



# **FEASIBILITY STUDY, DETAILED DESIGN AND PREPARATION OF TENDER DOCUMENTS FOR THUCHI DAM, EMBU COUNTY**

**Contract No. NIB/T/015/2013-2014**



## **ENVIRONMENTAL AND SOCIAL IMPACT ASSESSMENT STUDY REPORT**

**APRIL 2017**



**NATIONAL IRRIGATION BOARD  
P.O. BOX 30372-00100  
NAIROBI**



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**DECLARATION**

This report is made in accordance to the requirements of the Environmental (Impact Assessment and Audit) Regulations, 2003, pursuant to The Environmental Management and Coordination Act, (EMCA) 1999 (revised 2015).

Further, this report has been prepared in accordance with the terms and conditions of Kiri Consult Contract with the National Irrigation Board, Republic of Kenya.

To our knowledge, this report responds satisfactorily to the Terms of Reference as was provided by the National Irrigation Board and also to the requirements of the Environmental Management and Coordination Act, (EMCA) 1999 of the Republic of Kenya.

  
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## ACRONYMS AND ABBREVIATIONS

BOD	Biological Oxygen Demand
CO <sub>2</sub>	Carbon Dioxide
COD	Chemical Oxygen Demand
DBH	Diameter at Breast Height
EA	Environmental audit
EM	Environment Manager
EMCA	Environment Management and Coordination Act
EMU	Environmental Management Unit
EPA	Environmental Performance Assessment
EPI	Environmental Performance Indicator
ESIA	Environmental and Social Impact Assessment
ESMP	Environment and Social Management Plan
FGD	Focus Group Discussion
IUCN	International Union for the Conservation of Nature
KFS	Kenya Forest Service
KTDA	Kenya Tea Development Agency
KWS	Kenya Wildlife Service
MKE	Mount Kenya Ecosystem
MCM	Million Cubic Meter
NEMA	National Environmental Management Authority
NIB	National Irrigation Board
NO <sub>x</sub>	Compounds of Nitrogen Oxide
PAPs	Project Affected Persons
PM	Particulate Matter
PMU	Project Management Unit
PSR	Pressure State Response
RAP	Resettlement Action Plan
RCC	Resettlement Compensation Committee
RE	Resident Engineer
SO <sub>x</sub>	Compounds of Sulphur Oxide
WRMA	Water Resource Management Authority

## 0 EXECUTIVE SUMMARY

### 0.1 Introduction

This Environmental and Social Impact Assessment project report is for the proposed Thuchi Dam in Runyenjes town Embu County, Kenya that will be carried out by the National Irrigation Board (NIB). It has been carried out in fulfillment of the requirements of the EMCA, 1999 and Environmental management and coordination (EIA and EA) Regulations, 2003.

### 0.2 Project Objectives

The proposed Thuchi dam on River Thuchi is expected to conserve water during the rains and release it for irrigation purposes during the dry months of the year. It shall support 6,600ha of irrigation land in Kaagari-Gaturi Irrigation project area.

### 0.3 Objectives of the study

The principle objective of the EIA study is to carry out a systematic examination of the baseline environmental situation within the project area in order to determine whether or not the proposed project will impact adversely on the environment. The specific objectives of the proposed project include, but are not limited to, the following:

- 1) To determine the compatibility of the establishment of the proposed facility with the neighboring land uses and evaluate local environmental conditions.
- 2) To identify and evaluate the significant environmental impacts of the proposed project

### 0.4 Study methodology

The assessment involved field studies, interviews, literature survey and public consultations to obtain data on the baseline conditions of the general study area. Threats to the environment were identified and this was followed by related impact assessments using Leopold matrix and finally the compilation of a comprehensive report on the current status of the environment; possible positive and negative impacts that the project is likely to cause and the development of an ESMP.

### 0.5 Policy, Legal and Institutional Framework

This Environmental and social Impact assessment report is guided by a number of environmental legislations, the primary one being the Environmental Management and Coordination Act (EMCA, 1999). This act makes Environmental and Social Impact Assessments a legal requirement. The ESIA is also guided by a number of subsidiary legislations under EMCA. Other Acts include: The Water Act, 2002, Public Health Act (Cap 242), Occupational safety and Health Act (Cap 514), The Forest Act, The Agriculture Act, Physical Planning Act (Cap 286), The Penal Code (Cap 63) and The Wildlife Conservation and Management Act 2013.

The Key policies that have been reviewed in this work include: The Constitution of Kenya 2010, The Kenya Vision 2030, National Action Plan, National Policy on Water Resources Management and Development, The Agricultural Policy, Sessional Paper No. 6 of 1999 on Environment & Sustainable Development, Land Policy, Draft National Irrigation Policy and The Millennium Development Goals 2006.

The main institutions works that have been reviewed in this report include: National Irrigations Board, Ministry of Water & Irrigation, Ministry of Environment, Water & Natural Resources, National Environment Action Plan Committee (NEAP), Water Services Regulations Board (WSREB), Water Resources Management Authority (WRMA), Water Services Trust Fund (WSTF), Water Services Board (WSB) and NEMA Compliance.

## 0.6 Baseline Conditions

### 0.6.1 Physical environment

The proposed Thuchi dam will be located in sites characterized by rugged topography with several small valleys and ridges which are the source of the major stream tributaries and springs feeding the River Thuchi basin.

The rocks present in Thuchi project area are Kenytes (a type of lava) which were erupted as part of the Mount Kenya volcanic activity. In the present state they directly overlie the sub-Miocene peneplanation indicating that no other volcanic formation between them and the weathered and deformed Basement System rocks.

The soils in the forest are dark brown and have a high organic matter added by the litter from the leaves of the trees. The cultivated area is characterized by brown to light brown deep fertile soils evidenced by the tea crop that they support. The riparian area has clay loam soils which are well drained.

### 0.6.2 Natural Environment

The vegetation in the proposed project site consists of both indigenous and exotic species. The farmlands have some natural vegetation which includes: *Anthocleista grandiflora*, *Cesaria battiscombei*, *Commiphora emini*, *Cordia abyssinica*, *Croton macrostachyus*, *Croton megalocarpus*, *Ficus sur* and *Myrianthus holstii*. Agroforestry trees include: mangoes, avocados and macadamia and the crops farmed are maize, beans, kales, bananas and tea as a cash crop.

The forest has high species diversity both planted and natural. It is a well-managed forest with minimal disturbance and canopy closure of about 70%. The forest has a thick underground covered with shrubs and herbs including: *Clerodendrum johnstonii*, *Cyperus immensus*, *Cyrtandra manniala*, *Eragrostis*, *Hypoestes aristata*, *Oplismenus bumanii*, *Piper capense*, *Pteridium aquilinum*, *Rhus pinato* and *Solanum incanum*. The tree species include: *Ehretia cymosa*, *Ficus sur*, *Harungana madagascariensis*, *Makaranga kilimandischarica*, *Myrianthus holstii*, *Neoboutonia macrocalyx*, *Ocotea usmbarensis*, *Polyscias fulva*, *Prunus Africana*, *Rhamnus staddo*, *Syzygium cuminii*, *Strombosia scheffleri*, *Terbanaemontana stapfiana*, *Trichilia emitica* among others. The forest has elephants as the most common species in the proposed project location.

River Thuchi has different species of fish depending on the part of the river and these include: *Mastacembelus Victoria*, *Alestes nurse*, *Tilapia zilli* and *Clarias angullaris*. Cat fish (*Clarias angullaris*) is found in the forest and are only harvested in January.

There are two main sources of water: surface and ground water resources. The surface water resources in the area include River Thuchi which is the main source of water and Kiajege stream. River Thuchi is an important source for domestic water and supports riparian agriculture as evidenced by farmlands on the riparian zone. Ground water resources include the numerous springs which dot the landscape and shallow wells found within the homesteads. The springs are mostly found on the ridges and steep slopes on the Embu side of the river Thuchi. The springs support farming of wetland crops like arrow roots among other crops. Shallow wells are mainly used by people who can't access the river. The area also has various community-based water projects which supply piped water to the community members. Some of the intakes of these projects are found in the section of the river that is in the forest.

## 0.7 Social – Economic

The farming system practiced in the project area is individual/household production system whereby individual farmers manage their farms taking into account all the physical, economic and social factors of relevance to production individually.

The major crops within the project area can be categorized as food crops, industrial crops and horticultural crops.

Maize and beans which are often intercropped comprise the most important food crops. Others are sweet potatoes, irish potatoes, sorghum and pulses in that order.

Industrial crops comprise of tea and coffee as the major crops. Macadamia is also an important industrial crop. There are also traces of cotton in the lower, drier area of the district. Bananas top the list of horticultural crops followed by mangoes and avocados. Other horticultural crops are paw paws, tomatoes, kales and French beans. Most of these are however in very small scale due to lack of irrigation and high dependency on rain fed agriculture.

The population of Embu county was computed at 516,909 (KNBS, 2009) and was projected to reach 561, 446 by 2015 with a sex ratio of 1:1. The youth in the age cohort 15-34 years are the majority at 34.5%.

## 0.8 Anticipated Impacts and Mitigation Measures

The most important potential negative impacts are; clearance of vegetation especially in the forest where about 43.8 ha of trees and shrubs will be cleared to give room to the reservoir, change in hydrological pattern of the area, impeded faunal movements due to construction of a wall across the river, reduced water regimes and alteration of aquatic, fish ecology and relocation of persons.

Other impacts include: increased sediments in the river, soil erosion and potential landslides, increased surface runoff, reduced water quality for the intakes, loss of forest ecosystem, loss of wildlife habitat and insecurity. Mitigation measures for the identified negative impacts were provided.

## 0.9 Environmental Management Plan (EMP)

The Environmental and Social Management Plan (ESMP) is prepared to show how site specific concerns and mitigation measures are addressed through the design, pre-construction, construction and post-construction / operation phase of a project.

The objectives of the ESMP are:

- To bring the project into compliance with applicable national environmental and social legal requirements;
- To outline the mitigating/enhancing, monitoring, consultative and institutional measures required to prevent, minimize, mitigate or compensate for adverse environmental and social impacts, or to enhance the project beneficial impacts;
- To address capacity building requirements within the relevant ministries if necessary.

In order to ensure the sound development and effective implementation of the ESMP, it will be necessary to identify and define the responsibilities and authority of the various persons and organizations that will be involved in the project. The following entities will be involved on the implementation of this ESMP:

- a. National Irrigations Board;
- b. National Environmental Management Authority;
- c. Resident Engineer.
- d. Environmental and Social Officer;
- e. Contractor;
- f. Technical Auditor

## 0.10 Conclusion and recommendation

The proposed Thuchi Dam will comprise a small reservoir to store water for irrigation purposes. It will necessitate hiving off of some 48 ha of the forest to create the reservoir. The Kenya Forest Service has been consulted and is willing to cede the land as long as the right procedures are followed. It is proposed that compensatory tree planting be undertaken for at least a minimum of 43 ha and this could be done in degraded parts of the forest using indigenous species.

The main source of adverse impacts relate to alteration of downstream water flow that could impact on a range of parameters including downstream riverine ecology, aquatic life and livelihoods. A range of mitigation measures that have been proposed include maintaining a minimum residual flow of 30% at any given time but increasing this flow during the dry season. Impacts on fish found in the river include provisions in the dam design to allow for fish migration up and downstream. Other impacts relate to water quality issues occasioned by contamination of reservoir by inundated pit latrines and submerged organics which can increase both COD and BOD. The findings of the ESIA conclude that these negative impacts can be avoided or reduced by applying the prescribed

mitigative and compensatory measures, particularly taking into consideration the large socio economic benefits that will accrue from the dam. This EIA also presents a robust environmental and social management plan that prescribes a framework for applying the mitigation measures to ensure effectiveness. However, permanent impacts that are related to acquisition of land and conversion from a terrestrial to an aquatic environment cannot be reversed. The EMP has proposed an elaborate process of monitoring environmental performance both during the construction and operational phases of the dam. The Pressure State Response approach has been proposed to aid in assessing environmental performance of the project. Further a detailed management plan has been proposed to avoid or minimize the identified impacts. This permanent impact is common to all dam projects. Dam safety has been emphasized and the design engineers are aware of this important aspect.

The dam will lead to acquisition of land and even property to create room for construction of the dam axis and the reservoir. The reservoir will mainly cover a deep gorge and therefore the horizontal expanse is relatively small. The potentially affected persons are mainly farmers and loss of land and homesteads would have a very strong adverse impacts on their families and livelihoods. It is therefore very strongly recommended that a detailed Resettlement Action Plan be prepared.

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# 1 INTRODUCTION

## 1.1 Background

This Environmental and Social Impact Assessment report has been produced for the proposed Thuchi Dam project in Embu County, Kenya, that will be carried out by the National Irrigation Board (NIB). It has been carried out in fulfillment of the requirements of the EMCA, 1999 and Environmental management and coordination (EIA and EA) Regulations, 2003. The EMCA, 1999 second schedule requires that a large infrastructure project such as a dam must undergo an EIA that is subject to the review and approval of NEMA before it can commence. The ESIA has been carried out to assist in the identification of the anticipated impacts in the preconstruction, construction and operational phases of the project. It is also expected to assist in the identification of the mitigation measures for the negative impacts and preparation of an Environmental monitoring plan.

## 1.2 Objectives

### 1.2.1 Project Objectives

The proposed Thuchi dam shall conserve water during the River's high flow and release it for irrigation purposes during the dry months of the year. It shall also provide water demands for the immediate neighboring community after the dam is constructed. The proposed Thuchi dam will have capacity to significantly provide for domestic, hydro-power, tourism and water sport needs of the community.

Kaagari-Gituri Irrigation project targets more than 12000 farmers and covers a total area of about 6600ha. It falls under Kagaari South, Kagaari Gaturi Central, Gaturi North, Kagaari North and Kieni wards. The project is at advanced stage: phase 3 covers an area of 7325 acres, [construction complete], phase 2 covers 6600 acres [at tendering stage] and phase 1 2475 acres. This water needs for this project are immense hence the need for Thuchi dam.

### 1.2.2 Objectives of EIA Project Study

The principle objective of the EIA study is to carry out a systematic examination of the baseline environmental situation within the project area in order to determine whether or not the proposed project will impact adversely on the environment. The specific objectives of the proposed project include, but are not limited to, the following:

- 1) To determine the compatibility of the establishment of the proposed facility with the neighboring land uses and evaluate local environmental conditions.
- 2) To identify and evaluate the significant environmental impacts of the proposed project with special emphasis on:
  - Impacts on water quality and water quantity
  - Impacts on fauna and flora
  - impacts on livelihoods
  - Impacts on noise, dust and air quality
  - Impacts on land use and land degradation

- Impacts on health, safety and security
  - Impacts on drainage and solid waste management
  - Impacts on socio-cultural aspects
  - Impacts on economic aspects
  - Impacts on institutions and related services.
- 3) To assess and analyze the environmental costs and benefits that may be associated with the proposed project.
  - 4) To evaluate and select the most optimal project alternative from the various options available.
  - 5) To incorporate environmental management plans and monitoring mechanisms during implementation and operation phases of the project.

### 1.3 Project Proponent and Consultant

The project proponent is National Irrigation Board (NIB). The board has a mandate to develop, promote and manage all national irrigation schemes in the country. In line with this mandate, NIB is currently managing seven national irrigation schemes and four research stations in various regions of the country while undertaking the implementation of new irrigation and drainage infrastructural projects in other parts of the country. The proposed Thuchi dam on River Thuchi is to conserve water during the rains and release it for irrigation purposes during the dry months of the year.

NIB announced an invitation for proposals to provide the required services and Kiri Consult Ltd. was awarded the contract after successful participation. The Contract between NIB and the Consultant was signed on 18-12-2013. The Contract became effective on 28-12-2013.

### 1.4 Project Location

The proposed Thuchi dam will be located at the border of Embu and Tharaka Nithi counties at the edge of Mt. Kenya Forest. The dam is on the shared border between Runyenjes and Chuka Sub-Counties in Embu and Tharaka Nithi Counties respectively. Figures 1.1 and 1.2 show the location of the dam. The dam is located at the following coordinates: (37N 341002, 9959189) (37N 341195, 9959564) (37N 340998, 9959183)(37N 341197, 9959566).

