-being of the people through sustainable water resources development and management. The policy describes the guidelines that promote comprehensive water resources management and development with the private sector and community participation as the prime movers in the process to guarantee sustainability.

The policy underscores the threat of water resources due to degradation of water catchment areas affecting siltation; run-off, water balance and groundwater recharge characteristics. This has led to the diminishing or drying up of the water resources. The paper calls for preservation, conservation and development of national water resources for the benefit of all Kenyans. The policy stresses the need for developing options for mitigating negative impacts as well as enhancing positive ones through a careful analysis of the environment. This is aimed at improving the environment on which the water development sustenance depends.

The policy further states that the government will support initiatives aimed at development of appropriate water and sanitation facilities in the rural areas as a means of attracting viable economic activities and improving health. The proposed project is guided by this policy as it is in the rural area and aims at improving economic activities and thus ensures sustainable water resources use and environmental protection to protect the investment.

5.4.7 National Water Resources Management Strategy (NWRMS)-2012- 2017

The formulation of the NWRMS 2012-2017 was guided by the emergence of new developments in the water resources sub-sector through policy development brought about by the Constitution of Kenya 2010, the vision 2030, the Water Bill 2014, the National Rain Water Harvesting and Storage policy, the guidelines on the use of trans boundary water resources and the National Water Master Plan (NWMP) 2030.

The strategy was founded on major thematic areas in water resources management. These included data acquisition and management, water resource planning and allocation, adequate quantity and quality water resources, catchment protection and management, human resource development and management and financial resources mobilization and accountability.

Based on these thematic areas, strategic objectives were formulated and are identified as follows;

Strengthening monitoring networks to enhance data collection and improve information management system;

- Improving the use of water resources management tools for effective water resources planning and allocation;
- Strengthening stakeholder collaboration to enhance water storage and adaptation to climate change impacts;
- Strengthening enforcement mechanism and collaboration for effective catchment protection and conservation;
- Building staff capacity and improve work environment;
- Enhancing resource mobilization and effective use of finances;

The strategy recognizes the negative impact on water resources due to environmental changes and the continued demand for water services.

The Ministry of Water Sanitation and Irrigation has emphasized on storage development through which the National Water Harvesting and Storage Policy which provides a

framework for water harvesting including mandatory requirement to provide buildings with rainwater harvesting systems, has been developed.

The NWMP 2030 aims at progressively increasing availability of water resources through accurate assessment, optimal management and development of existing potentials. This entails enhancing water storage through designing additional large/medium and small-scale storage facilities as envisaged in Vision 2030. It also entails promoting rainwater harvesting and storage systems, re-establishing green water storage area such as wetlands and forests, water saving technologies, ground aquifer re-charging, recycling treated effluent water, and restoring and rehabilitating identified storage systems constructed since the colonial period.

5.4.8 The BIG 4 Government agendas- Food Security and Nutrition

To find a lasting solution to the multiple and inter-locking factors responsible for food insecurity and poor nutrition, the President committed to the following actions:

- ✓ Reduce targeted taxation to put idle arable land to use
- ✓ To continue to encourage and facilitate large-scale commercial agriculture to diversify the country's staples through irrigation and other technologies.
- ✓ To protect Kenya's water towers.
- ✓ Better extension services and market access for small-scale farmers.
- ✓ Subsidies to be redesigned to improve food yields and production quality
- ✓ To work with the private sector to deal with the challenges of distribution, waste, storage and value addition that hamper production.
- ✓ The Ministries of Agriculture and Irrigation to publish terms and conditions by which commercial farmers will be able to lease idle agricultural land owned by government, to raise production of strategic crops.

The proposed project is in line with this policy as it aims at promoting rainwater harvesting and increasing storage and it turn increasing availability of water resources which will be used for food production.

5.5 Institutional framework

5.5.1 Introduction

The Constitution of Kenya is the supreme law of the Republic and binds all persons and all state organs at all levels of government. It provides broad frame work regulating all existence and development aspects of interest to the people of Kenya, and along which all national and sectoral legislative documents are drawn.

In relation to the environment, article 42 of chapter four and the Bill of Rights confers to every person the right to a clean and health environment, which includes the right to have the environment protected for the benefit of present and future generations through legislative measures, particularly those contemplated in article 69, and to have obligations relating to the environment fulfilled under Article 70.

Environmental impact assessment is a tool for environmental conservation and has been identified as a key component in new project implementation. According to section 58 of the Environmental Management and Coordination Act (EMCA Cap 387), second schedule and Environmental (Impact Assessment and Audit) Regulation, 2003, both new and old projects must undergo Environmental Impact Assessment and Audits. The report of the same must be submitted to NEMA for review/approval and issuance of the relevant certificates/licenses. This was necessary as many forms of developmental activities cause damage to the environment and hence the greatest challenge today is to maintain sustainable development without interfering with the environment.

5.5.2 Environmental Problems in Kenya

There are many environmental problems and challenges in Kenya today. Among the cardinal environmental problems include: loss of biodiversity, land degradation, water management and environmental pollution. This has been aggravated by lack of awareness and inadequate information amongst the public on the consequences of their interaction with the environment. In addition, there is limited local communities' involvement in participatory planning and management of environmental and natural resources.

Recognizing the importance of natural resources and the environment in general, the Kenyan Government has put in place wide range of policy, institutional and legislative framework to address the major causes of environmental degradation and negative impacts on ecosystem emanating from industrial and economic development programmes.

Two major institutions are in place for purpose of administration of the Environmental, namely, National Environmental Council (NEC) and National Environmental Management Authority (NEMA).

5.5.3 National Environmental Council (NEC)

This is a body that is made up of members charged with the duty of natural resource management and conservation with members drawn from all the relevant ministries as well as a broad range of other stakeholders. The functions of the council are to formulate national policies, goals, and objectives and determination of policies and priorities for the environmental protection. The council also promotes co-operation among all the players engaged in environmental protection programmes.

5.5.4 National Environmental Management Authority (NEMA).

NEMA is the organization responsible for the administration of the environmental act. Among the functions of NEMA include;

- Co-ordination of various environmental management activities
- Initiation of legislative proposals and submission of such proposals to Attorney General
- Research, investigate and carry out surveys in the fields of environment
- Enhance environmental education and awareness on the need of sound environmental management
- Advice the government on regional and international agreements to which the country should be a party and issue an annual report on the state of environment
- Charged with the responsibility of the execution of EIA and EA

5.6 Environmental Legal Framework

In 1999, the Government of Kenya provided a bill for the establishment of an appropriate legal and institutional framework for the management and protection of the environment. The same was enacted into law as the Environmental Management and Co-ordination Act (EMCA), 1999 and received the presidential assent on 6th January 2000.

Other key national laws governing the management of environmental resources in the country are as outlined.

5.6.1 Environmental Management and Co-ordination Act (EMCA Cap 387)

Part II of Environment Management and Co-ordination Act, 1999 states that every person in Kenya is entitled to clean and healthy environment and has duty to safeguard the same. To ensure this is achieved EIA/EAs are prepared to very existing and new projects as already stated above. The second schedule of the Act proposes that urban development activities are among the facilities to undergo EIA.