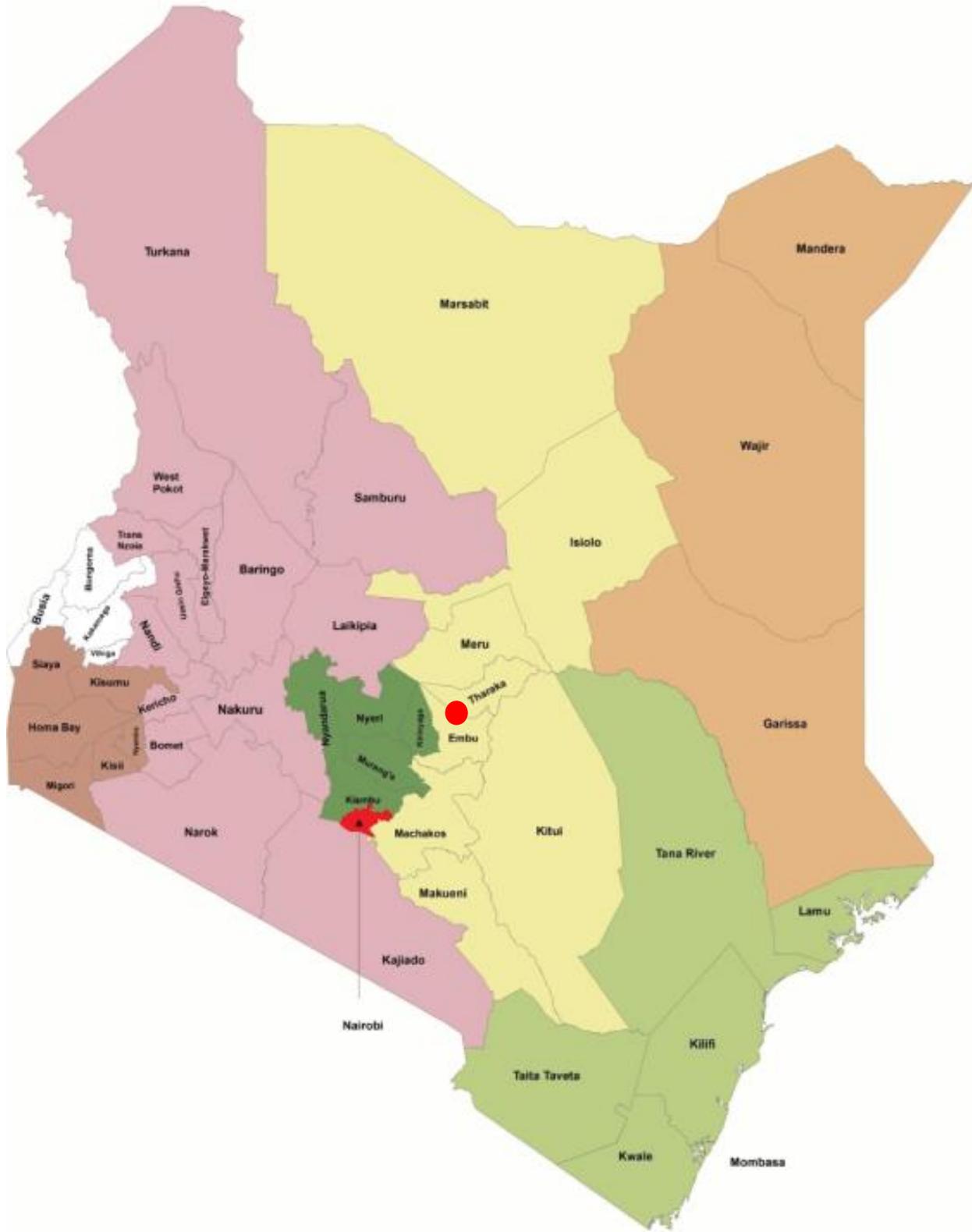


Figure 1-1: Project Location in the context of Kenya

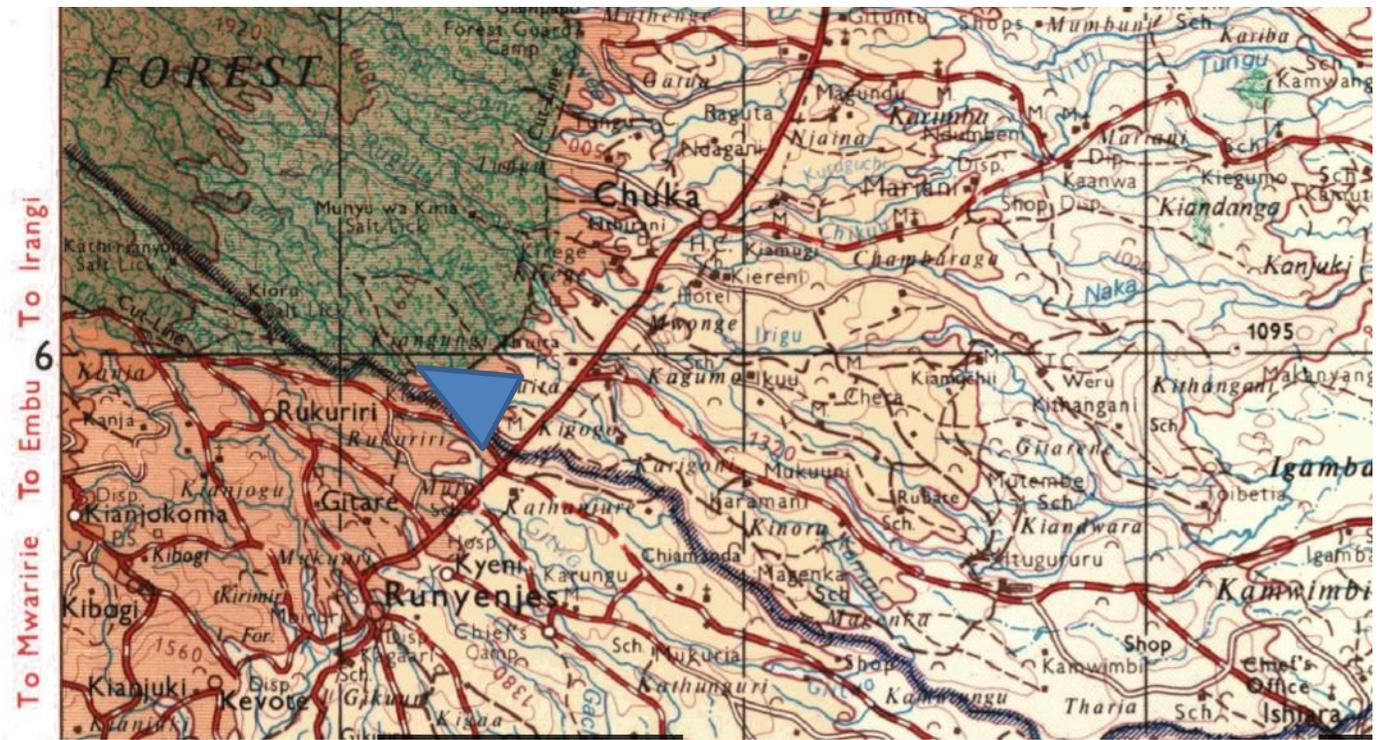


Figure 1-2: Close up of the project location

## 2 METHODOLOGY

A detailed study for the Environmental and Social Impact Assessment (ESIA) was undertaken in light of the legislative requirements of the Environmental Management and Coordination Act (EMCA), 1999 and the Environmental Impact Assessment and Environmental Audit Regulations, 2003. During the ESIA study, the key focus was to identify potential environmental, social and cultural impacts of the proposed dam and highlight possible mitigation measures for these impacts. The assessment adopted the following study procedures:

### 2.1 Desk Review

An extensive desk review was conducted pertaining to the proposed project. This included baseline information on the project area with respect to geography, geology, soils, climate, socio economic activities and the people around the area of the proposed dam location. Literature review of the relevant laws and policies in Kenya that guide an ESIA process was also undertaken. The findings of this desk review are presented in chapter 3 of this report.

### 2.2 Field Survey

The field survey adopted various techniques of baseline data collection on the existing environmental conditions, namely:

- Field observations and recordings including photography along predetermined transects in the project area and its vicinity.
- Use of one meter diameter plots in the forests to identify the various tree species, shrubs and herbs.
- Use of checklists for determining potential environmental impacts of the proposed project.
- Discussions with key informants (Fisheries Department, KWS, KFS, WRMA, NEMA and KTDA)

The field survey for socio- economic issues is outlined below

- **Public Participation** : Participants in the ESIA exercise were drawn from the following categories of PAPs and stakeholders [a] Relevant government agencies such as the ministry of water and irrigation, Ministry of agriculture, the county government of Embu [through the Runyenjes sub-county office], local community leaders [political, administrative and religious] together with village elders and youth leaders. From such fora the consultant learnt a lot about project-relevant Aembu and Atharaka culture and traditions. These meetings were hosted at Iriari primary school.
- **Public consultation**: The consultant engaged experts in group discussions with an objective to understand the dynamics of dam making and dam impacts in and was able to localize that to the Thuchi dam host community. Such key informants were drawn from the ministries of Agriculture, Fisheries, water and from the Kenya forest service. Out of these discussions the consultant was able to know that there are no Thuchi –specific fauna and or flora which could be adversely affected by the dam barrier or inundation.

- **In-depth Interview:** These were undertaken by the consultant through administration of project relevant questionnaire which was administered to every household which was expected to be affected in any way by inundation. The aim was to understand the feelings of the PAPs towards the dam project because they were the most affected by the project. Although none opposed the project out-rightly, fears existed especially about resettlement, perceived break-down of established relationships and neighborhoods. All these feelings are analyzed in the EMP

## 2.3 Assessment of impacts

The Assessment shall identify, analyze and assess environmental and social impacts of the Project. It will distinguish between positive and negative impacts, direct and indirect impacts, and immediate and long-term impacts. Identify impacts that are unavoidable or irreversible. Wherever possible, describe impacts quantitatively, in terms of environmental components affected (area, number), environmental and social costs and benefits.

The significance of impacts of the proposed project shall be assessed, and the basis of this assessment shall be specified.

### 2.3.1 Impact Identification & prediction

A logical and systematic approach needs to be taken to impact identification. The aim is to take account of all of the important environmental/project impacts and interactions, making sure that indirect and cumulative effects, which may be potentially significant, are not inadvertently omitted.

The most common formal method used for impact identification is the matrices. They are good method to linking action to impact and for displaying ESIA results

### 2.3.2 The Leopold matrix

A matrix is a grid that is used to identify the interaction between project activities, which are displayed along one axis, and environmental characteristics, which are displayed along the other axis. For the identification of impacts a breakdown of the environment into elements or factors that may be affected and a breakdown of the various actions or activities of the project under study will be done.

For the identification of impacts we will realize a breakdown of the environment in elements or factors that may be affected, and a breakdown of the various actions or activities of the project under study. For each of these elements in the environment there may be identified operations or project elements that may cause or may cause alterations in that element, using an array of double entry, with environmental factors in the columns and measures likely to produce an impact on rows, identifying and pointing out the possible impacts and corresponding crossings

### 2.3.3 Impact identification and evaluation

Impacts should be also predicted quantitatively. Quantification means using numbers to indicate the impact. It is helpful to present information in summary form to give readers an overview of the impact characteristics of the Project and the alternatives to it.

To characterize the impacts identified using a table which includes, columns of information arranged in the following manner: first, the receiving environment impact (1st column), operation, task or project action generated by the impact ( 2nd column), physical action that causes the impact on the factor of the environment (3rd column),

the alteration that lead the impact to the factor of environment (4th column) and, finally, the phase of the project I which the impact occurs on impact, (under construction or in operation) (5th column).

Once we got the list of impacts or changes on the different elements of the medium we proceed to characterize them, for which we use the following features and criteria:

- Sign (Nature)
- Type
- Intensity
- Extension
- Time
- Reversibility
- Recoverability
- Persistence.

The following describes the meaning of the terms used:

- **Sign /Nature of the impact:** Alludes to the beneficial nature (+), bad (-)
- **Intensity** It refers to the degree of impact on the factor, in the specific area in which it operates. Ranked from 1 to 3. The three expressed an almost total destruction of the factor in the area in which the effect occurs.
- **Type:** Refers to the nature of the impact, direct (3) indirect (2) or cumulative (1)
- **Extension/Location:** An area of influence covered by the impact in relation to the project environment. In this sense, if the action produces a much localized effect within the space, it is considered that the impact is low (1). If, however, the effect does not support a precise location within the project environment, having a pervasive influence beyond the project footprint, the impact will be large (3). Intermediate situations are considered as partial (2).
- **Timing:** Refers to the moment of occurrence, the time lag between the onset of action and effect on the appearance of the corresponding factor. We consider three categories according to this time period is zero, up to 2 years, or more than two years, which are called respectively as immediately (3), medium term (2), and long term (1).
- **Reversibility:** It refers to the possibility of reconstructing the initial conditions once the effect. Can be characterized as short-term, easily reversible (1), medium term, partially reversible if mitigated (2) and impossible (3).
- **Duration/ Persistence:** Refers to the time that supposedly stays the effect, from the onset of the action in question. Two situations are considered, depending on whether the action produces a temporary effect (1) or permanent (3). It is therefore this generic characterization because spaces are not discrete time

course associated with these categories and because in any case, it is very difficult, in the limit, to discern on temporary or permanent effects.

A logical and systematic approach will to be taken for impact identification. The aim is to take into account all the important environmental/project impacts and interactions, making sure that indirect and cumulative effects, which may be potentially significant, are not inadvertently omitted. Individual environmental issue should be viewed in respect of the different facets of the project. (For example, water quality issues related to the reservoir also have impacts downstream of the reservoir).

The rating evaluation will be as follows:

Table 2-1: Summary of rating evaluation

EVALUATION PARAMETER	RATING	RATING
Nature of impact(NI)	-Positive -Negative -Uncertain	+ - -/+
Intensity(IT)	-Major -Medium Minor	3 2 1
Extent(EXT)	-Disperse -Medium -Localized	3 2 1
Timing (TM)	-Immediate -Medium -Delayed, long term	3 2 1
Reversibility(R)	-Short term, easily reversible -Long term, partially reversible -Not reversible	3 2 1
Persistence(P)	-Temporary effect -Permanent effect	1 3
Type of impact (TI)	-Direct -Indirect -Cumulative	3 2 1
Phase	-O -C	Operational period Construction period

### Impact magnitude Indicators

As pointed in LEGAL NOTICE No. 101 THE ENVIRONMENTAL (IMPACT AND AUDIT) REGULATIONS, 2003 ARRANGEMENT OF REGULATIONS, SECOND SCHEDULE the following issues may, among others, be considered in the making of environmental impact assessments.

- Impacts on the Physical Environment
- Impact on the Biological Environment
- Impact on socio-economic environment

The Magnitude or Importance impact represents the entity or significance of the effect, includes the degree of incidence and the "form" of that effect, represented by other attributes. Its value is clear from taking the attributes

described by the following formula.

$$\text{Imp} = \text{Sign} (3I_{ij} + 2E_{ij} + TM_{ij} + P_{ij} + R_{ij}),$$

Where:

- **Imp:** Importance of the impact generated by the action on the project i j element of the medium
- **Ii:** Intensity of the impact generated by the action on the project i j element of the medium.
- **Ei:** Extent of the impact generated by the action on the project i j element of the medium.
- **TMi:** Timing, the moment of impact generated by the action on the project i j element of the medium.
- **Pi:** persistence of effect, from the onset of the action in question.
- **Ri:** Possibility of reversibility.

As indicated in the Terms of Reference of the ESIA and the Scoping Report, following the WB methodology (1995) only two impact characterization parameters included in the matrix are not considered in the impact magnitude valuation formula, these are the “type” and “recoverability”

## 2.4 Analysis of Alternatives

In the interim report, there were three possible dam sites:

**Alternative 1:** Approximately 4.0km into the Mt. Kenya Forest



Figure 2-1: Alternative 1 dam location and a summary of its characteristics

Dam Height (m)	Volume (m <sup>3</sup> ) (10 <sup>x6</sup> )	Embankment length (m)	Area of Impended water(ha)	Fetch (m)	Embankment CL coordinates (UTM)
60	13.5	350	54.2	1970	(334809,9963027)(335058,9963270)
70	19	395	64.1	2060	
75	22.15	425	69.5	2090	
80	25.5	450	75.3	2180	

This alternative being in the forest was not suitable because a lot of vegetation would have been cleared for construction of the dam and the reservoir area.

**Alternative 2:** Dam is outside the forest but about 43.8 ha of the Mt. Kenya forest area will be inundated.



Figure 2-2: Alternative 2 dam location and a summary of its characteristics

Dam Height (m)	Volume (m <sup>3</sup> ) (10 <sup>x6</sup> )	Embankment length (m)	Area of Impended water(ha)	Fetch (m)	Embankment CL coordinates (UTM)
70	22.06	490	77.3	2435	
65	20.39	505	74.2	2440	(339494,9959247)(339771,9959671)
60	17.04	450	64.6	2315	(339501,9959282)(339760,9959654)
55	13.92	392	58.5	2110	(339489,9959349)(339752,9959640)
50	11.39	350	49.6	2035	(339514,9959371)(339745,9959631)

Dam Height (m)	Volume (m <sup>3</sup> ) (10 <sup>x6</sup> )	Embankment length (m)	Area of Impended water(ha)	Fetch (m)	Embankment CL coordinates (UTM)
45	9.05	315	44.6	1870	(339534,9959383)(339741,9959620)

From all three alternatives, this one was more suitable. It strikes a balance between vegetation to be cleared and the people to be resettled.

**Alternative 3:** Dam outside forest impounded water in inhabited area.

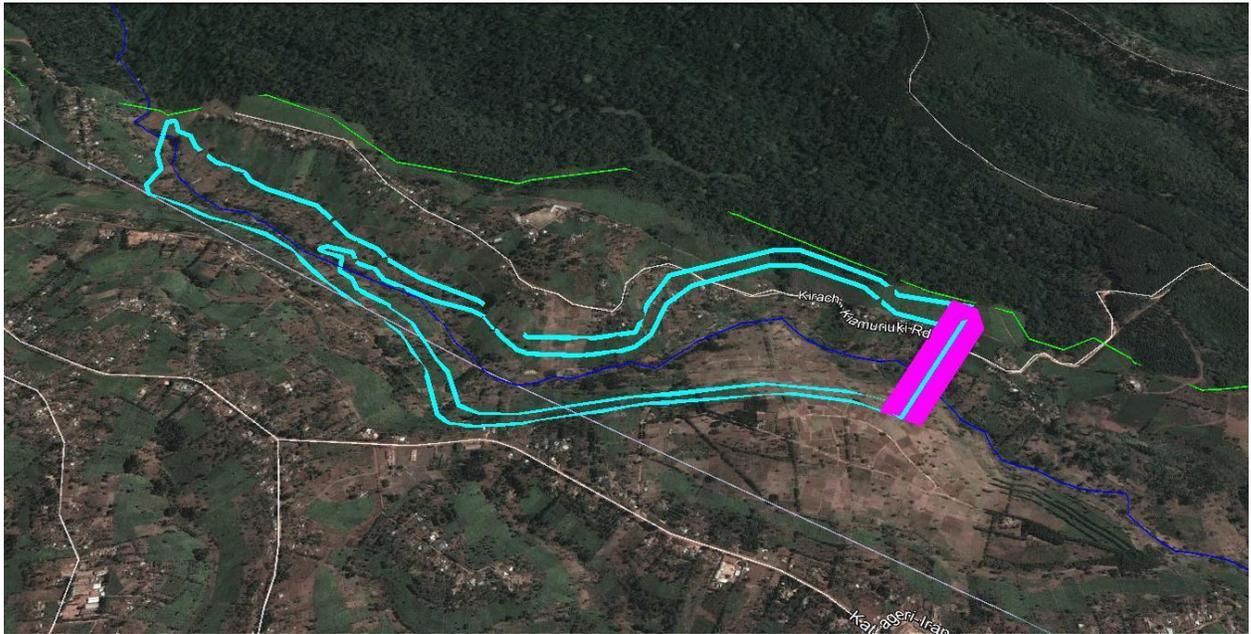


Figure 2-3: Alternative 3 dam location and a summary of its characteristics

Dam Height (m)	Volume (m <sup>3</sup> ) (10 <sup>x6</sup> )	Embankment length (m)	Area of Impended water(m <sup>2</sup> )	Fetch (m)	Embankment CL coordinates (UTM)
55	16.14	422	69.0	2500	(341002, 9959189)(341195, 9959564)
60	20.81	476	77.0	2600	(340998, 9959183)(341197, 9959566)
65	24.3	490	89.0	2675	

This alternative would have so many people resettled because the location in the settled area and was therefore not found suitable.