Although there are other sectorial laws on environment, this is the supreme Act and it is the Act that established NEMA

5.6.2 Environment (Impact Assessment & Audit) (amended) Regulations, 2019

The regulations were gazetted in June 2003 but amended vide legal notice no 31 by the cabinet secretary in charge of Environment in April empowered under section 147 of EMCA. These regulations provide the framework for carrying out EIAs and EAs in Kenya by NEMA licensed Lead Experts or Firm of Experts. ***The proponent has initiated the writing of this Environmental Impact Assessment project report***

5.6.3 Environmental Management and Co-ordination (Water Quality) Regulations, 2006

These Regulations applies to drinking water, water used for industrial purposes, water used for agricultural purposes, water used for recreational purposes, water used for fisheries and wildlife, and water used for any other purposes

The regulation is very clear on the discharge of effluent to the environment. It states that "Every person who generates and discharges effluent into the environment under a licence issued under the act shall carry out effluent discharge quality and quantity monitoring in accordance with methods and procedures of sampling and analysis prescribed by the Authority, and shall submit quarterly records of such monitoring to the Authority or its designated representative."

Article 19 of the regulation is very explicit on the use of wastewater for Irrigation. It states, "No person shall be permitted to use wastewater for irrigation purposes unless such water complies with the quality guidelines set out under the Eighth Schedule to these Regulations".

5.6.4 Environmental Management and Co-ordination, (Waste Management) Regulations, 2006

This regulation defines the responsibilities of waste generators and the duties and requirements for transportation and disposal of wastes. It states that "no person shall dispose of any waste on a public highway, street, road, recreation area or in any public place except in a designated receptacle and a waste generator shall collect, segregate and dispose such waste in the manner provided for under these regulations". It provides for mitigation of pollution and provides for hazardous and toxic wastes.

Responsibilities of a waste generator

No person shall dispose of any waste on a public highway, street, road, recreational area or in any public place except in a designated waste receptacle.

Any person whose activities generate waste shall collect, segregate and dispose or cause to be disposed of such waste in the manner provided for under these Regulations.

Without prejudice to the foregoing, any person whose activities generates waste has an obligation to ensure that such waste is transferred to a person who is licensed to transport and dispose of.

Cleaner Production Principles

Any person who owns or controls a facility or premises which generates waste shall minimize the waste generated by adopting the following cleaner production principles:

Improvement of production process through: -

Conserving raw materials and energy

Eliminating the use of toxic raw materials within such time as may be prescribed by the Authority

Reducing toxic emissions and wastes monitoring the product cycle from beginning to end by: -

- Identifying and eliminating potential negative impacts of the product.
- Enabling the recovery and re-use of the product where possible.
- Reclamation and recycling.
- Incorporating environmental concerns in the design, process and disposal of a product.

5.6.5 Environmental Management and Coordination Act (Noise and Excessive Vibration Pollution) (Control) Regulations 2009

The Act is conferred by section 147 of EMCA 1999. Part II section (5) states that "no person shall make, continue or cause to be made or continued any noise in excess of the noise levels set in the First Schedule, unless it's necessary to the preservation of life, health, safety or property". Section (6) (1and 2) ensures that no person shall cause noise from any source which exceeds any sound level as set out in the regulations and measurements shall be taken by the relevant lead agency.

Sub section (5) states that "any person who makes noise more than the prescribed levels commits an offence". Section 7 (a-d) exempts noise emitted during alerting, performance or noise in connection with the protection of the health and safety of residents or their property during emergency conditions and or warning devices necessary for the protection of public safety.

5.6.6 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 that Local Authorities take all lawful, necessary and reasonably practicable measures to maintain their jurisdiction and sanitary clean to prevent occurrence of nuisance or condition liable to be injurious or dangerous to human health.

Such nuisance or conditions are defined under section 118 as waste pipes, sewers, drainers or refuse pits in such state, situated or constructed as in the opinion of the medical officer of health to be offensive or injurious to health. Any noxious matter or waste water flowing or discharged from any premises into the public area in general or into the gutter or side channel or watercourse, irrigation channel, or bed not approved for discharge is also deemed as nuisance. Other nuisances are accumulation of materials or refuse which in the opinion of the medical officer of health is likely to harbour rats or other vermin.

On responsibility of the Local Authorities Part XI, section 129, of the Act states in part "It shall be the duty of every local authority to take all lawful, necessary and reasonably practicable measures for preventing any pollution dangerous to health of any supply of water which the public within its district has a right to use and does use for drinking or domestic purposes….".

Section 130 provides for making and imposing regulations by the local authorities and others the duty of enforcing rules in respect of prohibiting use of water supply or

erection of structures draining filth or noxious matter into water supply as mentioned in section 129. This provision is supplemented by section 126A that requires local authorities to develop by-laws for controlling and regulating among others private sewers, communication between drains and sewers and between sewers as well as regulating sanitary conveniences in connection to buildings, drainage, cesspools, etc. for reception or disposal of foul matter.

Part XII, Section 136, states that all collections of water, sewage, rubbish, refuse and other fluids which permits or facilitates the breeding or multiplication of pests shall be deemed nuisances and are liable to be dealt with in the matter provided by this Act.

5.6.7 The Chiefs' Authority Act CAP 128

The Act in Section 10 States that any chief may from time to time issue orders to be obeyed by the persons residing or being within the local limits of his jurisdiction for any of the following purposes;

- Preventing the pollution of the water in any stream, watercourse or water-hole and preventing the obstruction of any stream or watercourse
- Regulating the cutting of timber and prohibiting the wasteful destruction of trees
- Preventing the spread of diseases, whether of human being or animals
- Prohibiting any act or thing that may cause damage to any public road or to any work constructed or maintained for the benefit of the community

5.6.8 Water Act, 2016

This is an act of parliament whose purpose is to provide for the regulation, management and development of water resources and sewerage services and other connected purposes in line with the Constitution.

Article 63 of the acts states that every person in Kenya has a right to clean and safe water in adequate quantities and to reasonable standards of sanitation as stipulated in article 43 of the constitution.

The act also establishes a Water Services Regulatory Board (WSRB) whose principle objective is to protect interests and rights of consumers in the provision of water services.

Section 108 of the act states that; It shall be the duty of a licensee receiving trade effluent into its sewerage system to ensure that it has in place measures for the receipt and handling of the effluent without causing; pollution of the environment, Harm to human health, damage to the sewerage system or Contravention of applicable laws or standards set by the Regulatory Board.

Further, a person shall not discharge any trade effluent from any trade premises into the sewers of a licensee without the consent of the licensee.

An application for consent shall be made to the licensee and shall state among other things; the nature or composition of the trade effluent, the maximum quantity of the effluent which it proposes to discharge on any one day, the highest rate at which it is proposed to discharge the effluent and any other information required by the licensee.

The licensee's consent may be given subject to conditions, including conditions requiring pre-treatment and payments to the licensee of charges for the discharge.