## **2.5 Summary**

Alternative 2 was most suitable because it strikes a balance between forest area and settled area. Therefore, the number of people to be resettled is not as high as alternative 1 and the forest area to be cleared is not large compared to alternative 3.

## 3 LEGISLATION, POLICY AND ADMINISTRATIVE FRAMEWORK

### 3.1 LEGAL FRAMEWORK

#### 3.1.1 Environmental Management and Coordination Act, 1999

EMCA Act, 1999, is the legislation that governs Environmental Impact Assessment (EIA) studies in Kenya. Part II of the Environment Management & Coordination Act, 1999 states that every person in Kenya is entitled to a clean and healthy environment and has the duty to safeguard and enhance the environment in order to partly ensure this is achieved. The new constitution has also embraced and provided further anchorage of EMCA, whose requirements for environmental protection and management have largely informed Sections 69 to 71 of the New Constitution.

The EMCA 1999 provides under the *Second Schedule*, a list of projects that must undergo screening for EIA. The proposed Thuchi Dam project falls under this schedule and as such requires that an EIA Project Report be undertaken and submitted to NEMA. The 2003 regulations will be used to guide the methodology and provide the framework for the Project ESIA report. Further, EMCA, 1999 in Section 7(1) creates the National Environment Management Authority (NEMA) with the mandate to exercise general supervision and co-ordination over all matters relating to the environment and to be the principal instrument of Government in the implementation of all policies relating to the environment.

##### 3.1.1.1 *Environmental Management and Co-ordination Water Quality Management Regulations, 2006 (Legal Notice No. 120)*

These regulations were drawn under section 147 of the Environmental Management and Coordination Act 1999. In accordance with the regulations (part II), every person shall refrain from acts that could directly or indirectly cause immediate or subsequent water pollution and no one should throw or cause to flow into water resources any materials such as to contaminate the water. The regulation also provides for protection of springs, streams and other water sources from pollution. The act also states that no farming activities should be carried out near a river or stream to a minimum of six meters and maximum of thirty meters based on the highest recorded flood level. Part IV provides regulations for agricultural use and it states that any owner or operator of an irrigation scheme shall create a buffer zone of at least fifty meters in width between the irrigation scheme and the natural water body into which such irrigation scheme discharges its waters.

*This regulation is relevant in two ways: (a) the proposed project will be implemented in a wetland area, within the floodplain of river Thuchi, and in an area which has a number of springs and; (b) the dam's major purpose is to provide water for irrigation. The contractor will therefore be required to exercise extreme caution to ensure pollution of the river is avoided as much as possible. Further, they will have to go by the stipulated regulations for spring protection and irrigation.*

### **3.1.1.2 Environmental Management and Co-ordination (Wetlands, Riverbanks, Lakeshores, and Seashores Management) Regulations 2009**

The main purpose of this regulation is to provide for the conservation and sustainable use of wetlands and their resources in Kenya. Environmental Impact Assessment and Environmental Audit as required under the EMCA shall be mandatory for all activities likely to have adverse impact on the management of wetlands. Part II section 4 of the act provides for the management of wetlands and wetland resources, especially with a view to (c) to ensure the conservation of water catchments and the control of floods; and (e) to ensure the protection of wetlands as habitats for species of fauna and flora. Section 5(1)(a) states that wetland resources shall be utilized in a sustainable manner compatible with the continued presence of wetlands and their hydrological, ecological, social and economic functions and services. In that line, section 5(1)(b) requires that an environmental impact assessment and environmental audits as required under the Act shall be mandatory for all activities likely to have an adverse impact on the wetland.

*While this report serves as a compliance to the section 5(1)(b), the proponent and the contractor will be required to ensure that the project complies with all the relevant provisions of the act, especially those that have been cited above. This should be achieved in terms of project design, sitting and adherence to good engineering practices during construction phase.*

### **3.1.1.3 Environmental Management and Co-ordination Waste Management Regulations, 2006 (Legal Notice No. 121)**

The regulations are formed under sections 92 and 147 of the Environmental Management and Coordination Act, 1999. Under the regulations (Part I CAP 243), a waste generator is defined as any person whose activities produces waste while waste management is the administration or operation used in handling, packaging, treatment, conditioning, storage and disposal of waste. Part II of the regulations requires a waste generator to collect, segregate and dispose each category of waste in such manners and facilities as provided by relevant authorities. Part II section 9 states that, licensed persons shall operate transportation vehicles approved by NEMA and will collect waste from designated areas and deliver to designated disposal sites.

*This regulation puts specific obligation on the contractor to ensure that the waste generated (especially the bulk soils which will be generated during the excavation for the dam construction) is carefully handled and transported to a designated place offsite. Any other wastes generated during the construction phase and from the campsite will also require proper handling and safe disposal.*

### **3.1.1.4 Environmental Management and Co-ordination Noise and Excessive Vibration Pollution Control Regulations, 2009**

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

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

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

*It is anticipated that heavy machinery and other construction equipment will be used during the construction phase of the project. As such, the use of these will have to comply with the regulations set aside regarding noise and excessive vibration pollution control.*

#### 3.1.1.5 Environmental Management and Co-ordination Air Quality Regulations

Under the general prohibitions (Part II), section 5 states that no person shall act in a way that directly or indirectly causes immediate or subsequent air pollution. Among the prohibitions are priority air pollutants (as listed under schedule 2 of the regulations) that include general pollutants, mobile sources and greenhouse gases. Odors are also prohibited under section 9 of the regulations (offensive emissions). Emissions into controlled areas such as schools, hospitals, residential areas and populated urban centers are also prohibited. Other sources recognized at sections 32 and 33 are those arising from construction equipment and materials as well as particulate matter from demolitions of structures and buildings as well as stockpiled dry materials.

*The requirements of this regulation will be relevant during the construction phase when the generation of particulate matter (PM) and emission of noxious and greenhouse gases (NO<sub>x</sub>, CO<sub>2</sub>, CO, SO<sub>x</sub> etc) are anticipated. And, as is applicable under the Noise and Excessive Vibration Pollution Control Regulations, 2009, it is anticipated that heavy machinery and other construction equipment will be used during the construction phase of the project. As such, the use of these will have to comply with the regulations set aside regarding emissions resulting from fuel combustion.*

#### 3.1.1.6 Environmental Management and Co-ordination Conservation of Biodiversity, Access to Genetic Resources and Benefit Sharing Regulations 2006

The Conservation of Biodiversity Act Sections 5-9 provides for the protection of endangered species, creation of an inventory, and monitoring of their status, protection of environmentally significant areas, provision of access permits, material transfer agreements and benefit sharing. Part II of Regulations, section 4 states that no person

shall engage in any activity that may have adverse impacts on ecosystems, lead to introduction of exotic species or lead to unsustainable use of natural resources without an EIA license. The regulation puts in place measures to control and regulate access and utilization of biological diversity that include among others banning and restricting access to threatened species for regeneration purposes. It also provides for protection of land, sea, lake or river declared to be a protected natural environmental system in accordance to section 54 of EMCA, 1999.

*Thuchi Dam project is proposed on a unique ecosystem. Part of the dam (more so the reservoir area) will touch the gazetted Mt. Kenya forest, which is also part of Mt. Kenya national park. Besides, it is located within the River Thuchi wetland area. The construction of the dam will result to some degree of destruction of vegetation, and may disrupt some wildlife and fish species. This regulation is therefore very important in regards to protection of particular species that may be found in the area. It makes it obligatory for an inventory of the species in the area and their characteristics to be generated.*

### **3.1.2 The Environment Impact (Assessment and Auditing) Regulations, 2003**

Legal Notice No. 101 stipulates the ways in which environmental experts should conduct Environmental Impact Assessment and Audits in conformity with the stated requirements. It is concise in its report content requirements, processes of public participation, licensing procedures, inspections and any possible offences under the Act. Section 58 of the EMCA No.8 of 1999, second schedule 9 (I) and environmental (impact assessments and audits) regulation 203, stipulate that both new and old projects must undergo EIA and audits. This is 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. In section 8(e) of the Second schedule of EMCA, this project is among the listed projects that require an Environmental Impact Assessment before the start of the project.

*This report has been done to meet the requirements of EMCA for the projects approval.*

### **3.1.3 The Water Act 2002**

Part II section 18 of the act provides for national monitoring and information systems on water resources. Following on this, sub-section 3 allows the Water Resources Management Authority (WRMA) to demand from any person, specified information, documents, samples or materials on water resources. Under these rules, specific records may be required to be kept and the information thereof furnished to the authority on demand. Section 25 of the Act requires a permit to be obtained for among others any use of water from a water resources, discharge of a pollutant into any water resource. According to section 29 of the same Act, application for such a permit shall be subject to public consultation as well as an environmental impact assessment as per the Environmental Management and Coordination Act, 1999.

The conditions of the permit may also be varied if the authority feels that the water so used is causing deterioration of water quality or causing shortage of water for other purposes that the authority may consider has priority. This is provided for under section 35 of the Act. Section 73 of the Act allows a person with a license to supply water (licensee) to make regulations for purposes of protecting against degradation of sources of water, which he is authorized to take. Under the Act, the licensee could be a local authority, a private Trust or an individual and the law will apply accordingly under the supervision of the Regulatory Board. Section 75 and sub-section 1 allows a

licensee for water supply to construct and maintain drains, sewers and other works for intercepting, treating or disposing of any foul water arising or flowing upon land for preventing water belonging to the licensee or which he is authorized to take for supply from being polluted. However, if the proposed works will affect or is likely to affect any body of water in the catchment, the licensee shall obtain consent from the Water Resources Management Authority.

*The project, when completed, will be involved in abstraction of water from Thuchi River and Kiajege stream. A permit has to be acquired from WRMA in order to comply with this act.*

### **3.1.4 Public Health Act (Cap.242)**

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

*The use of machinery during the construction phase, with possibility of oil leaks and spillage in the area, the steep gradient of the area and the close proximity to river Thuchi, the spills, soil particles and other wastes may find their way to the river, thereby causing pollution of the river and becoming a nuisance to the people downstream. The contractor will have to comply with the regulations as provided to ensure that no activity that takes place during the project phase generates consequences that could be injurious or dangerous to human health. From the act the local authority have the mandate to visit the site and ensure that the area is kept clean and that they are adhering to the set rules and regulations.*

### **3.1.5 Occupational safety and Health Act Cap 514**

Part IV of the act covers health issues. Part V covers safety, operation and maintenance of machinery, fencing requirements, storage of dangerous substances, training, and supervision of workers. Part X deals with welfare issues: drinking water supply, washing facilities, sitting areas and first aid provision. Part IX deals with chemical safety. Section 53 of this Act requires that for workers employed in a process involving exposure to any injurious or offensive substances, suitable protective clothing and appliances (gloves, footwear, goggles, and head coverage) shall be provided.

*The project will employ a number of people both from the locality and from other places. The relevant stakeholders will therefore have to ensure that they comply with this act while dealing with their employees.*

### **3.1.6 The Forest Act**

The Forest Act No. 7 of 2005 consolidates all forests under the act, and prescribes heavy penalties for damage to forests and trees. 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 is intended to 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, riverine and shoreline protection. The Act puts emphasis on the need to strengthen community-based institutions by creation of Community Forest Associations, which gives the public a greater participatory role to the community in the forest conservation.

*This act is important as its mandate is to protect the forest from any damage. Since this project will occupy part of a gazetted forest area, the proponent will have to seek relevant authorization from all the concerned institutions (and where necessary obtain a legal mandate to operate in such an area) before any development activity is initiated. This may include seeking legal means to de-gazette any part of the forest that may be affected by construction activities, or that may be submerged by the dam's reservoir area.*

### **3.1.7 The Agriculture Act (Chapter 318)**

The Agriculture Act is the principal land use statute covering inter alia soil conservation, agricultural land use and conservation issues such as the preservation of soil fertility. The Act (Part IV) prohibits any land use practices that may intensify soil erosion. They prohibit cutting down or destroying vegetation on any land of which the slope is 35 per cent. The rules stipulate strict regulations on the cultivation of any land whose slope is between 12 percent and 35 per cent when the soil is not properly protected from erosion. The Act also provides for protection of watercourses setting aside a riparian zone of a minimum 2 meters equivalent to the width of river to a maximum of 30 meters.

*The proposed project will be implemented partly on an agricultural land. As a result, part IV that prohibits acts that may intensify soil erosion will apply. The act also requires for the protection of watercourses. Further, during the operation phase, the proposed project will be focusing on agricultural practices (irrigation). This act therefore draws attention to the obligation places on the proponent and contractor to ensure no unnecessary damages to the land and water resources as a result of the project implementation.*

### **3.1.8 Physical Planning Act (Cap 286)**

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

Section 30 states that any person who carries out development within an area of a local authority without development permission shall be guilty of an offence and the development shall be invalid. The act also gives the local authority power to compel the developer to restore the land on which such development has taken place to its original conditions within a period of ninety days. If no action is taken, then the council will restore the land and recover the cost incurred thereto from the developer. In addition, the same section also states that no person shall carry out development within the area of a local authority without development permission granted by the local authority.

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

*The proponent will be expected to notify and to seek necessary local approvals for its planned development, including approvals for project designs and plans.*

### **3.1.9 The Penal Code (Cap.63)**

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

*It is therefore necessary for the contractor to make site-specific arrangements to ensure that their operations are carried out within the allowable limits. The wastes, products and by-products that may corrupt and or pollute water and atmosphere, thereby giving sufficient ground for affected persons to constitute legal proceeding against the constructor will need to be excluded or to be kept to a minimum level*

### **3.1.10 The Wildlife Conservation and Management Act 2013**

Part IV section 29 of this act states that the holder of a permit or license under this act shall use the land in question in accordance with the requirement for sustainable use of land. Section 30 outlines that any activity which is likely to have adverse effects on the environment including the seepage of toxic waste into streams, rivers, lakes and wetlands is prohibited.

*The proponent will therefore need to get a permit to use part of the forest as a reservoir as per this act and also ensure that there are no adverse effects on the environment.*

## **3.2 POLICY PROVISIONS**

### **3.2.1 Constitution of Kenya 2010**

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

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

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

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

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

*The provisions of the Kenyan Constitution therefore requires that wide consultations between the project proponent and key stakeholders (including the relevant institutions and the wider public, especially the affected*

persons) be held to ensure the right of Kenyans to enjoy a cleaner and sustainable environment versus the right to enjoy the potential benefits that the proposed development may bring are matched.

### **3.2.2 The Kenya Vision 2030**

Kenya Vision 2030 is the current national development blueprint for period 2008 to 2030 and was developed following on the successful implementation of the Economic Recovery Strategy for Wealth and Employment Creation which saw the country's economy back on the path to rapid growth since 2002. The objective of the vision 2030 is to transform Kenya into a middle income Country with a consistent annual growth of 10 % by the year 2030.

*One of the aims of the vision is to make Kenya to be a nation that has a clean, secure and sustainable environment by 2030. This will be achieved through promoting environmental conservation to better support the economic pillar.*

### **3.2.3 National Environment Action Plan (NEAP)**

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

### **3.2.4 National Policy on Water Resources Management and Development**

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

While the National Policy on Water Resources Management and Development (1999) enhances a systematic development of water facilities in all sectors for promotion of the country's socio-economic progress, it also recognizes the byproducts of this process as waste water. It, therefore, calls for development of appropriate sanitation systems to protect people's health and water resources from institutional pollution.

Development projects, therefore, should be accompanied by corresponding waste management systems to handle the waste water and other waste emanating there from. The same policy requires that such projects should also undergo comprehensive EIAs that will provide suitable measures to be taken to ensure

environmental resources and people's health in the immediate neighborhood and further downstream are not negatively impacted by the emissions.

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

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

- To ensure that from the onset, all development policies, programs and projects take environmental considerations into account,
- To ensure that an independent environmental impact assessment (EIA) report is prepared for any development before implementation,
- To ensure that effluent treatment standards will conform to acceptable health standards

### **3.2.6 The Agricultural Policy**

In Kenya the agricultural policy revolves around key areas of policy concern including increasing agricultural productivity, especially for small-holder farmers, emphasis on irrigation, encourage diversification into non-traditional agriculture commodities, enhancing food security, encourage private sector-led development and ensure environmental sustainability. The policy observes that droughts and floods have increased in frequency and intensity in the past three decades resulting in high crop failure and livestock death. Increased land degradation has decreased land resilience thereby exacerbating the effects of drought and floods leading to devastating famine that has taken a toll on human and animal lives. Some of the famine experienced could have been avoided or their impacts significantly mitigated.

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

### **3.2.7 Land Policy**

Environmental management principles: To restore the environmental integrity the government shall introduce incentives and encourage use of technology and scientific methods for soil conservation. Fragile ecosystems shall be managed and protected by developing a comprehensive land use policy bearing in mind the needs of the surrounding communities. The sustainable management of land based natural resources depends largely on the governance system that defines the relationships between people, and between people and resources. To achieve an integrated approach to management of land based natural resources, all policies, regulations and laws dealing with these resources shall be harmonized with the framework established by the Environmental Management and Coordination Act (EMCA), 1999.

### 3.2.8 Draft National Irrigation Policy

There is large scale rained and irrigation farming mainly on the Kenyan side. The Draft National Irrigation Policy<sup>15</sup> aims at achieving sustainable development and management of the irrigation and drainage sector. The policy direction shifts the role of the Government from implementation of the policy and let communities, the private sector and other sector stakeholders to play a bigger role.

The policy objectives include:

1. To fully develop the irrigation and drainage potential in the country for economic development
2. To effectively regulate, coordinate and manage all activities within the irrigation sub-sector to create an appropriate financing system that will attract investment into the sector
3. To create an enabling environment for effective participation of the farmers' organizations and other stakeholders in the provision of quality and cost-effective support services
4. To enhance a multi-sectoral approach to irrigation research and development involving Government, private, Civil Society and Communities.

In the absence of an Irrigation Policy, the Ministry of Water and Irrigation has developed guidelines for the development, operation and management of smallholder farmer-managed schemes. The Irrigation Development Board has developed guidelines and manuals to direct the development of smallholder irrigation and the process of community participation for sustainable development.

### 3.2.9 Millennium Development Goals 2006

Chapter 2 goal 7A is focused on ensuring environmental sustainability by integrating the principals of environmental sustainability into country policies and programs and reverses the loss of environmental resources. Part 7.1 deals with the proportion of land area covered by forest, while 7.4 proportion of fish stocks within safe biological limits and 7.5 proportions of total water resources.

*This project will have an effect on forest land, fish habitat and water resources and the stipulated guidelines under these goals will have to be adhered to in order to ensure environmental sustainability.*

## 3.3 INSTITUTIONAL STRUCTURE

### 3.3.1 National Irrigation Board

The mission of the National Irrigation Board is to develop, promote and improve irrigated agriculture through sustainable exploitation of available irrigation and drainage potential in Kenya in order to ensure food security and security and create wealth and employment, therefore improving the living standards of Kenyans.

The core functions are:

1. Controlling and improving national irrigation scheme in the country;
2. Conducting research and investigating into the establishment of national irrigation schemes;

3. Designing, constructing, supervising and administering irrigation schemes;
4. Determining the number of settlers to be accommodated in national irrigation schemes;
5. Coordinating and planning settlement on national irrigation schemes;
6. Promoting marketing of crops and produce grown or produced in national irrigation schemes in liaison with organizations responsible for marketing of agriculture produce;
7. Formulating and executing policy regarding national irrigation schemes in conjunction with the water resources authority.

### **3.3.2 Ministry of water and irrigation**

The mandate is formulation, review and implementation of policy on the water sector, the irrigation and drainage sector and in the reclamation of degraded lands for sustainable development of our Nation.

The function includes:

1. Water harvesting and storage infrastructure for water conservation which will help in mitigation drought and feminine;
2. Catchments area conservation;
3. Water resources management policy;
4. Urban and rural water development and supply;
5. Waste water treatment and control;
6. National water conservation and pipeline corporation;
7. National irrigation policy which aims to sustainably accelerate development and performance improvement of irrigation, drainage and water storage;
8. Irrigation and dam construction schemes;
9. Flood preparedness and management to cope with and mitigate the impacts;
10. Water quality and pollution control by adopting the 'polluter pays' principles in order to ensure water user responsibility.

### **3.3.3 Ministry of Environment, Water and Natural Resources**

The mandate of the ministry is to monitor, protect, conserve and manage the environment and natural resources through sustainable exploitation for socio-economic development aimed at eradication of poverty, improving living standards and ensuring that a clean environment is sustained now and in the future. The ministry comprises of various divisions at the headquarters and the following parastatals and departments

- National Environment Management Authority
- Kenya Meteorological Department

- Mines and Geology Department
- Department of Resource Surveys and Remote Sensing (DRSRS)

The following are the functions of the ministry include and are not limited to:

- Environment and Natural Resources Policy formulation, analysis and review
- Sustainable management of Mineral resources and conservation of environment
- Continuous development of geo-database for integrated natural resources and environmental management systems

Promote, monitor and coordinate environmental activities and enforce compliance of environmental regulations and guidelines

### **3.3.4 National Environmental Council (NEC)**

The National Environment Council (NEC) is established under Section 4 of EMCA. NEC which is chaired by the Cabinet Secretary in charge of the environment, is the highest policy making body under EMCA. NEC is responsible for policy formulation and directions for purposes of EMCA. NEC sets national goals and objectives and promotes cooperation among both public and private organizations engaged in environmental protection programs.

### **3.3.5 Public Complaints Committee**

The Public Complaints Committee is established under Section 31 of EMCA. The PCC is concerned with the investigation of complaints relating to environmental damage and degradation generally. The PCC has powers to investigate complaints against any person or even against NEMA or on its own motion investigate any suspected case of environmental degradation. The PCC is required by law to submit reports of its findings and recommendations to NEC. The law however is weak in that it does not provide PCC with the mandate to see its recommendations carried through. Further, NEC is not specifically required to do anything with regard to the reports submitted by the PCC and will often note and adopt the same without any further follow up action. So far the PCC has experienced challenges such as failure to honor summons, hostility between parties, hostility directed at PCC investigators, lack of understanding of EMCA and abdication of duty by Lead Agencies.

### **3.3.6 National Environment Action Plan Committee (NEAP)**

The National Environment Action Plan Committee (NEAP) is established under Section 37 of EMCA. This cross-sectoral committee is responsible inter alia, for the development of a five year national environment action plan. The national environment action plan shall contain among other aspects analysis of the natural resources of Kenya and their distribution, quantity and various uses. It shall also recommend legal and fiscal incentives for business that incorporate environmental requirements into their planning and operational processes as well set out guidelines for the planning and management of the environment and natural resources. The national environment action plan shall upon adoption by Parliament be binding on all organs of government. Provincial and district environmental committees are also required to develop their own five year environmental action plans which are incorporated in the national environment action plan

### 3.3.7 Water Services Regulatory Board (WSREB)

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

- a. Overseeing the implementation of policies and strategies relating to provision of water services licensing of Water Services Boards and approving their appointed Water Services Providers,
- b. Monitoring the performance of the Water Services Boards and Water Services Providers, Establish the procedure of customer complaints,
- c. Inform the public on the sector performance,
- d. Gives advice to the Minister in charge of water affairs.
- e. Regulating the provision of water and sewerage services including licensing, quality assurance, and issuance of guidelines for tariffs, prices and disputes resolution.

### 3.3.8 Water Resources Management Authority (WRMA)

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

- a) Implementation of policies and strategies relating to management of Water resources  
Development of principles, guidelines and procedures for the allocation of water,
- b) Development of Catchments level management strategies including appointment of catchments area advisory committees,
- c) Regulate and protect water resources quality from adverse impacts,
- d) Classify, monitor and allocate water resources.

### 3.3.9 Water Services Trust Fund (WSTF)

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

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

### **3.3.10 Water Services Boards (WSBs)**

The WSBs are responsible for the efficient and economical provision of water and sewerage services in their areas of jurisdiction. Tana Water Services Board (TWSB) is among the seven catchment Boards established under the Act mandated to;

- (i) Develop the facilities, prepare business plans and performance targets
- (ii) Planning for efficient and economical provision of Water and sewerage services within their areas of jurisdiction;
- (iii) Appointing and contracting Water Service Provider
- (iv) Asset holding of Central Government facilities

### **3.3.11 NEMA Compliance**

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

## 4 PROJECT DESCRIPTION

### 4.1 Location and site

The proposed Thuchi dam will be located at the border of Embu and Tharaka Nithi counties at the edge of Mt. Kenya Forest. The dam is on the shared border between Runyenjes and Chuka Sub-Counties in Embu and Tharaka Nithi Counties respectively. Figures 1.1 and 1.2 show the location of the dam. The dam is located at the following coordinates: (37N 341002, 9959189) (37N 341195, 9959564) (37N 340998, 9959183)(37N 341197, 9959566).



Figure 4-1: Location of the dam

### 4.2 Project Design and Plan

Based on the preliminary geological and geotechnical investigations and studies, the dam considered under this study is an, earth fill embankment with a core. The planned crest elevation will be at sufficient level to cater for 23 MCM storage and a sufficient freeboard to avoid overtopping.

The general arrangement includes a spillway and a low level diversion tunnel. The tunnel will house the downstream release flow pipe and the draw-off pipe. It has been established that the materials required to construct the dam will be available in the immediate vicinity of the dam except for the core material that shall have to be source about 5km away.

#### 4.2.1 Embankment

The embankment slopes are proposed to be 1:4 –3 upstream and downstream respectively. There will be 7 m cofferdam. There will either be a clay core or a concrete facing on the upstream side of the dam. The clay core will slope at 1:0.3. A toe drain will be provided on the downstream side of the dam. Its materials can be

developed from the rock deposits within the potential cuts or potential borrow areas. Rip-rap for erosion protection will be placed on the upstream face while grassing on the downstream face.

It may be necessary to provide a grout curtain under the core trench depending on results obtained from the drilling and permeability testing. The purpose of this grout curtain would primarily be to address the potential for seepage through fractured zones oriented roughly parallel to the valley wall along with zones oriented roughly parallel to bedding if any.

#### **4.2.2 Diversion Culvert**

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

An adequate slope for drainage will be ensured. A rectangular cross-section for the culvert will be adopted. This will allow higher flow at lower depths for diversion purposes and easier construction compared to a circular cross-section which has better hydraulic characteristics. The control gate chamber will be located at the upstream end of the culvert to enable dewatering of the conduit for inspection purposes.

#### **4.2.3 Draw-off works**

Draw-off pipes will be installed in the diversion tunnel once the dam is complete. The water drawn from the dam will pass through the diversion culvert to downstream side.

#### **4.2.4 Design of Spillway**

Either an open channel spillway or a morning glory spillway will be provided to prevent the dam from overtopping. At the end of the spillway will be a stilling basin

#### **4.2.5 Dam Access, Pipeline Connection and irrigation areas**

The access to the dam will be through the existing roads. The roads will be upgraded to all weather roads before commencement of the dam construction.

### **4.3 Design Alternatives**

The consultants explored the most economical design to arrive at the choices settled on for various components.

### **4.4 Construction Techniques**

The contractor will have to choose methods that least damage existing ecological systems. The proposed Project will be constructed using modern, locally and internationally accepted materials to achieve public health, safety, security and environmental aesthetic requirements. Locally sourced materials such as stones, cement, sand, pipes and fittings that meet the Kenya Bureau of standards requirements will be used. At the same time materials such as valves that will be imported will meet the internationally accepted standards.

## 5 BASELINE ENVIRONMENTAL CONDITIONS

### 5.1 Topography and relief

The geographical expanse which forms the Embu County rises from about 700m above sea level at the Tana River basin in the East to about 5200 m at the top of Mount Kenya in the North-west. It is topography of plains (e.g. Mwea) some isolated hills such as Ki valleys as you approach mount Kenya. The proposed Thuchi dam will be located in sites characterized by rugged topography, with several small valleys and ridges, which are the source of the major stream tributaries and springs feeding the River Thuchi basin. Elevations of the catchment area above sea level ranges between 1540-4090 masl.

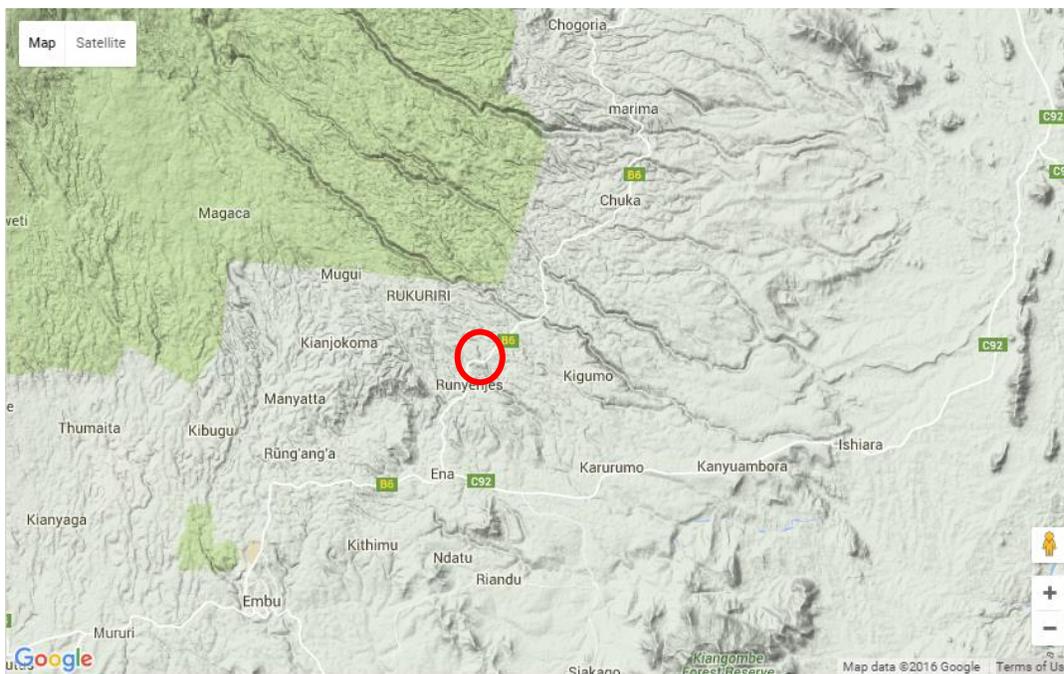


Figure 5-1: Terrain map

### 5.2 Rainfall

Thuchi area, in Runyenjes, has a tropical climate. The area receives bimodal rainfall. The long rains are between the months March-May. The short rains are in the months of October- December with maximum being in November. According to long term statistics of the region, maximum rainfall is received in April, while February record lowest averages. Table 1 below gives rainfall distributions around the Thuchi river basin (mm).

Table 5-1: Rainfall distributions around the Thuchi river basin (mm)

Month	Catchment		Tea Zone	Coffee Zone	Cotton Zone
	Kerugoya Castle (9037115)	Embu Met (9037202)	Irangi Forest 9037077	Ena Leaf 9037164	Karurumo 9037172
Jan	71.1	40.7	71.1	32.9	48.6
Feb	40	22.1	40	22.7	38.1
March	111.9	109.1	111.9	88.3	87.8
April	352.1	306.7	352.1	316.5	265.2
May	442.9	170.8	442.9	71.1	91.3
June	125.9	28.6	125.9	8.8	13.3
July	129	28.4	129	6.2	12.8
August	134.6	38	134.6	2.5	5
September	98.7	31.7	98.7	12.5	12.3
October	228.3	169.9	228.3	137.9	136.2
November	71.1	248.3	215.3	259	48.6
December	40	73.8	71.1	32.9	38.1
Annual	1845.6	1268.1	2020.9	991.3	797.3

### 5.3 Temperature

The temperature increases from upstream to downstream, the lowest temperatures being experienced in June – July. The warmest month of the year is March with an average temperature of 21°C. July has the lowest average temperature of the year at 18°C.

The average annual temperature in Runyenjes is 19.6°C

### 5.4 Geology and Soils

#### 5.4.1 Geology

The rock succession and the chief geological events of the evolution of the general project area are summarized in the Table 2 (after Schoeman, 1951/2007). This general evaluation is essential in understanding the geology of the area, because the interrelationships of the various rock types determine the structural geology and other features that rock foundation such as weathering, deposition and faulting system. The project area does not seem to have experienced any regional faulting. The foundation conditions in this area seem to be controlled by deposition of weathered material on peneplanation surfaces and folding and foliation on Basement System rocks. The table below is a summary of geological events.

Table 5-2: Summary of Chief Geological Events of General Project Area

Age	Formations	Earth Movements, Climatic and Erosion Phases
Recent	Soils, Laterites, Calcretes	Re-excavation of river gravels dry -----
Pleistocene	U –River gravels and sands, lateritic soils	Gamblian Pluvial Period
	M –Gravel beds (Thuchi river) Parasitic Cones (Kenytes)	Kamasian Pluvial Period; local peneplanation.
	L –Olivine Basalts (Nyambeni Volcanic Series)	Laterite formation at times, erosion reaching maturity
	-----	Disturbance
Pliocene	Mount Kenya Volcanic Series (Kenytes)	End-Tertiary Peneplanation,
	-----	Disturbance;
Miocene		Sub-Miocene peneplanation;
	-----	Disturbance;
Cretaceous		Peneplanation
Pre-Cambrian (Archaean)	Basement System rocks	Deposition of sedimentary formation that underwent folding, and metamorphism

The rocks present in Thuchi project area are Kenytes (a type of lava) which were erupted as part of the Mount Kenya volcanic activity. In the present state they directly overlie the sub-Miocene peneplanation indicating that no other volcanic formation between them and the weathered and deformed Basement System rocks. The succession of the Mount Kenya Volcanic Series is as shown below:

- i.) Basalts of Parasitic craters (not present in Thuchi project area).
- ii.) Olivine basalts –unknown thickness (not present in Thuchi project area).

- iii.) Finely porphyritic and dense phonolites –more than 610 m thickness (not present in Thuchi project area).Kenytes –over 914 m in thickness –this is the country rock of Thuchi dam site Area
- iv.) Basalts with phonolites –no thick (not present in Thuchi project area)

From the general study we conclude that the geology of Thuchi dam sites area is composed of a thick complex of Mount Kenya volcanic rocks consisting of inter-bedded lavas, agglomerates and tuffs whose thickness reaches over 900 m. These rocks overlie a flat surface of the sub-Miocene Penepplain. The structural geology of the area indicates that NO major faults are present and any deformational structures are only in the underlying deep seated Basement System rocks. The site is therefore on stable geological foundation.

#### 5.4.2 Ecological Condition

The Farm management handbook (2006) describes Embu County as portraying a typical agro-ecological profile of the windward side of the mountain. From cold and wet upper zones to hot and dry lower zones in the Tana River Basin. The farm management handbook continues to report that the average annual rainfall reflects this contrast: from more than 2200 mm at 2500 m to less than 600 mm near the Tana River at 700 m above sea level. The variation is mainly due to the mountain but also to the “water recycling” effect of the forest by evapo-transpiration. Above 2500 m, rainfall decreases due to the lower moisture content of the colder air and the stronger influence of the trade wind system, but nevertheless the area is still very wet.