Any person who is dissatisfied with the decision of the licensee on an application under this section may within thirty days of the decision, appeal to the Regulatory Board.

A person who contravenes the provisions of this section commits an offence.

In this section of the act, "trade effluent" means any liquid, whether with or without suspended particles, produced as a by-product in the course of any trade or industry.

5.6.9 The Water Resources Authority (WRA)

The Water Act, 2016 established the Water Resources Authority (WRA) whose functions, among others are to:

- Formulate and enforce standards, procedures and Regulations for the management and use of water resources and flood mitigation

- Regulate the management and use of water resources as well as enforce the regulations
- Issue water permits for water abstraction, water use and recharge and enforce the conditions of those permits
- determine and set permit and water use fees and collect water permit fees and water use charges
- provide information and advice for formulation of policy on national water resource management, water storage and flood control strategies

Application for authorization to construct works for purposes of impounding water (storage) is submitted to WRA. WRA then reviews the application and issue a permit to construct works.

5.6.10 Water Resources Management Rules, 2007

Part I section 56 all through to section 58 provides specific guidance with regard to dams. Section 56 provides criteria for dam classification which is presented in the Fourth Schedule whiles section 57 states that dam shall be designed and supervised by appropriate category of qualified water resource professional. Section 58 states that a dam shall be constructed by the appropriate category of contractor. Section 59 (1) requires that the dam owner ensures that the dam is inspected according to criteria provided in the Fourth Schedule and the inspection report prepared and submitted to the Authority.

Design guidelines for net freeboard and return period for design of dam spillway respectively provided in Part I section 60 and 61. Part VII Section 97 of the Rules states that the Authority shall, where applicable require an applicant to show evidence of compliance with the provisions of the EMCA. Section 99 states the need for controlling and measuring devices for accurate measurement of the water abstracted.

As per WRA Rules, 2007 Part VIII section 104, the Authority shall be paid for water abstracted by any person in possession of a valid water permit or supposed to have a

valid water permit. The fees requirement for assessment and issuance of permits per water use category is provided in the first schedule part 2.

WRA Rules, 2007 Part XII of the gives the reserve –related to quantity and its probability and quality of the resource. Section 128 subsection 2 states that establishing reserve shall be guided by:

- Ecological vulnerability
- Vulnerability of population dependent on the water resource
- Local observations with respect to the naturalized flows or water levels of the minimum values observed during periods of prolonged drought
- Where water flow is known to be normally perennial, then the reserve quantity shall be sufficient to ensure perennial flow; and
- Consultations with the Water Resources Users Association where it exists

5.6.11 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. 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 put 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.

5.6.12 Climate Change Act, 2016

This Act requires that no entity or a person who willingly, unwillingly, knowing or not knowing shall undertake any project which is likely to bring about adverse changes in the environment and likely to affect the climate negatively.

6.0 ENVIRONMENTAL IMPACTS & PROPOSED MITIGATION MEASURES

6.1 Preview

Construction of the dam will generate both positive and negative social, economic and environmental impacts. This report makes proposals for monitoring and management of social and environmental impacts during the life cycle of the project. During construction, the main responsibility for the incorporation and monitoring of mitigation measures lies with the proponent Clerk of Works (COW) and the contractor.

Some of the positive impacts of the proposed dam project include but not limited to:-

- **Creation of Employment opportunities for residents of the project area**

The proposed project will provide short term and long term employment opportunities to the local community. Skilled, Semi-skilled, unskilled laborers and formal employees are expected to obtain gainful employment during the construction phase. With labor intensive construction technologies, the project will provide employment for youths and provide support to the Government of Kenya initiatives on creation of jobs. The creation of employment opportunities is beneficial both from the economic and social point of view. Economically, it means the workers will be paid for work they are engaged to do abundant thus boasting them.

Socially these people will be engaged in productive employment and minimize social ills like alcohol abuse which is rampant in the project area.

- **Injection of Money into the Local Economy**

The project will contribute to the National kitty. The contractor will pay taxes on purchasing materials for the project. Construction workers will also pay income tax from their earnings while working on the project. A large sum of the project money shall be released into the local economy due to the construction activities. This money will inform of payments for skilled and unskilled labor; Purchases of construction materials; payments for local provisions such as fuels, foods and accommodation.

- **Creation of Market for Construction Materials**

The project will require materials, some of which will be sourced locally within the project area. Some of this includes sand, hard-core and soft stones for the construction of lining of the dam, minor road repairs, crossing and construction of the intake weir and basin.

6.2 Physical/Cultural Chance Find Procedures

Chance finds procedures are an integral part of the project ESMP and civil works contracts. 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 and follow the below procedure: - 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); the responsible local authorities and 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 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

6.3 Possible Negative Impacts during Construction Phase of Kanjogu dam

6.3.1 Air Quality

During the establishment of the proposed Kanjogu dam project, there will be increased gas emissions from the machinery and Lorries ferrying construction materials to the site. Some of the hazardous exhaust fumes released by the lorries/trucks include carbon oxides (COx), Sulphur Oxides (SOx) and Nitrogen Oxides (NOx). Dust i.e. sand and soil particles will be caused by construction works and vehicle movement during transportation of materials to the construction site. Such dust and gases have direct negative impact on the air quality.

Mitigation Measures

- Construction materials shall be obtained from NEMA compliant quarries
- Material transporting trucks/machinery shall be well maintained with minimal exhaust fumes
- Supply and construction vehicles will only use the designated transport routes
- Drivers will also be advised to stick to prescribed speed limits
- Sensitize truck drivers to avoid unnecessary revving and hooting of vehicles at loading /offloading and parking areas
- Ensure appropriate vehicle speeds in road sections that will be used by construction vehicles on a needs basis to eliminate the creation of dusts
- Ensure proper repair and maintenance of vehicles and equipment to minimize exhaust fumes
- Provide Personal Protective Equipment (PPE) to the workers

- Sensitized workers on health hazards encountered in such work environment and encouraged to go for regular health check ups
- Sprinkle water on earth roads to maintain dust to the low minimum at all times

6.3.2 Noise Pollution

Noise is any loud unreasonable or unusual sound that annoys, disturbs, injures or endangers the comfort, health or safety of others and the environment. Excess noise is dangerous to workers, neighbours and passers-by. Sources of noise include; Mechanical earth working excavators, manual compressed air excavators and hand tools, vehicles delivering construction materials and workers at the site.

Mitigation Measures

- Maintain the levels of noise pollution from the machinery in accordance to the manufacturer's specification
- Workers shall be provided with PPE/materials such as earmuffs and earplugs when operating noisy machinery and when in a noisy environment
- Drivers/operators shall be sensitized to switch off vehicles and machinery engines when not in use
- Drivers shall avoid unnecessary hooting and revving of vehicles
- Transport vehicles shall be well maintained with minimum noise
- Have only the essential workers at any construction site
- Construction works to be done during day time only
- Use machines that are less vibrating and those that are well serviced to prevent excessive vibration
- Where vibration due to compacting is very high, we propose the compaction to be done during the day

6.3.3 Destruction of Indigenous Vegetation, Loss of Soils & Habitats

During excavation of the dam it will be inevitable to avoid destruction of any existing indigenous vegetation at the proposed sites. Therefore, it will be important to formulate ways of mitigating the impacts caused at the end of construction phase. The site is

within the forest where different species of flora is found. Lower class animals and variety of insects family are common and will inevitably be affected during the construction stage of the dam. Clearing of vegetation during the construction and excavation works for the dam could also result in an increase in runoff along the line and thus encourage erosion. Soil will accumulate and may pose significant negative environmental effects. If left unattended over a long period, the soil may be swept into the nearby rivers resulting in excessive flooding and silting during the rainy seasons.

Mitigation Measures

- Avoid as much as possible destruction of indigenous tree during construction activities
- Replace/ plant vegetation cover and trees soon after completion of the dam
- Encourage growth of indigenous tree nurseries for increasing vegetative cover and replacing those destroyed during project implementation activities
- Restrict clearing to immediate requirements i.e. minimize unnecessary clearing
- Restrict clearing for fuel wood
- Stock pile soil for re-use
- Re-vegetate site after construction wherever possible (borrow areas, riparian area, etc.) using adequate stockpiled top soil
- Rare flora species to be identified and relocated'
- Ensure reserve flow
- Incorporating soil conservation measures during construction to mitigate damage caused by erosion
- Only the areas to be utilized will be excavated
- Carry out inspection of each of the sites soil stability before excavation
- Transportation of construction materials is done through the existing local roads
- The construction work-force will be sensitized on the importance of environmental conservation and ecological protection to prevent the

exploitation of natural resources around the project area and destruction of ecosystems

- On completion of the construction work, the project areas will be allowed to re-vegetate with fibrous rooted vegetation species

6.3.4 Water Quality

The overall potential impact of the project will be improvement of water supply for the community in the project area. This is a major positive move that will also have negative impacts associated with implementation activities. The disturbance of soil by excavation for the dam will make it loose and can easily be eroded and transported into the nearby rivers and streams, thereby negatively affecting the water quality.

While it is expected that this will be mitigated effectively during implementation, if not properly managed, silting could also cause significant rise in the water level of the rivers and streams in the project area with ultimate flooding downstream.

Mitigation Measures

- Provide adequate provision for aeration of releases within the project design
- Provide proper containerized storage of fuels, lubricants and chemicals
- Create vegetated buffer within riparian area

6.3.5 Occupational Health and Safety (OHS)

During the proposed construction of the dam and other facilities associated with the project, there will be increased dust, noise, air pollution as well as possibility of accidents within and around the project site. The workforce, neighbours and passers-by will be subjected to these environmental hazards and disturbances.

Food for the workforce at the construction sites will probably be provided by mobile individuals. Accidents may occur by slipping into the dug trenches or stumbling into heaps of trenched out materials within the dam area.

Mitigation Measures

- Pre warn the residents of the possible accidents
- Erect an appropriate project signboard as directed by the proponent
- Erect appropriate safety signage along the construction route cautioning against various health and safety risks and prescribing particular mandatory actions
- Fence the construction site to prevent neighbours and passers-by from trespassing and exposing them to health hazards
- A fully equipped First Aid Kit shall be provided at the construction site always and manned by trained/qualified persons
- Depending on OHS hazards anticipated while performing assigned jobs/task(s), workers may require proper fitting PPE to avoid injuries and illnesses.
- Provided workers with protective gear which should include working boots, overalls, helmets, goggles, earmuffs, dust masks, and gloves among others
- All workers will be required to produce their National identification cards, NHIF and NSSF registration numbers
- Child labour will not be used in project
- Persons providing food for workers at the site must have the necessary public health licenses
- Warning tapes should be put along the trench line to alert pedestrians on the dangers
- Construction workers will be sensitized on effects of negative anti- social behaviour and their consequences
- Workers shall be provided with emergency telephone numbers to request for assistance in case of an accident
- In case of an accident, the injured person should be given first aid and immediately taken to the nearby hospital
- An investigation should be initiated immediately to ascertain the cause of the accident and preliminary findings released within 12 hours

- The contractor shall have Workman Compensation Insurance Cover for the workers which should comply with Workman's Compensation Act as well as all Ordinances, Regulations and Union Agreements
- A comprehensive HIV/AIDs sensitization programme will be formulated to create awareness among construction workers and local community. The programme will be supported by a qualified community health practitioner who will also offer testing and counselling services. Information fliers and protection devices will also be made freely available during the construction phase

6.3.6 Increased Human Activities

The construction activities of the dam and other infrastructures associated with the project will have an increase in human activities around the area. There are people who will be actively involved in construction activities while others will be idlers. As a result, this increase in human activities will lead to an increase in accidental risk to the people and generation of wastes.

Mitigation Measures

- Warning tapes shall be put along the trench line to alert people of the dangers
- Ascertain that only the vital workers are hired at different stages of establishment
- Restrict the entrance to the site
- Ensure that there is a work breakdown structure in place for each phase
- Each phase will take the minimum time possible
- Ascertain that there is proper waste disposal management

6.3.7 Soil and Other Solid Waste

During dam construction, soils and other solid waste including; wasted mortar, ballast, cement and other packaging materials, sand, metals, plastics and parts of PVC pipes, and garbage will be generated. These wastes generated during construction may impact negatively on the environment if not properly handled and managed.

Mitigation Measures

- The proponent shall work hand in hand with the County Government of Tharaka Nithi to facilitate sound waste management
- All the solid waste generated during construction activities should be collected and sorted into non-recyclable and recyclable
- Hardcore materials could be re-used on site for construction and filling the voids along the road
- Provision of bins, one for bio-degradable and another for non-degradable matters.
- These bins shall be of appropriate type, size and color for effective waste separation and disposal
- Train/educate all stakeholders involved in the proposed project on the importance and means of waste management and handling especially during establishment and operational phases

6.3.8 Oil Leaks and Spills

Oil leaks and spills are common in construction sites resulting from construction machinery and material transporting trucks. These oils and greases are of petroleum products which contain hard/hazardous elements that are detrimental to the environment

Mitigation Measures

- Use of well serviced machinery with minimal or no grease/oil leakages
- Maintenance of trucks and machinery shall be carried out in designated areas i.e. petrol stations, owners' service yards and garages where oils/greases are completely restrained from reaching the ground and not at the site
- Fuel products should be keep far away from water sources

6.3.10 Fire Outbreaks

Fire outbreak in the construction camp or in the machinery being used is always a risk. This is because there are flammable substances in use. Depending on the severity, fire can cause loss of life, disability or property damage. Thus precautions are necessary.

Mitigation Measures

- Label all inflammable materials and store them appropriately
- Provision of adequate firefighting equipment capable of fighting all classes of fire
- Put — NO SMOKING Signs in areas where flammable substance are stored
- Train workers on the use of firefighting equipment
- Display a list of emergency contact numbers prominently
- Prohibit cooking on site
- Provide a fire assembly point in the contractor's camp

6.3.11 Contractor's Camp Sanitation

Improper handling of human wastes at the camp can have far reaching health implications on the workers and the host population. This is an impact that can be experienced far from the camp site.