River Thuchi, the host of the proposed dam originates high up in Mount Kenya and circumvents her way out of the forest at Mutwetaru village. It is a permanent river with peak flow volumes reported in the months of April and May. Interviewed potential Project affected persons reported that during its peak, River Thuchi has a lot of water moving very fast and sometimes breaks her banks to carry with it any crops and farm structures that it finds on the way. ‘It is very furious’, an interviewee commended.

#### 5.4.3 Soils

The soils in the forest are dark brown and have a high organic matter added by the litter from the leaves of the trees. The cultivated area is characterized by brown to light brown deep fertile soils evidenced by the tea crop that they support. The riparian area has clay loam soils which are well drained.



*Figure 5-2:Light brown soils on a cultivated slope**Figure 5-3:Forest soils*

## 5.5 Seismicity

This is the frequency, intensity and distribution of earthquakes in a given area. Earthquake distribution and intensity varies within the different geographical zones in Kenya. The intensity of shaking is not strong to inflict serious damage, but can cause some cracks in walls as the houses in Kenya are mostly made of brick or adobe and are highly vulnerable for damage when serious shaking is taking place.

The seismicity of Embu county, Runyenjes constituency where the dam is located encounters an active continental rift in eastern Africa that appears to be a developing divergent tectonic plate boundary. This intensity is reported as **III MMI= a weak shaking**.

An earth tremor as reported from by the meteorological department on *Daily nation* as at 11th January 2016 records an occurrence within the vast parts of Embu county causing mild forms of earth tremor. The occurrence was associated with the short durational movement that was felt within sections of the county as seen for Runyenjes.

The epicenter for the county had still not been identified as the meteorological department reports, but the effect was felt when the dam site residents and those living a round River Thuchi.

### 5.5.1 Seismic Distribution Map (WHO)

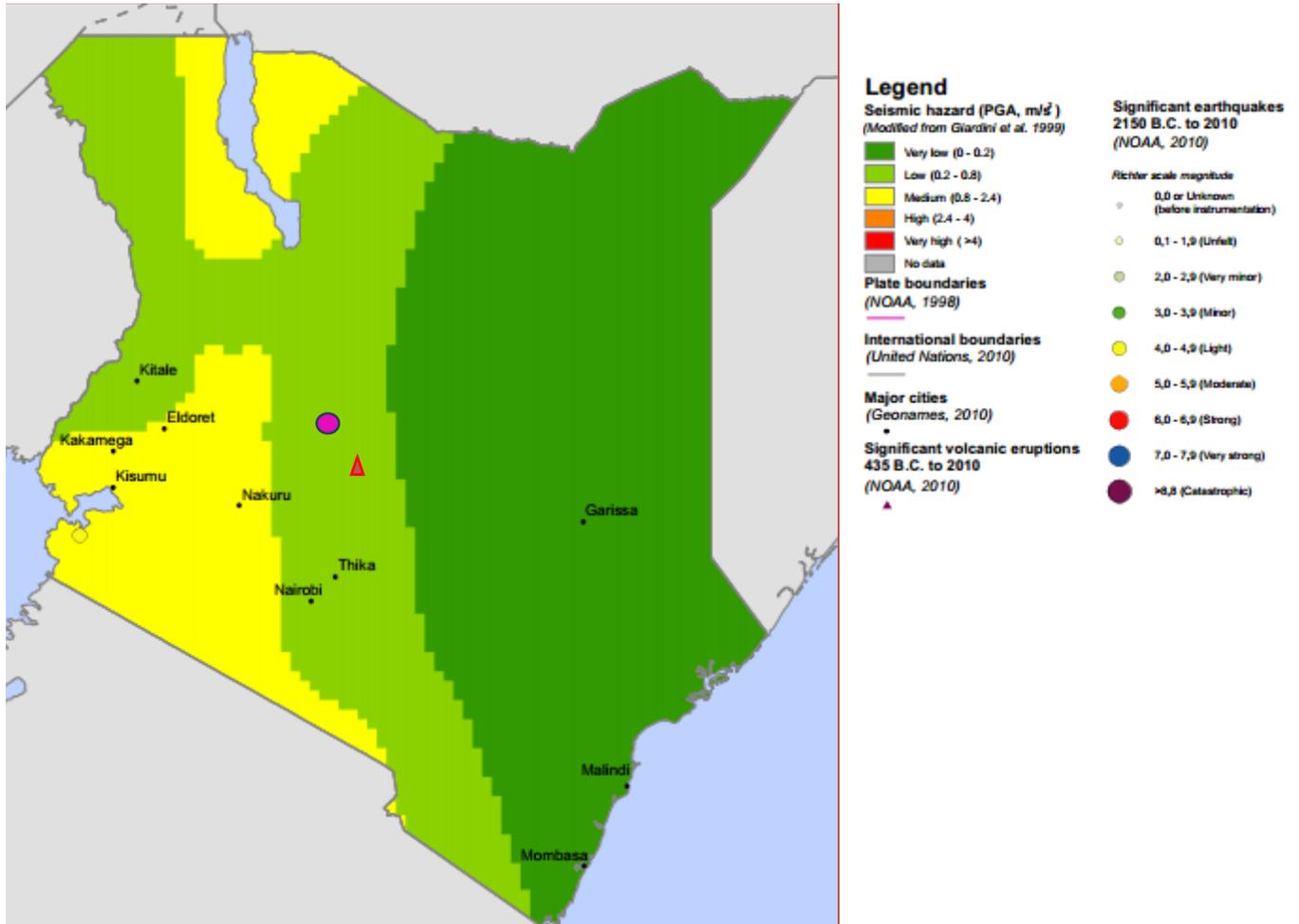


Figure 5-4: Seismic distribution map

The proposed Thuchi dam as indicated falls within the great eastern rift valley floor region. This makes it exhibit similar earthquake intensities, seismic hazards and even the distribution frequencies within the entire regions. An occurrence of other schemes and dams around the region i.e. Kindaruma ( $0^{\circ}43'35.58''S$   $37^{\circ}48'44.05''E$ ), Kamburu, ( $37^{\circ}50'11.67''E$ ,  $0^{\circ}48'29.0''S$ ), and Masinga ( $0^{\circ}52'50''S$ ,  $35^{\circ}35'20.8''E$ ) set a good precedence for the engineering work.

### 5.6 Radio Activity

The proposed project site has no radio activity since it lies in a rural area with no industries or military base which are indicators of potential radio activity. There is therefore no need for measurement of radio activity.

## 5.7 Vegetation cover

The area covers both forest area and farmlands. In the farmlands, most natural vegetation has been cleared to pave way for farming. The natural vegetation is either a fence, within homesteads or along the river. Some of the natural species include: *Anthocleista grandiflora*, *Casearia battiscombei*, *Commiphora eminii*, *Cordia abyssinica*, *Croton macrostachyus*, *Croton megalocarpus*, *Ehretia cymosa*, *Ficus sur*, and *Myrianthus holstii*. Agroforestry trees include: mangoes, avocados and macadamia.

The area is extensively farmed with tea on the steep slopes and subsistence farming at the valley near the river. Some of the crops farmed are: maize, beans, kales and bananas.

The forest is a highland forest with high species diversity both planted and natural. It is a well-managed forest with minimal disturbance and canopy closure of about 70%. The forest has a thick underground covered with shrubs and herbs including: *Clerodendrum johnstonii*, *Cyperus immensus*, *Cythea manniala*, *Eregrostis*, *Hypoestes aristata*, *Oplismenus bumanii*, *Pipers capense*, *Pteridium aquillinum*, *Rhus pinato* and *Solanum incanum*. The forest trees are listed in the table below.

Table 5-3: Forest Trees

Scientific Name	Local Name
<i>Anthoclaesta grandiflora</i>	Mutunguru (kik), Mutete (Mer)
<i>Arubizia gimifera</i>	Mukurue (kik), Mukurue (Mer)
<i>Casearia battiscombei</i>	Muirungi (kik), Munogo(Mer)
<i>Celtis Africana</i>	Murundu(kik), Murundu(Mer)
<i>Cola greenwayi</i>	Murundu(kik), Murundu(Mer)
<i>Croton macrostachyus</i>	Mutundu (kik), Mutundu(Mer)
<i>Ehretia cymosa</i>	Murembu(kik), Murembu(Mer)
<i>Ficus sur</i>	Mukuyu (kik)
<i>Harungana madagascariensis</i>	Muithathua(kik), Munyanwe(Mer)
<i>Makaranga kilimandischarica</i>	Mukuhakuha(kik), (Mer)
<i>Myriathus holstii</i>	Mutuya(kik), Mutuya(Mer)

Neoboutonia macrocalyx	Mutundu (kik), Mutuntuki(Mer)
Ocotea usmbarensis	Muthaiti (kik), Muura(Mer)
Polysias fulva	Mutati (kik), Mukurukuru (Mer)
Prunus Africana	Muiri (kik), Mweria (Mer)
Rhamnus staddo	Mubura (kik)
Syzygium cuminii	Mukoe (kik), Muiru (Mer)
Strombosia scheffleri	Muthiringu (kik), Mutimuiru (Mer)
Terbanaemontana stapfiana	Mwerere (kik), Muerere (Mer)
Trchilia emitica	Mururi (kik), Mutwati (Mer)
Vengueria madagascariensis	Mubiru (kik), Mubiru (Mer)
Xymalos monospora	Mukohokoho(kik), Muako(Mer)
Zanthoxylum usambarensis	Muguchwa (kik), (Mer)

The trees in the forest not only vary in species but also in height and frequency of occurrence. The table below shows the average height of various species and the diameter at breast height.

Table 5-4: Average height and Dbh per species

Species	Height (feet)	Diameter at breast height (cm)
Anthoclaesta grandiflora	13.5	18
Casearia battiscombei	12	7
Celtis africana	25	18

<i>Cola greenwayi</i>	15	10
<i>Croton macrostachyus</i>	25	18
<i>Ehretia cymosa</i>	10	12
<i>Ficus sur</i>	40	150
<i>Harungana madagascariensis</i>	13	12
<i>Makaranga kilimandischarica</i>	18	11
<i>Myriathus holstii</i>	18	15

<i>Neoboutonia macrocalyx</i>	18	12
<i>Ocotea usmbarensis</i>	25	22
<i>Polysias fulva</i>	5	3
<i>Prunus africana</i>	15	10
<i>Rhamnus staddo</i>	20	15
<i>Syzygium cuminii</i>	18.2	20.8
<i>Terbanaemontana stapfiana</i>	22.3	28.3
<i>Trchilia emitica</i>	8	12
<i>Xymalos monospora</i>	10.3	17.6
<i>Zanthoxylum usambarensense</i>	10	11



Figure 5-5: Farmed area



Figure 5-6: Forest

## 5.8 Land Use and Land Cover

The catchment area under consideration for location of the proposed water reservoirs on River Thuchi is wholly in the gazetted Mount Kenya forest and national park.

Mount Kenya forest is along the equatorial trough of the Intercontinental Convergency Zone (ITCZ) within a pressure cell where the south easterly and north easterly trade winds converge but due to local deference in elevation and continentality, the climate falls under “modified” equatorial climate.

The catchment area is covered by Moorland high altitude grass above 3000masl, Bamboo and thicket between 2500 and 3000masl and dense forest of thick natural forest woodland with heavy vegetation cover undergrowth between 1600 and 2500 masl.

## 5.9 Fauna

A number of wild animals are found in the forest. The most common are the elephants. They feed on grasses, leaves, bamboo, bark, roots, banana and sugarcane. Elephants can freely roam though in their natural habitat and they actually do lots of good for the environment. They clear away trees and plants so that new forms of vegetation can grow there. Incidents of elephants crossing from the forest to the farms had been reported in the past but currently there is an electric fence which acts as a barrier between the forest and the farmlands.

River Thuchi has different species of fish depending on the part of the river and these include: *Mastacembelus Victoria*, *Alestes nurse*, *Tilapia zilli* and *Clarias angullaris*. Cat fish (*Clarias angullaris*) is found in the forest and are only harvested in January0

*Mastacembelus Victoria* is a demersal species. It occurs in swamps, marginal wetlands and shallow coastal waters. Also found in temporary streams, rivers and floodplains generally living amongst vegetation, tree roots or rocks. It feeds on fish and insects; mainly on insect larvae.

*Alestes nurse*- is a pelagic, potamodromous species. It inhabits rivers, lakes, irrigation canals and fringing vegetation. It feeds on zooplankton, caridina, insects, snails and vegetation. It spawns at the beginning of the

rainy season and are full migrants. Dams, water pollution (agriculture, domestic and commercial/industrial) groundwater extraction and drought have been stated to all pose possible threats to this species.

*Tilapia zilli* – this species natural habitats are marginal vegetation and seasonal floodplain streams, lakes and ponds. They feed primarily on detritus, filamentous algae, aquatic macrophytes and plants of terrestrial origin.

*Clarias anguillaris* – This species is very common in inundated areas and bury themselves in the mud when the pools are drying up. They feed mainly on fish and mollusks also diatoms, detritus and bottom organisms. Reproduction takes place in the rainy season. This species are of minor importance in commercial fisheries.

Salmonidae (trout) – it's usually found in cool (50-60° F or 10-16° C) clear streams and lakes. Trout generally feed on other fish and soft bodied aquatic invertebrates such as flies, mayflies, caddieflies, stoneflies, mollusks and dragonflies.

The birds sited in the area are: *Vanellus armatus*, *Apus niansea*, *Dirurus adismilis*, *Nectariria kilimensis* and *Streptopelia semitorquata*.

### 5.10 Water resources and water quality

The County is served by six major rivers which are Thuchi, Tana, Kii, Ruringazi, Thiba and Ena. Several man made dams that serve the country's electricity needs are located in Embu County. They include Masinga dam, Kamburu dam, Kindaruma dam, Kiambere dam and Gitaru dam. The proposed Thuchi dam will add to the dam count in the county.

There are two main sources of water in the area selected for dam construction: surface and ground water resources. The surface water resources in the area include River Thuchi which is the main source of water and Kiajege stream. River Thuchi is an important source for domestic water and supports riparian agriculture as evidenced by farmlands on the riparian zone. Ground water resources include the numerous springs which dot the landscape and shallow wells found within the homesteads. The springs are mostly found on the ridges and steep slopes on the Embu side of the river Thuchi. The springs support farming of wetland crops like arrow roots among other crops. Shallow wells are mainly used by people who can't access the river. The area also has various community-based water projects which supply piped water to the community members. Some of the intakes of these projects are found in the section of the river that is in the forest.

The quality of the water resources in the area is generally good. River Thuchi has clear water, and this is a pointer to low pollution. For this reason, the local households usually consume its waters without any form of treatment. However, owing to the intense agricultural activities in the sub-catchment areas, the water quality of the river is increasingly being compromised. The area is steep therefore; when it rains runoff may wash off the residual fertilizers and other agrochemical farm inputs into the river. Pollution of the ground water may occur in the area either through fertilizers leaching to the lower horizons and mixing with the groundwater or through contamination through seepage from the pit latrines which are common among the households. This may be aggravated by the high water table (as evidenced by the springs).



Figure 5-7: spring



Figure 5-8: Clear water of River Thuchi

### 5.10.1 Domestic Water Demand

Domestic water demand has been categorized into human and livestock demands. The table 5 is a summary of the projected human population in Manyatta and Runyenjes constituencies based on the 2009 census projected at a growth rate of 1.4% to the ultimate design period of 50 years. Table 6 gives a summary of livestock population in the command area of the proposed dam.

Table 5-5: Projected Human Population to be served by Thuchi Dam (Manyatta an Runyenjes constituencies)

Location / Area	2009	FINAL Growth Rate/yr (%) - 1999-2009	Projected Population		
			2015	2025	2065
GATURI NORTH	24398	1.4%	26,521	30,476	61,074
KAGAARI SOUTH	20426	1.4%	22,203	25,515	51,131
CENTRAL	23600	1.4%	25,653	29,479	59,077
KAGAARI NORTH	24952	1.4%	27,123	31,168	62,461
KYENI NORTH	21546	1.4%	23,420	26,914	53,935
KYENI SOUTH	27438	1.4%	29,825	34,274	68,684
GATURI SOUTH	13,544	1.4%	14,722	16,918	33,904
<b>Totals</b>	<b>155,904</b>		<b>169,467</b>	<b>194,744</b>	<b>390,267</b>

Table 5-6: Livestock population

Livestock Type	Manyatta and Runyenjes Consituencies	Manyatta (By rations)	Runyenjes (By rations)	TOTALS
Cattle	67052.00	26859.26	40192.74	67052.00
Sheep	20716.00	8298.28	12417.72	20716.00

Livestock Type	Manyatta and Runyenjes Consituencies	Manyatta (By rations)	Runyenjes (By rations)	TOTALS
Goats	54116.00	21677.44	32438.56	54116.00
Camels	2.00	0.80	1.20	2.00
Donkeys	579.00	231.93	347.07	579.00
Pigs	5021.00	2011.28	3009.72	5021.00
Indigenous chicken	234489.00	93930.11	140558.89	234489.00
Commercial chicken	53217.00	21317.33	31899.67	53217.00
Beehives	26972.00	10804.27	16167.73	26972.00

### 5.10.2 Irrigation Water Requirements

The amount of water required to effectively support the 6,600 ha of Kagaari-Gaturi irrigation scheme was estimated in consideration of the crop, weather and irrigation areas of various parts of the project. CROPWAT 8.0 modelling software was used to determine the crop water requirements of the individual crops selected to represent the given proposed crops for the scheme. This was then amalgamated to give the projects global water demand that included various classes of losses.