Mitigation measures:

- Provision shall be made for employee facilities including shelter, toilets and washing facilities
- Toilet facilities supplied by the contractor for the workers shall occur at a minimum ratio of 1 toilet per 15 workers
- The exact location of the toilets shall be approved by the Public Health Department prior to establishment
- Sanitation facilities shall be located within 100m from any point of work, but not closer than 50 m to any water body
- All temporary/portable toilets shall be secured to the ground to prevent them toppling due to wind or any other cause
- The contractor shall ensure that the entrances to toilets are adequately screened from public view

- Only approved portable toilets should be used
- These facilities shall be maintained in a hygienic state and serviced regularly. Toilet paper shall be provided
- The contractor shall ensure that no spillage occurs when the toilets are cleaned or emptied and that the contents are removed from site to an approved disposal site
- Discharge of waste from toilets into the environment and burying of waste is strictly prohibited
- Wash areas shall be placed and constructed in such a manner so as to ensure that the surrounding areas, which include groundwater, are not polluted
- The contractor should develop campsite environmental management plan

6.3.12 Security and Social Unrest

The security of people around should not be taken for granted. The camp sites might act as a hideout for criminals when construction workers are in, while stored construction materials might attract people with evil motives.

Social unrest emerges mainly due to:

- Acts of omission or commission by project Proponent or Contractor for example delay in honoring agreements.
- Employment opportunities.
- Misunderstanding amongst stakeholders

Mitigation Measures

- The material storage site shall be properly fenced
- All workers will be vetted to ascertain that they are of good character
- Guards will be hired to safeguard the site and materials round the clock
- The guards shall document and report any suspect movements within and around the site
- Idlers shall not be allowed within the project site
- Maintain open communication with local community
- Provide inclusive structure for community participation

- Set out clear labor policies that favor local employment where possible
- Ensure compliance with labor laws
- Notify downstream water users, WRA and WRUA of likely changes in water quality and reliability
- Immediate action undertaken as soon as possible and within 24 hours of receipt of a complaint
- Investigations completed within seven days of receipt of complaint
- All corrective actions implemented by due date
- All incidents or complaints about either environmental or social issues will be
- managed in accordance to the existing procedure in line with the legal framework
- All incidents and complaints will be recorded in the contractors incident reporting system
- Additional environmental awareness training of the workforce with respect to
- procedures to be followed for environmental incidents or complaints
- Sensitize workforce on cultural sensitivities
- Employ a community liaison officer

6.3.13 Emergency Response Plans (ERP)

Emergencies and disasters are a reality of everyday life. Workers/people must therefore be sensitised and prepared on how to react to either emergencies or disasters during the establishment and operational phases. Absence of such plans may be risky since there would be no guidelines on how to handle or control emergencies if they occur.

Mitigation Measures

- The contractor/proponent shall initiate and develop effective ERP to cater for various eventualities such as fire outbreaks, and other accidents/incidents that are likely to occur
- ERP must be properly documented and made available to all
- Regular drills shall be conducted on possible incidences

6.4 Possible Impacts during Operational Phase

6.4.1 Water Use Related Conflicts

Water will be the main factor during the operation of the dam/water pan. Opening the project after completion will create additional demand for water within the area.

Uneven distribution of water between the beneficiaries may result in water use conflicts. This scenario will arise when some farmers in the upper section of the project will over-abstract the water and minimize the water availability to the downstream users.

Water abstraction from any water body in Kenya, is guided by WRA. The authority outlines the quantity of water abstracted by any user while WRUAs solves any conflict of water use in any river in that catchment.

Too much abstraction of water from the river South Maara could result in conflicts between the upstream and downstream users. This will be a one of the worst case scenarios that could result to the withdrawal of the water abstraction permit for Kanjogu dam by Water Resources Authority (WRA).

Mitigation Measures

- Water Users Association (WUA) will be formed to guide the use of the water in the irrigation fields.

The WUA will assist in the following:

- Formation of the committee who will be required to form strict by-laws that will guide on water usage and conflict resolution in the project
- Conduct farmers training on best irrigation practices that aim at efficient water use
- Install a water meter at the intake and at household levels in order to control water usage and form a basis of rationing
- Strictly enforce the Water Act 2016, in order to guide on water usage for the benefit of all stakeholders

6.4.2 Dam Operation and Maintenance

The following aspects should be monitored to ensure the safe and sustainable operation of the dam. Routine checks should be carried out monthly during the initial year of operation and then according to a fixed schedule in future years.

Mitigation Measures

a. Embankment

- Monitor the crest to ensure that the edges do not erode and the crest width does not deteriorate. If required, additional material should be placed on the crest and a good grass cover maintained
- Monitor the crest and slopes for cracks. The location, alignment and depth of crack should be reported and cracks should be in-filled by compacting similar soil into the cracks
- Resurvey the crest every 5 years to check for slumping and low spots
- Maintain the downstream slope with a thick grass cover.
- Give attention to spots were vegetation does not take off, these areas should be dressed with top soil and planted with grass starters
- Check the up-stream face for signs of wave or wind erosion
- Any erosion of the slope should be addressed by improving the rip rap cover
- Trees and bushes should NOT be allowed to grow on the embankment
- Monitor the embankment for burrowing animals; in the event they are found they should be removed and their burrows excavated and back filled with compacted material
- Monitor the downstream slope for seepage or leaks. Wet patches, excessive vegetation growth in one patch, depressions or slumping should be noted and reported
- Monitor the normal seepage flows
- The outflow from the filter/seepage blanket should be monitored and the discharge recorded

- Record the water levels and at the same time as measure the filter blanket discharge

b. Spillway

- Maintain the spillway in good condition and repair it immediately if required
- Trees and bushes should NOT be allowed to grow in the spillway channel
- Monitor the spillway channel for signs of erosion; any areas that are eroded should be treated by grassing the channel or construction of a concrete sill
- Ensure the spillway channel is free of debris

6.4.3 Water Logging and Soil Salinity

Water-logging and salinization of soils are common problems associated with irrigation. Water-logging results primarily from inadequate drainage and over-irrigation and to a lesser extent from seepage from canals and ditches. It concentrates salts drawn up from lower in the soil profile in the plants' rooting zone. Alkalization which is the build-up of sodium in soils is a particularly detrimental form of salinization which is difficult to rectify. On irrigated land, salinization and alter of soil structure are the major cause of loss of land productivity which is one of the most prolific adverse environmental impacts associated with irrigation.

During the operation of the dam to serve irrigation projects it is expected that soil erosion might occur from the tilled land (agriculturally induced erosion), the canals, dykes, drains etc. The method of irrigation profoundly affects the vulnerability of the land to erosion. Because irrigated land is wetter, it is less able to absorb rainfall and runoff will therefore be higher.

Mitigation Measures

- Regular soil test which will help ensure the soils are not destroyed in the long
- Proper choice of the irrigation method
- Strictly follow irrigation schedule to prevent an increase in the irrigation hours in one section

6.4.4 Increase in Waterborne Diseases

The dam is expected to improve the water supplied for domestic use and to the irrigation systems. Once the irrigation water is supplied to the farms, most households will use the same as drinking water and for domestic use without any treatment. This would increase the chances of contracting waterborne diseases such as typhoid and cholera. There will be increased chances of stagnating water in the farmers and thus attracting the breeding of mosquitoes, which will be responsible for the spread of malaria leading to ill health problems among the residents and even increase the chances of child mortality rates in severe cases.

Mitigation Measures

- Have separate system for domestic and irrigation water
- Chose an irrigation system that is very efficient and does not cause water logging in the field
- The designed irrigation schedule should be followed to prevent an increase in the irrigation hours in one section
- Repair and maintenance staff shall drain the pipeline sections to be worked on to avoid spillage of water
- Pipeline leakages or bursts shall be swiftly repaired to avoid triggering land-damages on steep slope

6.4.5 Agrochemical Uses in the Project

Increased use of agricultural biocides (insecticides, herbicides, fungicides etc.) and fertilizers due to expected intensification of agricultural activities in the project area is a key environmental issue during operation phase of the project. Production of horticultural crops (high value crops) will demand increased use of biocides many of which are toxic and can have a long term effect on soils. Agrochemicals might also find their way into the steams thus impact negatively the downstream ecosystems.

The pollution of surface & underground water by agricultural chemicals leads to the deterioration of water quality while increased nutrient levels in the irrigation and drainage water results in algal blooms, proliferation of aquatic weeds and eutrophication in irrigation canals and downstream waterways.

Mitigation Measures

- Use of agrochemicals should be limited as much as possible
- Agrochemical should only be used under strict control and only when other options are not available
- Agrochemical shall not be used near sensitive environments especially wetland areas
- Use "best practices" in handling/using agrichemicals
- The proponent and other relevant government should ensure that invasive alien plant species are not introduced to the area and should they be identified then this should be immediately removed
- Enforcement of relevant legislations in the upstream areas

6.4.6 Water Table

In the long-term; frequent problems of irrigation projects is the rise in the local water-table (water logging). Low irrigation efficiencies are one of the main causes of rise in water table. Poor water distribution systems, poor main system management and old in-field irrigation practices are the main reason. High water table also makes working on soil difficult.

Mitigation Measures

- Use of good irrigation management
- closely matching irrigation demands and supply
- Installation and maintenance of adequate drainage system

6.4.7 Solid Waste

During operation period of the dam which will have direct linkage to the irrigation projects, solid waste (biodegradable and non-biodegradable) will be generated which will include but not limited to waste farm produce empty agrochemical containers, cans, paper bags and cartons.

Mitigation Measurers

- Provision of bins, one for bio-degradable and another for non-degradable matter
- These bins shall be of appropriate type, size and color for effective waste separation and disposal and shall be strategically placed
- Waste shall be properly segregated to encourage re-cycling and re-use
- All the wastes shall be disposed appropriately as per the Tharaka Nithi County government by-laws and Environmental Management and Co-ordination, (Waste Management) Regulations, 2006

6.5 Impacts during Decommissioning Phase

6.5.1 Overview

Decommissioning a structure does not necessarily mean removing the structure because the process of decommissioning may cause negative environmental and/or social impacts. Decommissioning implies making the structure safe through a process of analysis of the options and impacts, and establishing a decommissioning plan that aims to secure the best long term beneficial impacts to both the social and bio-physical environment.

Decommissioning of a small dam, pan or water conservation structure can arise for a number of reasons which may include:

- The structure has filled with sediment or for whatever reason cannot provide the stream of benefits for which it was constructed;

- The structure has become an uncontrolled public safety hazard. This could arise if proper maintenance of the spillway was neglected by the owner and WRA decides to withdraw the water permit;
- The proponent decides to decommission the structure

If decommissioning involves transfer of the project to another user, then it means the new user does not have to construct another dam therefore minimizing negative impacts of construction of another dam.

If the decommissioning involves demolition of the dam, then the positive impacts may include:

- Improved aesthetics of the area as the contractor restores the site and re-vegetate as necessary
- Job creation for the skilled and unskilled workers involved in demolition exercise
- Increased runoff downstream that can be harvested and stored by an interested person

In the event that the removal of the structure is inevitable, then breaching, in the case of a dam, may be considered. Gradual emptying the dam or lowering the water level (by cutting down the spillway or opening the scour pipes) to reduce pressure on the embankment should be undertaken before any breaching of the embankment is undertaken.

Decommissioning may not take place in a near future given that the proponent will involve professionals in design, construction and maintenance of the dam. The relevant authorities will ascertain that the proponent complies with all the legal and technical requirements to avoid condemnation of the dam. However, in the event of decommissioning, policies that will be in place then should be adhered to.

6.5.2 Social Economic Aspect

Reduced availability of water to users hence reduction in production of high value farm produce cultivated in the irrigation project area. This will affect the households who are

used to constant irrigation water supply for production of their high value produce for market. Business people used to get supplies from the project area will also be affected in case of closure or decommission of the project.

Further, this will lead to loss of jobs and income to workers in addition to loss of revenue to the farmers, the Central and County government. The workers will too be affected by closure/decommissioning of the facility.

Mitigation Measures

- The proponent shall work within the laws to avoid closure of the project
- The proponent shall provide an alternative source of irrigation water to the beneficiaries of the project
- Prior assessment on the water resources in the area will be done
- Ensure the establishment leaves enough space for future road expansion.
- The workers shall be given adequate notice and all the dues due to them settled
- Irrigation water consumers to be given adequate notice

6.5.3 Environmental Aspects

In case the dam is to be decommissioned, there will be effects on the environment resulting from the process of removal and disposal of the waste materials resulting from the demolition. These will include building materials piping and equipment.

Mitigation Measures

- Remove all the underground water pipes, underground storage tanks,
- Backfill any surface openings
- Restore/rehabilitate the site to acceptable standards
- All the wastes to be disposed by NEMA authorized waste handlers and to NEMA approved sites
- Develop a decommissioning plan and present it to NEMA for approval

7.0 ENVIRONMENTAL MANAGEMENT PLAN

7.1 Preamble

The purpose of the ESMP is to ensure that environmental and social impacts and risks identified during the ESIA are effectively managed during the construction, operation and decommissioning phases of the proposed dam project. The ESMP specifies the mitigation and management measures for each impact/risk, party allocated responsibility, means of monitoring and frequency, objective verifiable indicators and an indicative budget.

The project proponent shall avail this ESMP to the successful contractor awarded the tender for construction works for this project. The contractor will be required to formulate a more specific ESMP and work methods that will ensure construction of the project in compliance with established standards and legislation. The contractor will factor the costs of implementing the ESMP into their budget. The project proponent will take the necessary steps to ensure that the ESMP is fully implemented.