### 5.10.3 Crop Water Requirement

The following factors/parameters were considered during the review of the general water requirements:

- i. Crops and cropping patterns;
- ii. Crop development stage factors (Kc);
- iii. Evapotranspiration and effective rainfall;
- iv.  $ET_{crop} = ETo \times Kc$

Where;

ETo =The Reference Evapotranspiration, obtained using the Penman-Monteith Method from a combination of climate data namely:

- i. Temperature
- ii. Humidity
- iii. Sunshine
- iv. wind speed

Kc Crop Coefficient at various growth stages taken from the crop parameter from FAO Crop Water Information resources

### 5.10.4 Domestic commercial and institution water demand.

The water demand for the proposed project is categorized into the following;

- Rural domestic Water demand
- Urban domestic Water demand

- Commercial Water Demand
- Institutional Water Demand

Water consumption is greatly influenced by the levels of income, the type of housing and the type of service. People with high and medium incomes can afford individual connections. However, people with low incomes will fetch water from shared facilities such as water kiosks.

In an effort to conserve and manage water better, water supply should be through metered connections. People living in low class housing in urban areas can only afford individual connections as time progresses. The service types and consumption rates recommended in the Practice Manual for Water Supply service in Kenya were used for estimation of water demands.

### 5.10.5 Total water demand

The total water demand is the sum of irrigation water, domestic, institutional and commercial water requirements. The table below gives the total water demand.

Table 5-7: Total water demand

Month	Irrigation Water Requirement (m <sup>3</sup> )	Domestic, Institutional & commercial @ 50yr (m <sup>3</sup> )	Total Water Demand (m <sup>3</sup> )
Jan	6,121,764	1,316,700	7,438,464
Feb	5,597,064	1,272,810	6,869,874
Mar	2,368,476	1,316,700	3,685,176
Apr	-	1,316,700	1,316,700
May	1,163,448	1,316,700	2,480,148
Jun	4,772,196	1,316,700	6,088,896
Jul	4,566,276	1,316,700	5,882,976
Aug	4,728,636	1,316,700	6,045,336
Sep	6,534,000	1,316,700	7,850,700
Oct	590,436	1,316,700	1,907,136
Nov	-	1,316,700	1,316,700
Dec	2,421,936	1,316,700	3,738,636
<b>Totals</b>	<b>38,864,232</b>	<b>15,756,510</b>	<b>54,620,742</b>

### 5.11 Infrastructure

There is access to the site through a road network from Runyenjes town. The larger part of the road is all weather but as one approaches the site it's a loose surface dry weather road. There are also two bridges across river Thuchi which are used to link Embu and Chuka sub-counties of Embu and Tharaka Nithi counties, respectively. One is in a poor state making it difficult to cross during the rainy season due to rising water levels in the river. The settlement around the area is majorly composed of wooden structures. However, there are some that are masonry. There is a primary school (Iriare) in the neighborhood. The residents use pit latrines since there is no sewer line within the area. The area is supplied with electricity as evidenced by an electric line.



Figure 5-9:Foot Bridges across River Thuchi

### 5.12 Land use

The farming system practiced in the project area is individual;/household production system whereby individual farmers manage their farms taking into account all the physical, economic and social factors of relevance to production individually.

Also, farmers in the area practice intercropping with very few that grow their crops as pure stands. The main cash crops found in the area are coffee and tea grown in the upper and middle land use zones that are relatively wet. Tea is marketed through Kenya Tea Development Authority (KTDA) while coffee marketed through various farmers' co-operative societies. The lower- altitude areas produce mainly food crops such as maize and beans, horticultural crops and fruits among others. These are produced for household consumption, domestic and export market.

Inorganic farming (production by use of inorganic fertilizers and agrochemicals) is the most dominant practice in the project area. However, some NGO'S are promoting organic farming in the area. The Ministry of Agriculture (MOA) and some Non-Governmental Organizations (NGO'S) working in the area promote both organic and inorganic farming because organic farming alone is not sustainable, has low productivity and calls high levels of expertise that might not be available in the project area.

The study found out that the project area has salient problems that affect agricultural production in the area. The major ones that were identified were:

- High dependence on rain-fed production
- Low investment in irrigated agriculture
- Inadequate rural infrastructure
- Inadequate credit
- Difficulties in marketing produce
- Poor group management
- Inadequate extension services
- Seasonal productivity leading to gluts

Hence, to improve on productivity, there is need to improve access roads and storage facilities in the area since most of produce are perishable. It is also necessary to build the farmers capacities on appropriate technologies as well as create market linkages for improved market access.

Zero grazing was the most dominant livestock production system practiced in the area. However its intensification goes on decreasing as one transacts the project area from the upper to the lower zones. The livestock breeds that are kept are mainly exotic ones mainly Fresian, Ayrshire and Guernsey. Some cross breeds also dot the project area and are more prominent in the lower zones of the project area. Some pig rearing is also practiced in the area. Poultry and goats are also kept, mainly in the lower zones of the project area. Milk marketing is done through both formal (cooperatives) and informal marketing systems like through middlemen and individual supply to local hotels and schools.

### 5.13 Crop Production

Agriculture is the mainstay of the Kenyan economy and currently represents 24% of the Gross Domestic Product (GDP) – vision 2030. More than one-third of Kenya's agricultural produce is exported and this accounts for 65% of Kenya's total exports. The agricultural sector accounts for 18% of total formal employment in the country.

There are more than 5 million smallholders engaged in different types of agricultural activities in the country. Estates and plantation farms of various sizes are fewer in number and make up a smaller part of the sector.

The agricultural sector is made up of four major sub- sectors namely, industrial crops, food crops, horticulture, livestock and fisheries.

1. Industrial crops contribute 55 % of export and 17% to the national GDP
2. Horticultural crops contribute 38.5% of exports and 33% to the national GDP
3. Food crops contribute 0.5% of exports and 32% to the national GDP
4. Livestock and fish contribute 6 % of exports and 14% to the national GDP

The major crops within the project area can be categorized as food crops, industrial crops and horticultural crops.

Maize and beans which are often intercropped comprise the most important food crops. Others are sweet potatoes, irish potatoes, sorghum and pulses in that order.

Industrial crops comprise of tea and coffee as the major crops. Macadamia is also an important industrial crop. There are also traces of cotton in the lower, drier area of the district. Bananas top the list of horticultural crops followed by mangoes and avocados. Other horticultural crops are paw paws, tomatoes, kales and French beans. Most of these are however in very small scale due to lack of irrigation and high dependency on rain fed agriculture.

#### 5.14 Land Tenure

Land holds a significant position in the social and economic well-being of the population. Land is key in meeting the basic subsistence needs of the households in the area and it's perceived to be as a source of wealth and prestige to the family.

Land ownership in the project area is predominantly free hold whereby it is registered with title deed under individual absolute ownership. Land sizes vary in acreage from ½ to 10 acres. Land use rights are passed down by inheritance, purchasing or leasing the land.

#### 5.15 Administrative and Political Units

Administratively, Embu County is divided into five sub counties and 12 divisions.

Table 5-8: Administrative units of Embu County (by division)

Sub-county	Division	Area (km <sup>2</sup> )
Embu West	Central	69.5
	Nembure	87.7
Embu North	Manyatta	111.7
Embu east	Runyejes	153.4
	Kyeni	100.4
Mbeere south	Gachoka	297.6
	Mwea	172.7
	Makima	342.2
	Kiritiri	508.9
Mbeere North	Evurore	409.8
	Siakago	361.3

##### 5.15.1 Population dynamics

The population of Embu county was computed at 516,909 (KNBS, 2009) and was projected to reach 561, 446 by 2015 with a sex ratio of 1:1. The youth in the age cohort 15-34 years are the majority at 34.5%. However, this consultant found that there are many young persons in the proposed project hosting sub-locations who are unemployed and they would like to work, given an opportunity. Table 9 gives a summary of the population dynamics of the wards where the dam project is proposed to be set up. The population details for the rest of the county are important to help assess resettlement options and this is given in table 10.

Table 5-9: Population dynamics of the host Sub- locations

Sublocation	County	Male	Female	Total	Households	Area[sq Km]	Density
-------------	--------	------	--------	-------	------------	-------------	---------

Kiangungi	Embu	1574	1568	3142	824	4.5	701
Iriari	Embu	1677	1713	3390	911	5.1	671
Nthambo	Tharaka Nithi	1938	1984	3922	962	7.0	562
<b>Total</b>		5189	5265	10454	2697	16.6	AV.644.7

**Source: KNBS, Population and Housing Census**

Table 5-10: Population characteristics of Embu

Constituency	Ward	Male	Female	Total	Household	Area
<b>Manyatta</b>	Ruguru-Ngandori	13,517	14,408	27,925	7,344	42.9
	Kithimu	9,329	9,670	18,999	4,769	46.7
	Nginda	14,163	14,348	28,511	7,176	43.7
	Mbeti North	16,746	16,722	33,468	9,618	52.6
	Kirimari	15,599	16,586	32,185	10,344	23.6
	Gaturi South	6,719	6,825	13,544	3,466	22.1
<b>Runyenjes</b>	Gaturi North	11,923	12,475	24,398	6,410	37.5
	Kagaari South	10,223	10,203	20,426	5,170	78.3
	Central	11,588	12,012	23,600	6,398	31.4
	Kagaari North	12,126	12,826	24,952	6,599	43.8
	Kyeni North	10,380	11,166	21,546	5,670	29.2
	Kyeni South	13,730	13,708	27,438	7,174	71.2
<b>Mbeere South</b>	Mwea	14,904	15,213	30,117	7,334	172.7
	Makima	10,841	10,450	21,291	4,896	342.3
	Mbeti South	15,269	14,310	29,579	7,308	255.2
	Mavuria	17,242	16,897	34,139	7,637	264.4
	Kiambere	7,268	7,791	15,059	3,406	287.0
<b>Mbeere North</b>	Nthawa	13,467	13,258	26,725	6,755	136.4
	Muminji	7,942	8,786	16,728	3,892	224.8
	Evurore	21,327	24,255	45,582	10,317	409.9
	Mt. Kenya Forest	N/A	N/A	N/A	N/A	202.8

Source: KNBS, Population and Housing Census, 2009

## 5.16 Aembu/ Atharaka Culture

The following aspects of the project host community are critical social parameters

### 5.16.1 The Embu Culture and Land Ownership: The place of a woman

Although the Kenya Constitution [2010] grants equal rights to land for male and female Kenyans, the existing Embu [and to the same extent Atharaka] tradition prescribes ownership of ancestral land inheritance by which system land is subdivided between sons in each successive generation. This system has overtime led to subdivision of land to very small uneconomic pieces of land per household. Land in the proposed project area is owned by individual land owners on a free hold basis. These individuals have title deeds for the parcels owned.

Culturally, Aembu women do not inherit land from their parents or parents- in- law, a system which has created land inequalities/injustices especially for unmarried, separated or widowed women and their children. A similar scenario exists and persists in Tharaka Nithi.

The consultant found out that unmarried Embu and Tharaka women are by tradition allocated small plot fit for constructing a dwelling place only and cannot claim ownership to the rest of the parental land. Parental land belongs to the sons of that home (the men). Widowed women take over the role of household head but cannot inherit land or hold title to it as land may be inherited only by the biological relations of the late husband. The consultant experienced this first hand in Kiangungi sub-location when a widowed young mother of three was denied [violently, by late husbands' cousins] any chance to engage with the consultant on any land related discussion. In the FGD session with key opinion leaders, one participant said *'When it comes to land, Embu women do not talk; a woman's land is that which she has bought with her own money!'* Other participants agreed with this statement wholly.

The consultant recommends that the process of compensation for acquired land should be strongly based on the Kenya Constitution (2010) and other relevant laws together with cultural considerations to avoid negative impacts for any project affected woman and their children.

The consultant recommends also that a Resettlement Action Plan [RAP] should be prepared in advance to guide decision making in the process of acquisition, relocation, resettlement and compensation. Interviewed women expressed fears that Cash for Land compensation system could be detrimental to families as some men may find it too much cash to handle and run away from home and responsibilities: The women preferred a Land for Land arrangement. This fear was supported by the Iriari Sub-location assistant chief who proposed that compensation cash should be paid through a joint account between the spouses to safeguard families.



Figure 5-10: A widowed woman from Kiangungi sub location; she 'cannot talk on land issues!'

### 5.17 Economic vulnerability

In general, Embu County [and neighboring Tharaka Nithi County] is economically vulnerable, an effect associated to several factors including decreasing farm sizes, declining land productivity, dependence on rain-fed agriculture and effects of rainfall variability and climate change among others. Economic vulnerability increases from the Upper tea zone [average Ksh. 6000 per household per month to lower cotton and tobacco growing lands [with an average monthly income of Ksh.1000 per household per month] to even lower potential areas where the incidence, frequency and severity of drought and famine has been increasing since the late 1980s. Thus the households' ability to provide adequate food, education and health care is influenced by these incomes and poverty.

### 5.18 Social Vulnerability

The Multiple Indicator Survey (KNBS, 2008) reported that the proportion of orphaned and vulnerable children in Manyata and Runyenjes constituencies is 10 percent. Vulnerability has a close link with disability 2.9 percent of the population in Manyatta and Runyenjes constituencies live with disabilities of diverse sorts. 12 per cent of children in the same constituencies were involved in child labor, [Kenya Domestic Health Surveys, 2008]. It is important to note that these two electoral areas are directly affected by the proposed project and the consultant recommends that child laws will be applied to guard children against child labor and retain them in school.

Children rights and laws should be observed/ implemented fully to protect children and school going girls against prostitution and unwanted pregnancies. The consultant however recommends that civic and sexual health education should be carried out in the host communities to help curb the spread of HIV-AIDS, other Sexually Transmitted Illnesses (STIs) and school drop outs. These feelings were discussed in the FGD and the participants agreed that Runyejes, Kathangeri and neighboring areas are known for irresponsible sexual habits and that sexual health education should be a priority.

The Vulnerability condition of the female gender (especially in land ownership) is an issue of concern for the consultant and recommends non biased application of the Kenyan constitution (2010) strictly to guard them against effects of loss of farm land and family disintegration.

## 5.19 Displacements

Table 5-11: Summary of the expected displacements anticipated

	Upper site	Lower site
Homesteads	57	53
Area under tea(Ha)	33.7	39.1
Area under other crops(Ha)	23.4	51.0
Mt. Kenya Forest Area(Ha)	30.1	none

## 6 PUBLIC CONSULTATION AND PARTICIPATION

### 6.1 Legal Requirement

Section 17 of the Environmental (Impact Assessment and Audit) Regulations of 2003, requires that all EIA studies incorporate Public Consultation(PC).The aim of the PC is to ensure that all stakeholders interested in a proposed physical improvement (including project beneficiaries and the public nearby) are identified and their opinion considered during project planning, design, construction, operation and decommission phases.

### 6.2 Objectives

In principal and in accordance to the EMCA requirements, consultations should be done with local stakeholders through means that induce broad public participation to a reasonable extent so as to take into consideration the environmental and social factors in a way that is most suitable to local situations. The consultant engaged experts in group discussions with an objective to understand the dynamics of dam making and dam impacts in and was able to localize that to the Thuchi dam host community. Such key informants were drawn from the ministries of Agriculture, Fisheries, water and from the Kenya forest service.

### 6.3 Participants' consultation

A stakeholder's consultative workshops were held at St. Marys Women Training Centre on 25<sup>th</sup> July 2014 and 28<sup>th</sup> November 2014 for workshop 1 and 2 respectively. It consisted of a representative of the Member of Parliament Runyenjes Constituency, Embu County director Water, Land and Environment, project team leader, Kiiri Consult representative, the sociologist and various participants from different organizations.

Table 6-1: Participants' fears/concerns and recommendations

Name of participant	Organization	Question	Answer
Johnson. Mbogo	KYEWASCO Director - Kyeni	Expressed concern that the issue of compensation will be a difficult task, and hence he proposed the dam site 1 inside the forest.	The Consultant explained to the workshop how difficult sometime it is, to obtaining a permit allowing one to construct a dam inside the forest. However, the permission could be granted only after a high level intervention.
John Waiganjo	County Director of Water Land and Environment	Wanted to know whether there was a provision for downstream release after impounding	The consultant explained that there was a provision for retaining a flow from the river for downstream users. However if more water was required, another dam could be constructed to provide more storage.

Alex Ndwiga	Kwanjara Village	Wanted to know the possible areas that could be irrigated by the dam.	The consultant indicated the area and indicated the limit up to which the 3 possible dam sites could irrigate. He displayed a figure showing Kagaari Kyeni Gaturi proposed Irrigation phases.
Mrs. Sarah Wawira	Nyagari Village	She wanted an elaboration on what was to happen because half of the dam would be located on Tharaka Nithi county.	The consultant responded by indicating that water is a natural resource that does not belong to any administrative county in Kenya. For the sake of development there will be no hindrance. Thuchi River marks the boundary of the two counties hence none of the three sites will be fully in Embu county.
Mr. Elijah Njiru	Kyeni	He requested for employment of the locals during the project implementation stage.	Comments appreciated and the consultant assured him that the locals will be considered for employment, but for labor that will require special skill, qualified people irrespective of their origin were to be employed.

In the course of preliminary design and out of experience with the social issues on the ground it was found necessary to hold workshops with the project affected person as a way of sensitizing and entry point to the community. The workshops were agreed to be held at the proposed dam site 2 that was found most feasible as per studies conducted, and also recommended by the client. This proposed site is located in the following villages:

- Gitogoto village of Meru South, Tharaka Nithi County.
- Mutuangima Village, Iriari location, Embu County.

The special workshops were held with the aim of obtaining permission from the land owners, to access parcels and properties lying within the limit of the dam embankment, spillway and other abutments. The target groups were the land owners and opinion leaders that included area Member of Parliament and County assembly members and witnessed by County Commissioner's officers. The two workshops were held as follows:

- 3th July 2015 at Gitogoto Primary school grounds for Gitogoto village in Meru South subcounty, Tharaka Nithi County
- 13th July 2015 at Iriari Primary school grounds for Mutuangima Village, Iriari location Embu County.

### **Tharaka Nithi County Workshop**

The workshop was held on on 3th July 2015 at Gitogoto primary school grounds. It was attended by the following:

1. The Member of Parliament Hon. Muthomi Njuki
2. The Meru South Sub-county commissioner staff led by Mr. C. Otieno, the Sub-county Commissioner.
3. The County Assembly staff led by Mr Gichiko, the area ward county assembly representative.
4. The Constituent Development Fund Chairman Mr. Patrick Munene
5. National Irrigation Board Representative
6. Kiri Consultant representatives.
7. Land owners.

Table 6-2: Participants' fears/concerns and recommendations

Participant	Question	Answer
Participant 1	Will the project provide domestic water supply,	The scope by this project is limited to making allowance for an off-take for abstraction of domestic water from the dam. However, the surrounding community can be provided with domestic water from a different source.
Participant 2	He sought to know how the compensation will be conducted	This is a study to establish suitability or not of the dam. A study for compensation will be done after this stage if the site proves favorable for the dam construction. At that study each item shall be valued at the market value and shall include a percentage for disturbance and each item shall be agreed between the valuer and the affected person, before this is represented for payment.
Participant 3	Shall the local youths be employed during investigation and construction?	At both stages the local youths and persons with necessary skills shall be given first priority.
Participant 4	Requested honesty and fairness during compensation	Amicable agreement involving all affected people and within the law will be done.
Participant 5	He sought to know how the negative impacts will be handled.	An ESIA study is underway to establish all the negative impacts that can arise and possible mitigation. A perimeter fence around the dam may eliminate human animal conflict.

### Embu County Workshop

The workshop was held on 13th July 2015 at Iriari primary school grounds and attended by the following:

1. The Member of Parliament Hon. Cecily Mberire
2. The Runyenje's Sub-county commissioner staff led by Mr. Muchelule the Sub-county Commissioner.
3. National Irrigation Board Representative
4. Kiri Consultant representatives.
5. Land owners.

Table 6-3: Participants' fears/ concerns and recommendations

<b>Participant</b>	<b>Question</b>	<b>Answer</b>
Participant 1	He sought to know how the compensation will be conducted	This is a study to establish suitability or not of the dam. A study for compensation will be done after this stage if the site proves favorable for the dam construction. At that study each item shall be valued at the market value when it is new and shall include a percentage for disturbance and each item shall be agreed between the valuer and the affected person, before this is presented for payment.
Participant 2	What if one is not for the project?	If one is not for the project then he or she should give the reasons as to why he/she is not for the project. This shall form the basis for consideration compared with reasons given by the ones who are for the project
Participant 3	Wanted to know which kind of properties will be paid and which one will not.	It was stressed that the study is not for compensation but for suitability of the dam. However, if the location is suitable for the project then all properties shall be considered for payment as per agreement before anything is affected.
Participant 4	The area youths to obtain employment from the investigation to be conducted.	Jobs will be given to the available youths and persons with necessary skills apart from those jobs that require experts from outside
Participant 5	She sought to know where irrigation water for the surrounding farms shall be sourced from.	Irrigation water for the farms upstream of the dam will be sourced from the existing intake, while the one on the dam will be supplied to the downstream users

## 7 POTENTIAL IMPACTS AND MITIGATION MEASURES

### 7.1 General Overview

Construction of large dams provides ecological as well as social challenges even though the ultimate facility is generally beneficial to the stakeholders and the country in general. Impoundment of large volumes of water has implications on the upstream systems through shifting of ecosystem boundaries upstream as a result of changes in flood regimes. At the dam site itself and the inundated areas, implications ranges from slowed silt, nutrients and pollutant transportation rate to downstream zones, potential loss and/or introduction of species (both plant and animal), displacement of social and economic features and land use changes for the residual riparian landowners. Finally, downstream impacts are associated with regulated flows of the affected river/streams, shifting of species to upstream areas, safety risks and land use changes due to the constant flow trends introduced by the dam. The above impact concepts guide the identification of the impacts associated with the proposed Thuchi dam.

Table 7-1 The Tables below details the environmental impact analysis of the project

EVALUATION PARAMETER	RATING	RATING
Nature of impact(NI)	Positive Negative Uncertain	+ - +/-
Intensity(IT)	Major Medium Minor	3 2 1
Extent(EXT)	Dispersed Medium Localized	3 2 1
Timing (TM)	Immediate Medium Delayed, long term	3 2 1
Reversibility(R)	Short term, easily reversible Long term, partially reversible if mitigated Not reversible	3 2 1
Persistence(P)	Temporary effect Permanent effect	1 3
Type of impact	Direct Indirect Cumulative	3 2 1
Phase	O C	Operational period Construction period

Topic	Element	Action	Location	Impacts	NI	TI	EX	IT	R	T M	PI	Phase	MG
Floral species	Vegetation & farmlands	Civil works	Dam & reservoir area	Clearance of vegetation to create room for dam and reservoir	-	3	1	3	2	3	3	C	19
	Forest ecosystem	Civil works	Reservoir area	Lost CO2 uptake	-	2	1	1	1	3	1	C/O	10
				Loss of forest ecosystem	-	3	1	2	2	3	3	C/O	16
	Riverine	Civil works	Dam area	The effect of overburden on flora(dumping of excavated rock from the tunnel)	-	3	1	1	2	3	1	C	11
	Riverine	New dam	Lower catchment riparian areas	Reduced water regimes on fragile riparian areas in lower catchment	-	2	3	2	3	3	3	O	21
Faunal species	Forest ecosystem		Reservoir area	Loss of wildlife habitat	-	3	1	2	2	3	3	C/O	16
	Forest	Civil works	Dam area	The effect of noise & vibrations on fauna	-	3	1	1	1	3	1	C	10
	Farmlands	Civil works	Tunnel	The effect of overburden on fauna (dumping of excavated rock debris from the tunnel)	-	2	1	1	1	3	1	C	10
	Reservoir		Reservoir area	Alteration of aquatic and fish ecology	-	2	3	2	2	3	3	O	20
	River	Civil works	Embankment	Impeded faunal movements due to construction of a wall across the river	-	3	3	3	3	3	3	O	24
Water resources	Water quality		Reservoir area	Contamination of reservoir water from latrines in the reservoir area	-	2	1	2	1	2	1	O	12

	Water quality		Reservoir area	Contamination of reservoir water from farmlands	-	2	1	2	1	2	1	O	12
	Water quality		Reservoir area	Reduced water quality for intakes to be constructed in reservoir area	-	3	3	2	1	2	1	O	16
	Water quality	Civil works	Downstream of Thuchi river	Increased sediments in the river	-	3	3	2	1	3	1	C	17
Soil	Soil physical properties	Civil works	Dam area	Increased surface run off due to cutting vegetation	-	2	1	2	2	3	1	C	14
	Land condition	Civil works	Dam and reservoir area	Soil erosion and possible landslides	-	2	1	2	3	2	1	C	14
	Soil contamination	Civil works	Dam area	Potential soil contamination from fuels, oils & other hazardous materials	-	3	1	2	3	3	3	C	17
	Soil alteration	Civil works	Dam area and downstream	Alteration of soil water uptake, retention capacity and aeration	-	3	1	2	1	3	1	C	13
Noise and vibrations	Excessive vibration above ambient	Civil works	Dam area	Vibration during construction	-	3	1	1	1	3	1	C	10
Air quality	Air pollution	Civil works	Dam area	Dust and/or smoke generation during works	-	3	1	2	1	3	1	C	13
	Air pollution	Civil works	Dam area	Increased CO2 emission from use of fossil fuel	-	3	1	2	1	3	1	C	13

Hydrology	Riverine	New dam	Project area	Changes in hydrological pattern because of the new dam	+/-	3	3	3	3	3	3	O	24
	Ground water	New dam	Project Area	Changes in hydrological pattern because of the new dam	+	2	3	3	3	1	3	O	22

Topic	Element	Action	Location	Impacts	NI	TI	EX	IT	R	TM	PI	Phase	MG
Land acquisition	Locals	Construction of new dam	Embankment and reservoir area	Disruption of lifestyle	-	3	1	2	2	3	1	O	14
Public health	Outsiders	Construction of new dam	Site and neighborhood	Communicable diseases	-	2	2	1	2	2	1	C	12
Resources (Dam use)	Embu/Tharaka-Nithi County	Operation of dam	Cross boundary	Potential conflicts	-	2	3	1	1	2	1	O	13
Infrastructure improvement	Roads	Construction of new dam	Karagethi road	Easy access and movement	+	3	3	2		3	3	C/O	18
Employment	Locals	Construction of new dam	Site and neighborhood	Improved standards of living	+	3	3	2		3	1	C	16
Entry	Laborers	Construction of new dam	Site and neighborhood	Insecurity	-	2	1	1	2	2	1	C	10

### Analysis

Rating	Impact	Reasons
Construction phase		

<b>High</b>	Clearance of vegetation	A large area will be cleared to give room to the dam and reservoir. The area is densely populated with vegetation
<b>Medium</b>	Increased sediments in the river	Civil works
	Potential soil contamination from fuels, oils and other hazardous materials	Oil/fuel leaks and/or spillage from plant and machinery
	Soil erosion and potential landslides	As a result of clearance of vegetation facilitated by the steep slopes
	Increased surface runoff	Clearance of vegetation
<b>Low</b>	Alteration of soil water uptake, retention capacity and aeration	Compaction during civil works
	Increased CO2 emission	Civil works
	Dust and/or smoke generation during works	Civil works
	Effect of overburden on flora	Dumping of excavated material on flora habitat
	Noise and vibrations on fauna	Use of plant and machinery
	Effect of overburden on fauna	Dumping of excavated material on fauna habitat
	Excessive noise and vibration	From plant and machinery
	Insecurity	Entry of workers from other areas
	Communicable diseases	Entry of workers from other areas
<b>Operational Phase</b>		
<b>High</b>	Changes in hydrological pattern because of the new dam	Construction of new dam
	Impeded faunal movements due to construction of a wall across the river	Construction of dam

	Reduced water regimes	Construction of new dam
	Alteration of aquatic and fish ecology	New dam
<b>Medium</b>	Reduced water quality for the current intakes to be constructed in reservoir area	Probable reservoir water contamination at the initial stages due to decomposition of organic matter leading to high BOD and COD
<b>Low</b>	Contamination of reservoir water from latrines	New dam
	Contamination of reservoir water from farmlands	New dam
	Disruption of lifestyle	Relocation of people
	Potential conflicts	Dam being used for irrigation in one County (Embu)
<b>Construction and operation</b>		
<b>Medium</b>	Loss of forest ecosystem	Clearance of vegetation
<b>Low</b>	Loss of wildlife habitat	Clearance of vegetation
	Lost CO2 uptake	Clearance of vegetation

The rating of the impacts was as follows:

>18	High
14-18	Medium
<14	Low

## **7.2 Potential Positive Impacts**

### **7.2.1 Irrigation boost**

The dam's main objective is to supply water for the irrigation to the farms downstream. During the operational phase of the project, more land will be put under food production with the area growing a variety of food crops. Its production will be boosted as water will be available all year round hence enhanced food production. This will improve food security in the region and the country at large. With the improvement in food production and horticultural crops coupled with low production cost, the proceeds from the sale of the same will rise hence the economic status of the farmers will improve. This improvement will in turn bring an influence to the entire neighborhood hence improving their standards of living. This will impact positively on other sectors as more resources will be generated with the view of improving the living standards of the area.

### **7.2.2 Flood control**

During the rainy season, the level of water in the river rises resulting to inundation of downstream areas and reduces during the dry season. Creation of reservoir will provide means of holding excess flow during rainy season thereby providing a constant river flow downstream of the river hence preventing the floods.

### **7.2.3 Employment opportunities**

The construction of the different components of the project is labor intensive and will require a large labor force. This will mainly come from the local area and in turn their participation will generate income leading to improved standards of living. Once the project is operational it will require both skilled and unskilled labor to operate and maintain the system.

### **7.2.4 Skills development**

Local people employed in the Project will obtain technical in-service training, as well as training in health and safety matters, which will improve their capacities. Experience from projects in developing countries indicates that a transfer of health and safety skills acquired by employees to the community at large may occur (i.e. employees improve health and safety measures in their households, such as home and road safety awareness, and personal and nutritional hygiene). This impact is important, in the current Project, where health and safety standards in the local community are relatively low. It is an important positive impact resulting from the employment process. By this, temporary employees in the project will be able to get work in later projects requiring similar skills once their contract with the Thuchi project expires. The host community was found to have qualified masons, electricians, plumbers, drivers among other skills.

### **7.2.5 Enhanced local economy**

Positive impacts on the local economy are expected. Local procurement of goods and service (where possible) should be encouraged. The existing markets such as Iriari or Kiangungi are expected to grow economically and also socially as 'outside workers' are expected to be spending nights in rented facilities here. Local SMEs are expected to increase business profit as demand for their goods is expected to rise. For Example: The contractor should consider purchasing some office/site facilities such as stationery, furniture, and fuel from businesses in towns like Runyejes and the Iriari and Kiangungi trading centers. The area is rich in agricultural produce and the

workers on site should be encouraged to buy their foodstuff, fruit and vegetables from the community. This will also enhance relationship between the project and the community.

### **7.2.6 Infrastructure**

The use of land for the Project may temporarily cause inconvenience with regards to access both to major roads and between homesteads and social infrastructure e.g. Iriari Primary School.

The current bridges have a limitation during the rainy season when water level in the river rise making crossing difficult. Once the dam is complete, its crest can be used to serve as a bridge. The area has a steep terrain and can be tiring for the residents going up and down from one side of the river to the other. Since the dams crest will be high and level, it will be easier for the community members to walk across.

The road leading to the dam site is a dry weather road. Before the construction works begin, the road is expected to be upgraded to an all-weather road therefore benefiting the community by providing easy access even during the rainy season.

### **7.2.7 Possibility of hydropower**

There is a possibility of hydropower once the dam is operational. If this happens:

- It may reduce residents energy cost and generate income through the Feed-in tariffs.
- If it will be a small scale hydropower, it may contribute to a decentralized energy network

### **7.2.8 Recreational Activities**

The dam may bring about a number of recreational activities, the major one being fishing once fish are introduced into the reservoir. Through controlled fishing, the community members can sell this fish and bring them income raising their standards of living in the long run. The other activities include; boating, picnics and barbeque which will also be a source of income for community members and the local authority. Through payment of relevant taxes, rates and fees to the government and local authority, the project will contribute towards the national and local revenue earning from those using the facility.

## **7.3 Potential negative impacts during construction phase**

### **7.3.1 Vegetation**

#### *7.3.1.1 Clearing of vegetation*

The slopes of the farmed area are covered with tea, a few trees and annual crops such as maize, beans, kales and bananas. During construction, vegetation clearance will be required to create room for the dam. This will specifically occur through creation of access roads, camp site and workshops and at the dam axis. Excavations for sourcing construction material will also lead to loss of vegetation cover and possible biodiversity loss at a local scale. The tailrace of the dam will inundate 43.8 ha of forest land that is covered in dense mature indigenous trees. The implication is that these trees will require to be cleared prior to inundation.

### 7.3.1.2 Economic evaluation of the Forest area

The Kenya Forest Service (KFS) which is the custodian of all forest reserves in Kenya has a price formula for use to establish the monetary value of a tree when destined for sale for pulp or timber. This price formula disregards shrubs and saplings, and does not recognize that trees have a real value to the functioning of an ecosystem. The general consensus is that most trees have a positive ecological value, but that value varies greatly according to the perceived uses of the trees.

Trees benefit humans in many ways e.g. microclimate modulation, provision of food, wildlife habitat, soil protection and aesthetics. Post-harvest uses include timber, firewood, and paper, among others.

This point evaluate the impact by establishing a monetary value for the floral community to be decimated by the proposed reservoir, based on the significance of its effects on soil, nutrient, and water conservation, animal usage, and habitat characteristics. It presents a formula that sets a value on trees based on their ecological contribution to the environment. Judgments of ecological effects are converted to simple arithmetic steps to produce a numeric monetary value for the ecological contributions of the trees in that area.

### 7.3.1.3 Assigned Values

The KFS sells exotic tree species at Kshs 1,000 to Kshs 7,000 per tree, and indigenous species range between Kshs 8,000 to Kshs 30,000 depending on the location, species and the health of the tree.

The area to be flooded by the reservoir is an indigenous forest. The average cost of an indigenous tree in this area is pegged at Kshs 11,000 which translates to Kshs 36 per cm<sup>2</sup> at DBH.

### 7.3.1.4 Methodology

A total of 4 sample locations were chosen for the inventorying. A circular plot with a radius of 10 meters is determined and height and diameter are approximated.

The table below gives details about the sample plots.

Table 7-2: Sample plot location

Plot No	Northing's	Easting's	Altitude(m)
1	00° 21' 23.0"	037° 32' 52.3"	1653
2	00° 21' 12.5"	037° 32' 51.1"	1600
3	00° 21' 13.5"	037° 32' 57.1"	1614
4	00° 21' 13.2"	037° 33' 01.3"	1695

The forested area to be cleared for the reservoir is 43.8ha out of 18,500ha which makes only 0.24% of the entire forest. Each plot had an average of 8 trees therefore; an approximate figure of the total number of trees to be cleared is 11,150. This impact may therefore not be considered as significant because the area to be cleared makes a small percentage of the forest.

Since the diameter of the trees is small, the approximate economic value of the forest area to be cleared is 16,725,000 (if one tree is sold at KSH 1,500).

#### 7.3.1.5 The effect of overburden on vegetation

Stripping operations before the development of the site result in removal of top soil and other material surplus to requirements. This waste will be dumped downstream of the dam with implications on the vegetation growing in that area.

The positive impacts of overburden may include the potential for selling it for use in agriculture, in rehabilitating the plant area after construction or for re-vegetating completed earthworks.

The main negative impact of the overburden generated during construction phase are related to poor location of top soil and other stock piles which damages vegetation and affects the visual image of the site.