The ESMP has been developed to provide a basis for an Environmental Management System (ISO 14001 EMS principles) for life span of Kanjogu dam. Since key factors and processes may change through the life span of the project, considerable provisions have been made for dynamism and flexibility of these plans. As such, the ESMP will be subject to a regular regime of periodic review.

In general, the EMP outlines the potential safety, health and environmental risks associated with the project and details and all the necessary mitigation measures as well as the persons responsible for implementing and monitoring such measures. The EMP will be used as checklist in future environmental audits. The necessary objectives, activities, actions, mitigation measures and allocation of responsibilities pertaining to prevention, minimization and monitoring of significant negative impacts associated with the dam project and the associated irrigation projects are outlined in table below.

Table 7.1: Environmental Management Plan

Potential Impact	**Mitigation/Enhancement Measures**	**Responsibility**	**Monitoring means / Frequency**	**Verifiable Indicators**	**Estimated Costs (Kshs.)**
Construction Phase					
Air Quality	• Trucks and machinery shall be well maintained with minimal fumes • Vehicles will only use the designated transport routes and prescribed speed limits • Sensitize truck drivers to avoid unnecessary revving of vehicles at loading /offloading and parking areas • Ensure appropriate vehicle speeds road sections that will be used by construction vehicles on a needs basis to eliminate the creation of dusts • Proper repair and maintenance of vehicles and equipment to minimize exhaust gases • Provide Personal Protective Equipment (PPE) to workers • Sensitized workers on health hazards encountered in such work environment and encouraged to go for regular health check ups • Sprinkle water to maintain dust to the low minimum at all times	Contractor Contractor Contractor	Throughout the construction Phase	Dust and exhaust fumes along the roads and at sites	800,000.00
Destruction of indigenous	• Avoid destruction of indigenous tree during construction activities	Contractor	Throughout the	• Number. and type of vegetation	500,000.00

vegetation	• Replaced/ plant vegetation cover and trees soon after completion of laying of the pipes • Encourage farmers to grow indigenous tree nurseries for increasing vegetative cover and replacing those destroyed during project implementation activities	Proponent	construction Phase	cleared • No. and type of indigenous species re-planted • Size of area cleared • Size of area re-veg	
Loss of Flora and Fauna	• Ensure that clearing of any vegetation is limited to the water pipeline trench area (i.e.0.5 meters width) within the road reserve • Transportation of construction materials is done through the existing local roads. • Areas to be cleared for the water pipeline trench, camp-site and materials holding yard shall be identified and marked out prior to the start of construction activities • Avoid clearance of vegetation on riparian land • Work-force will be sensitized on the importance of environmental conservation and ecological protection to prevent the exploitation of natural resources around the project area and destruction of ecosystems • On completion the trenched pipeline areas will be allowed to re-vegetate with fibrous rooted vegetation species	Contractor Contractor Contractor /Proponent Contractor Contractor	Throughout the construction Phase	• Loss of plants within the dam area Vegetation around the dam area	300,000.00
Soil Disturbance and Erosion	• Incorporating soil conservation measures during construction • As much as possible, manual labour will be used as opposed to machinery • Only the areas to be utilized will be excavated • Carry out inspection of each of the sites soil	Contractor	Throughout the construction Phase	Handling of excavated soils Conditions at excavated areas	500,000.00

	stability before excavation				
Noise pollution and vibration	• Maintain noise levels from the machinery in accordance to the manufacturer's specification • Provide workers with PPE/materials such as earmuffs and earplugs when operating noisy machinery and when in a noisy environment • Sensitize drivers to switch off engines when not in use and avoid unnecessary hooting and revving of vehicles • Vehicles shall be well tuned to produce minimum noise • Have only the essential workers at any construction phase • Construction works to be done during day time only • Use less vibrating and well serviced machinery to prevent excessive vibration • Compaction to be done during the day	Contractor Contractor Contractor Contractor	Throughout the construction Phase	Noise generated by vehicles and machinery PPEs worn by workers Idlers at construction sites	300,000.00
Occupation Safety and Health	• Pre warn the residents of the possible accidents to prevent idling around the sites • Erect an appropriate project signboard as directed by the proponent • Erect appropriate safety signage along the construction site cautioning against various health and safety risks and prescribing particular mandatory actions • Fence the site to prevent neighbours and passers-by from trespassing and exposing them to health hazards • Provide a fully equipped First Aid Kit at the	Contractor Contractor Contractor Contractor	Throughout the construction Phase	Pre warning signage and project sign boards and yellow tapes	500,000.00

	construction site • Provide proper fitting PPEs to avoid injuries and illnesses. • Child labour will not be used in the project • Persons providing food for workers at the site must have the necessary public health licenses • Warning tapes should be put along the trench line to alert pedestrians on the dangers • Construction workers will be sensitized on effects of negative anti- social behaviour and their consequences. • Provide emergency telephone numbers to request for assistance at any time of accident • Have Workman Compensation Insurance Cover for the workers which should comply with Workman's Compensation Act as well as all Ordinances, Regulations and Union Agreements • Formulate a comprehensive HIV/AIDs sensitization programme to create awareness among workers and local community	Contractor Contractor Contractor Contractor Contractor Contractor			
Increased Human Activities	• Fence the sites • Warning tapes along the trench line to alert pedestrians on the dangers • Ascertain that only the vital workers are hired at different stages of establishment • Restrict the entrance to the construction site • Ensure that there is work breakdown	Contractor Contractor	Throughout the construction period	Idlers within the construction sites	800,000.00

	structure in place for each phase • Each phase will take the minimum time possible				
Soils and other Solid Waste	• Work with the county government to facilitate sound waste management • Sort the waste into non-recyclable and recyclable • Provide bins of appropriate type, size and colour for effective waste separation and disposal • Ascertain that there is proper waste disposal management • Train/educate all stakeholders involved in the proposed project on the importance and means of waste management and handling especially during establishment and operational phases	Contractor / County government	Throughout the construction period	Solid wastes along within the construction lines and sites	500,000.00
Oils Leaks and Spills	• Use of well serviced machinery with minimal or no grease/oil leakages • Carry out maintenance of trucks and machinery in designated areas i.e. petrol stations, owners' service yards and garages where oils/greases are completely restrained from reaching the ground and not at the site • Where possible manual labour will be used as opposed to machinery • Fuel products should be keep far away from water bodies	Contractor	Throughout the construction period	Oils and greases within the camp sites and along construction sites	500,000.00
Emergency Respond Plan (ERP)	• Develop effective ERP to cater for various eventualities for accidents/incidents that are likely to occur	Contractor	Throughout the construction	Availability of ERP	50,000.00

	• ERP must be properly documented and made available to all • Conduct regular drills on possible incidences		period		
Operational Phase					
Water use Related Conflicts	• Form Water Users Association (WUA) to guide the use of the water from the dam • Make strict by-laws that will guide on water usage and conflict resolution in the irrigation project • Conduct capacity building on best irrigation practices that aim at efficient water use • Install water meters at the intake and at household levels in order to control water usage and form a basis of rationing • Strictly enforce the Water Act 2016, in order to guide on water usage for the benefit of all stakeholders • Enforcement of relevant legislations	Dam management committee	Throughout the operational phase	An active IWUA with by laws in place Availability or not of water meters	300,000.00 200,000.00
Maintenance of Embankment	• Monitor the crest to ensure that the edges do not erode and that the crest width does not deteriorate. If required, additional material should be placed on the crest and a good grass cover maintained • Monitor the crest and slopes for cracks. • If there are cracks; the location, alignment and depth of crack should be reported to the consultant and cracks should be in-filled by compacting similar soil into the cracks • Resurvey the crest every 5 years to check for slumping and low spots • Maintained the downward slope with a thick	Dam management committee			1,000,000.00

	grass cover. Careful attention should be given to spots were vegetation does not take off; these areas should be dressed with top soil and planted with grass starters • Check the up-stream face for signs of wave or wind erosion • Any erosion of the slope should be addressed by improving the rip rap cover • Do Not allow trees and bushes to grow on the embankment • Monitor the embankment for burrowing animals; in the event that burrowing animals are found they should be removed and their burrows excavated and back filled with compacted material • Monitor downstream slope for seepage or leaks; note and report wet patches, excessive vegetation growth in one patch, depressions or slumping • Monitor normal seepage flows • Monitor and record the outflow from the filter/seepage blanket • Continuous recording of water levels at the same time measuring the filter blanket discharge				
Maintenance Spillway	• Maintain the spillway in good condition and be repaired immediately if need arises • Do NOT allow trees and shrubs to grow in the spillway channel • Monitor the spillway for signs of erosion; any areas that are eroded should be treated by grassing the channel or construction of a	Dam management committee			500,000.00

	concrete sill • Maintain the spillway channel free of debris				
Water Logging and Soil Salinity	• Regular soil test which will help ensure the soils are not destroyed in the long run • Ensure proper choice of the irrigation method • Strictly follow irrigation schedule to prevent an increase in the irrigation hours in one section	Dam management committee	Throughout the operational phase	Results of soil test and reported cases of improper use of prescribed irrigation methods	400,000.00
Increase in Waterborne Diseases	• Have separate system for domestic and irrigation water • Chose an irrigation system that is very efficient and does not cause water logging in the field • The designed irrigation schedule should be followed to prevent an increase in the irrigation hours in one section • Repair and maintenance staff shall drain the pipeline sections to be worked on to avoid spillage of water	Dam management committee	Throughout the operational phase	Reports of waterborne diseases in local dispensaries and hospitals	300,000.00
Agrochemical use in the Irrigation project	• Limit the use of agrochemicals as far as possible • Agrochemicals should only be used under strict control and only when other options are not available • No use of agrochemicals near sensitive environments especially wetland areas • Use “best practices” in handling/using agrichemicals • Ensure that invasive alien plant species are not introduced to the area and should they be identified then this should be immediately	Proponent and other relevant government office	Throughout the operational phase	Increase in usage of agrochemicals within the irrigation project Alien spices within the project area	200,000.00

	removed				
Soil Erosion and Slope Stability	• Pipeline leakages or bursts shall be swiftly repaired to avoid triggering land-damages on steep slope	Project management committee	Throughout the operational phase	Frequency of bursts and repairs	150,000.00
Effect on Water Table	• Use of good irrigation management • Close matching irrigation demands and supply • Installation and maintenance of adequate drainage system	Project management committee	Throughout the operational phase		150,000.00
Solid Waste	• Provision of appropriate bins; type, size and colour for effective waste separation and disposal • Segregation waste to encourage re-cycling and re-use • All wastes shall be disposed appropriately as per the county government by-laws and the Environmental Management and Co-ordination, (Waste Management) Regulations, 2006	Project management committee	Throughout the operational phase	Availability of bins within the projects	300,000.00
Decommissioning Phase					
Social Economical Aspects	• Work within the laws to avoid closure of the project • Provide an alternative source of irrigation water to the beneficiaries of the project • Prior assessment on the water resources in the area will be done • Workers shall be given adequate notice and all the dues due to them settled • Irrigation water consumers to be given adequate notice	Proponent			500,000.00

Environmental aspects	• Remove all the underground water pipes, underground storage tanks, • Backfill any surface openings • Restore/rehabilitate the site to acceptable standards • All the wastes to be disposed by NEMA authorized waste handlers and to NEMA approved sites • Develop a decommissioning plan and present it to NEMA for approval				500,000.00

8.0 CONCLUSION AND RECOMMENDATION

8.1 Conclusion

The proposed Kanjogu dam will bring many social economic benefits to the proponent and the residents of Maara Sub County and the Tharaka Nithi County in general. The study has identified the positive and negative impacts of the proposed irrigation project and proposed mitigation measures. With full adoption of mitigation measures stated and the implementation of the EMP during establishment, operational and decommissioning phases, the negative impacts of the project will be minimized to manageable levels.

Proper supervision during construction and due diligence on the part of the contractor is also essential for mitigating environmental and social impacts during construction. The inevitable negative impacts associated with the project have been noted and mitigations suggested where necessary. The developed EMP gives the proponent almost all what he needs to do to have environmentally sustainable project.

The positive impacts and the benefits associated with the project outweigh the few negative impacts highlighted. The project is thus viable and may be allowed and licensed to proceed.

8.2 Recommendations

To ensure environmental sustainable development the proponent should undertake the following: -

- ✓ Obtain all the necessary permits/licences from the relevant authorities
- ✓ Have qualified personnel to undertake the project as proposed
- ✓ Have adequate safety and healthy mitigation measures as per the statutory requirements
- ✓ Have a project sign board with all the required details erected at the project site
- ✓ Adhere to the developed EMP any other conditions imposed by NEMA.

References

Kanjogu Dam Design report
Hydrological Assessment report of South Maara River

Kenya gazette supplement number 56. Environmental Impact Assessment and Audit Regulations 2003, *Government printer,* Nairobi

Kenya gazette supplement Acts 2000, Environmental Management and Coordination Act Number 8 of 1999. *Government printer, Nairobi*

Kenya gazette supplement Acts *Public Health Act (Cap. 242) government printer, Nairobi*

Kenya gazette supplement Acts *Local Authority Act (Cap. 265) government printer, Nairobi.*

Kenya gazette supplement Acts *Physical Planning Act, 1999 government printer, Nairobi*

Kenya gazette supplement Acts *Land Planning Act (Cap. 303) government printer, Nairobi*

Kenya gazette supplement Acts *Water Act, 2002 government printer, Nairobi*

Kenya gazette supplement Acts *Building Code 2000 by government printer, Nairobi*

Kenya gazette supplement Acts Penal Code Act (Cap.63) *government printer, Nairobi*

Kibwage J.K (2002). Integrating the informal Sector in Solid Waste Management in Nairobi City, Maseno University Kenya

UNEP and ACTS (2001), The making of a framework Environmental law in Kenya. ACTS press, Nairobi

World Bank (1991), Environmental Assessment sourcebook volume i: Policies, procedures and cross-sectoral issues. World Bank, Washington