#### Mitigation measures

- Compensatory planting- NIB should purchase an equivalent acreage (i.e. 43.8 ha) and plant indigenous species for conservation and not commercial purposes.
- Create a buffer of trees around the reservoir to help with erosion and to protect the banks
- NIB should obtain an equivalent size of land allocated by KFS within the Mt. Kenya ecosystem for afforestation. Funds should be set aside to maintain the planted trees up to maturity or canopy cover and the planted trees should be similar to those cut down e.g. *Anthoclaesta grandiflora*, *Casearia battiscombei*, *Croton macrostachyus*, *Ehretia cymosa*, *Ficus sur*, *Myriathus holstii*
- Areas to be cleared should be agreed and demarcated before the start of the clearing operations

### 7.3.2 Impact on Soils

#### 7.3.2.1 Soil erosion

Clearance of vegetation will have direct and immediate impacts on soil erosion at the dam site environs and the effect will be spread over a wide geographical scale. This is because of dislocation and transportation of sediments from the cleared area through runoff will transgress various ecosystem boundaries. The high rainfall in the area will also facilitate soil erosion and possible landslides which have been experienced before.

The timing of these processes will be immediate because cutting of vegetation will expose the soil direct to erosive forces and the negative impacts will be moderate.

#### 7.3.2.2 Alteration of soil water uptake, retention capacity and aeration

The movement of machinery will affect the soil directly during construction where increased soil compaction by tires will reduce soil porosity and aeration. Compacted soil will reduce water uptake and retention due to decreased total pore volume. This will be majorly felt downstream of the dam where top soil is to be deposited. However, the impacts will be moderate and easily reversed through appropriate management practices.

Soil compaction is bound to disrupt soil structure. However, the effect is temporary because aggregates form, disintegrate and reform periodically with length of different phases hardly going beyond one crop season (Hillel, 1982)

### 7.3.2.3 Soil contamination

During construction, machinery and plant may have leakages which will result to oil and fuel spills. Accidental spills may also occur as they are fuelled or serviced. The chemicals contained in the fuel and oil deteriorates the quality of soil and makes them unsuitable for cultivation. If this soil is used to produce fruits or vegetables, the produce will lack quality nutrients and may contain some poisonous substance to cause serious health problems in people consuming them. This impact is immediate and moderate. The area around the top soil deposition site will experience the impact more because the soil may be used for agricultural purposes later.

#### *Mitigation measures*

- Before commencement of the project, the resident engineer (RE) should identify a specific location where the waste soil will be disposed.
- Stage site clearance works so as to minimize the area of soil exposed at any given time.
- Transport off site material immediately – no stock piling at the site.
- Monitor areas of exposed soil during periods of heavy rainfall throughout the construction phase of the project to ensure that any incidents of erosion are quickly controlled.
- Leveling of the project site to reduce run off velocity and increase infiltration of storm water into the soil.
- Plastic sheeting, sandbags or geo fabric approved by the RE shall be used to prevent the migration of fines through the edges of the fill into the river.

### 7.3.3 Air Quality

During construction phase, the atmospheric pollution sources include airborne dust from earthworks, and tail gases from construction equipment and vehicles. A variety of organic and inorganic substances could be released into the atmosphere, such as dust and other particulate matter from earthwork and handling of construction materials, or fumes, exhausts and spills from construction equipment using liquid fuel grease and lubricants. Increased vehicular traffic during the building activities will increase further the exhaust fumes and dust released into the atmosphere, temporarily. The dust will settle on trees and crops, and can cause respiratory problems for local residents. Dust and fumes will have medium direct but short-term impacts during the project construction phase.

Air pollution is potentially harmful or has nuisance effects on human beings, animals, plants, their biological communities and habitats, including the soil. Sources of such emissions include air borne dust from earthworks, tail gases from construction equipment and vehicles, rock grinding, concrete mixing, loading and transportation of soil material. Air emissions from construction machinery, including dust, is regarded as a nuisance when it reduces visibility, soils private property, is aesthetically displeasing or affects palatability of grazing fields. Therefore dust, CO<sub>2</sub> and smoke generated by construction related activities must be reduced to the bare minimum.

The construction work will use specialized heavy equipment and machinery, such as loaders, haulers, and dump trucks, which transport material to processing facilities using haul roads, and the processed material to

the required location for use. This will generate many of trips every single day for the duration of the construction, creating another unique set of environmental impacts, such as emissions of CO<sub>2</sub> from fuel combustion, fugitive dust from haul roads, noise and vibrations. The construction industry is a large emitter of dust, smoke and CO<sub>2</sub> gas which are spewed into the atmosphere. The industry produces 5% of global man-made CO<sub>2</sub>, but the industry recognizes that global warming is an important issue and that the industry shares in the responsibility for tackling the problem.

The effect on air quality of the increased traffic flow is considered to have a medium impact if no maintenance programme will be installed. Under good maintenance schedule, traffic exhaust emissions, will be intermittent and atmospheric dispersal of exhaust emissions will maintain the air quality. Sprinkling of the roads with water during construction work will further lessen generation of dust, and consequently alleviate the air pollution problem.

#### *Mitigation measures*

- Covering of all hauling vehicles carrying soil, aggregate and cement
- Stock piles of fine materials such as sand should be wetted or covered with tarpaulin during windy conditions
- Access roads and exposed grounds must be wetted in a way and frequency that effectively keeps down the dust.
- Workers in the dusty areas should be issued with dust masks during dry and windy conditions

#### **7.3.4 Fauna**

One of the species found in River Thuchi is the eel (*Mastacembelus*) whose habitat is in a rocky riverbed. Once construction has commenced and if the stones in the river are used for construction, this species habitat will be destroyed. However, this impact will only be in a small section of the river and minimal. During construction it's expected that the river will get dirty and trout cannot survive in dirty water. The impact is temporal and minimal.

Noise during construction works may scare, stress and disturb the normal way of life for the wildlife causing them to move to new territories as they escape the noise.

#### *Mitigation measures*

- *Avoid removal of rocks from the river as much as possible downstream so as to preserve the eel habitat.*
- *Re- introduce the same species downstream of the river.*

#### **7.3.5 Effect on water quality**

During construction, activities such as digging and clearance of vegetation will involve massive earth moving. This loosening of soil and steep slope terrain will create a situation where any heavy rains will freely wash down the soil into the river. The soil may contain high levels of organic matter and deposition of this may lead to anoxic conditions in the water with potential risk to the associated aquatic life. Increase in both dissolved and suspended solids in the river will result to discoloration reducing its aesthetic value.

In case rocks are sourced from the river, the bed will be disturbed causing sediments to rise and decolorize the water. This will be a major impact for the people downstream because they will have to treat the water before use.

#### Mitigation measures

- The steep slopes should be stabilized and compacted to reduce on erosion and potential landslides. The figure below shows the steepness of area by the closeness of the contours.

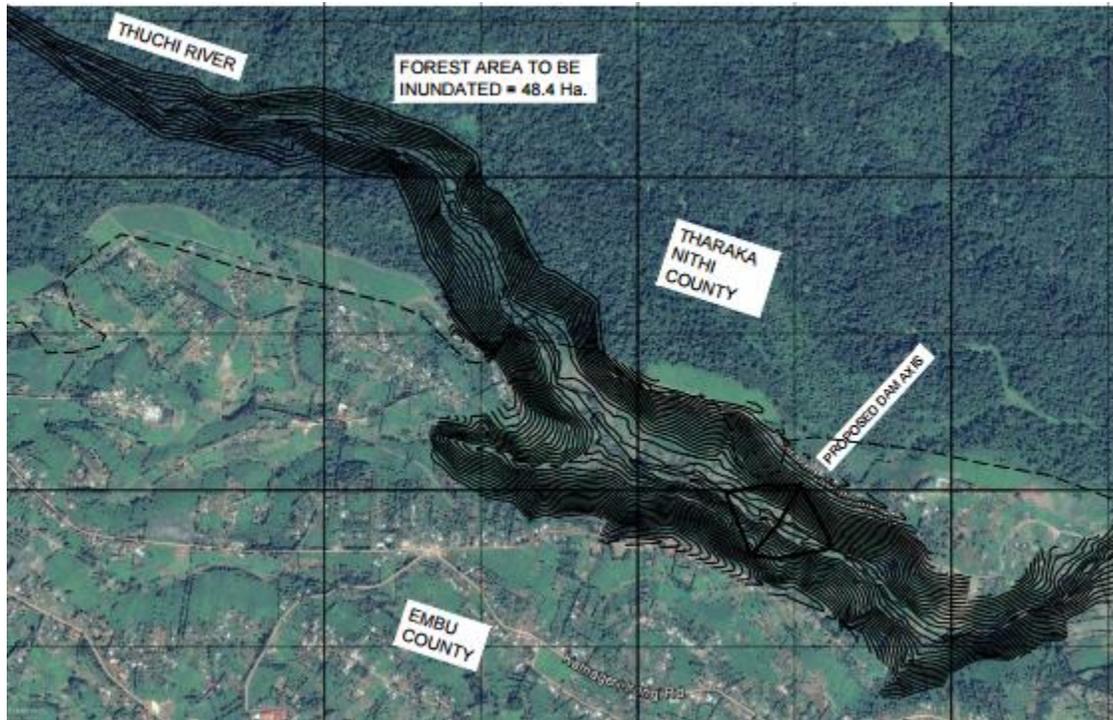


Figure 7-1: Proposed Thuchi Dam area

- Stage site clearance works so as to minimize the area of soil exposed at any given time.
- The activities to be carried out in the river such as sourcing of materials should be scheduled at particular times of the day to allow the river to clear and usable for people downstream.
- The people downstream should be notified on the probable degradation of the quality of water due to increased sediments as a result of construction works.

#### 7.3.6 Construction works noise and vibration

Noise and vibration will be produced by construction vehicles, plant and machinery during delivery of materials, processing of materials, and actual construction work. Due to an increase in activities and number of operational vehicles, the impacts of noise and vibration on human and other fauna depends on the noise characteristics of the equipment and the activity involved; the construction schedule; and the distance and location of the potentially sensitive noise receptors. It will cause disturbance to humans and animals, especially birds, which

are generally very sensitive to noise disturbances. However, the impact upon fauna is difficult to predict with certainty.

The area being generally quiet and peaceful will be disturbed from the activities stated above. However, impacts of noise and vibration are foreseen to be moderate, direct and short term, lasting to the end of the phase.

The table below gives typical noise and vibration levels emitted by different construction equipment (U.S. Environmental Protection Agency, 1995)

Table 7-3: Equipment Noise Level

Equipment	Noise level at 15 m (dBA)
Buckhoe	85
Bulldozer	87
Concrete plant	83
Concrete mixer	85
Dump truck	88
Front end loader	85
Roller compactor	80

NEMA has set standards for noise emissions from construction equipment which the contractor has to adhere to. The law prohibits vibrations that exceed 0.5 centimeters per second beyond any source property boundary or 30 meters from any moving source. The Maximum Noise Level Permitted (Leq) as measured from within the construction facility is 75dBA for day and 65 dBA for night, and as the table above shows the equipment named above will singularly and collectively emit significant amounts of noise that has to be regulated.

#### Mitigation measures

- A license will have to be obtained for emitting noise in excess of the laid out standards
- Restrict noisy construction activities to normal working hours i.e. 8am- 5pm
- Inform local residents beforehand via advisory notices and advisories of pending noisy periods and solicit their tolerance well before the commencement of the work
- Workers operating equipment that generate noise should be in protective gear including ear muffs and plugs. Workers operating equipment generating noise levels greater than 80dBA continuously for 8 hours or more should use ear muffs and those experiencing prolonged noise levels of 70-80dBA should wear ear plugs
- Limit idling time of pick-up trucks and other smaller equipment, observe a common-sense approach to vehicle use and encourage workers to shut off vehicle engines whenever possible
- All construction equipment should be regularly inspected and serviced
- No unnecessary hooting by project and resident vehicles, including operating equipment

- Activities that generate noise during the reproductive period the most valuable species inhabiting the project area will be avoided

### 7.3.7 Construction material sourcing

The construction materials such as rock, concrete aggregate and clay will be sourced from the site and its surrounding area. Rock and concrete aggregate will be sourced within the reservoir area while clay will be sourced 25km downstream of the dam site at 0348775E, 9951476N. The sourcing of these will necessitate clearance of vegetation, landscape scars, dust and general disturbance during excavation and the need to reinstate or restore the landscape after the contractor has completed excavation works. Clay materials sites if not reinstated and rehabilitated after project completion will create a badlands type of landscape with water bodies and scattered boulders on the surface. The pools of water that can form in borrow pits that are not free draining can be suitable habitats for disease vectors for example; bilharzias and liver fluke.

The landscape scars which lie in the reservoir area will be covered up once the area is filled with water.

#### *Mitigation measures*

- Carry out inspection of each of the site's soil stability before excavation
- All borrow pits sites shall be clearly indicated on a plan and approved by the RE
- Due to the steep terrain borrow pits shall be located more than 20 meters from watercourses in a position that will facilitate the prevention of storm water runoff from the site from entering the watercourse;
- The Contractor shall give 14 day notice to nearby communities of his intention to begin excavation in the borrow pits;
- Decommission the borrow pits upon completion of the Contract and reinstate the land to its natural condition by grading excavations and planting suitable saplings

### 7.3.8 Solid waste

Construction material will be sourced 30km from the dam site within the reservoir area. One of the requirements during this activity is that at least 150mm of top soil is stripped off. This soil will form part of solid waste which will be deposited downstream of the dam. Deposition of the soil will have the effect of overburden on vegetation and reduction in the aesthetic value of the area.

Construction works will also result to creation of various solid waste such as surplus earth and rock, metal scraps, plastics (wrappings and containers), wood, workshop wastes including e.g. used oil filters, and waste concrete. This can be a nuisance and the site should therefore be kept clean, neat and tidy at all times and most especially because the river is very close. The Contractor shall implement measures to minimize waste.

#### *Mitigation measures*

- The strip of top soil should be piled meters away from the river and covered to prevent it from being blown to the river by wind or carried off by surface runoff.

- The litter collection facilities need to be more than 20 meters from river and in a position that will facilitate the prevention of storm water runoff from the site from entering the river.
- All personnel shall be instructed to dispose of all waste in a proper manner.
- At all places of work the contractor shall provide litter collection facilities.
- The final disposal of the site waste shall be done at the location that shall be approved by the RE, after consultation with local administration and local leaders.
- No burying, burning or dumping of any waste materials, vegetation, litter or refuse shall be permitted.
- The spoil area should preferably be located on land already cleared wherever possible. Communities shall be involved in the site location to avoid destruction of any ritual site or any other conflict.
- Litter bins should have secured lids to prevent animals and birds from scavenging.

### 7.3.9 Liquid waste

#### 7.3.9.1 Waste water

During construction various liquid wastes will be produced such as concrete washings, runoff from workshops, streams from washing of construction vehicles and equipment washing. These will pose a threat and toxicity on the river, springs and underground water.

#### *Mitigation measures*

- Water containing pollutants such as concrete or chemicals should be directed to a conservancy tank for removal from the site where applicable.
- The contractor shall prevent runoff loaded with sediments from flowing into the river and springs.
- Potential pollutants of any kind and in any form shall be kept, stored and used in such a manner that any escape can be contained and the water table not endangered.
- In case of any form of pollution in the river, the contractor should notify the RE.

#### 7.3.9.2 Fuels, oils and other hazardous substances

The construction phase will involve use of stationary and mobile plant and equipment which will require fuelling and lubrication. This will increase the risk of accidental spillage of used engine oils, greases and diesel which may result to contamination of the soils. Should this spillage happen during the rainy season, the contaminants may also be washed off by surface runoff and find their way into the nearby river and/or springs. This will contaminate the water and will cause harm to the aquatic life and also temporarily render the water not suitable for domestic use. If the contaminated soil is within the reservoir area it will contaminate the water to be stored and therefore must be removed.

*Mitigation measures*

- To avoid pollution of River Thuchi through any construction activities, the contractor should ensure that the machines and equipment are in good condition especially leakages
- Interceptors such as sand can be used to prevent pollutants from reaching underground water, river Thuchi, and springs as well as polluting the soil
- Ensure proper handling of lubricants, fuels and solvents while maintaining the equipment
- Any chemical or fuel spills shall be cleaned up immediately. The spilt liquid and clean-up material shall be removed, treated and transported to an appropriate site licensed for its disposal.
- A safety and emergency response plan will need to be developed for all operations with emphasis on the protection of the environment prior to start up.

**7.3.10 Occupational Health and Safety**

During construction phase, accidental falls into the river, occupational diseases, ill health and damage to property can occur if precautionary measures are not taken. Increased movement of vehicles may lead to increased accidents among local communities, construction workers and vehicles operators.

*Mitigation measures*

- The contractor shall provide the appropriate personal protective equipment to all workers.
- The contractor should ensure there are warning signs on the construction site.
- The contractor shall provide standard first aid kit at the site.
- There should be a safety officer at the site who has safety training and knowledge of safety procedures
- The contractor must have an insurance cover for all workers

**7.3.11 HIV/AIDS**

The proposed project could impact on the community in many ways and one of them is the transmission of sexually transmitted diseases. Disease transmission could be facilitated by the migration of people, which invariably will accompany projects during construction. Work crews may bring with them or contract the diseases from the local community. Presence of construction workers earning above average incomes and often coming without their families may contribute to the spread of HIV/AIDS and STDs.

*Mitigation measures*

- A comprehensive health awareness campaign should be carried out in conjunction with the project workers

- The contractor shall take an active role in civic and public health education to his employees
- Provision of condoms (free)
- Have wellness centers in the area

### 7.3.12 Insecurity

The area is generally quiet and slow without having many commercial activities. Safety is a concern although minor and temporal.

The safety of their homes, shops and other installations may be compromised by an increase in 'outside workers/jobseekers'. The cases anticipated are however not major ones e.g. pick pocketing, fights in the local pubs among others. The site does not have an existing police station (nearest is in Runyenjes about 30 km] thus this fear is realistic. This concern also should be observed from the point of view of the workers safety; and the safety of the Contractors' machines and equipment among others. The community members may steal from the 'outside workers' with the notion that they may be having more money thereby raising a security concern for this group of people.

#### *Mitigation measures*

- The chief may enforce community policies such as nyumba kumi and vigilance among the locals

## 7.4 Potential negative impacts during the post construction phase

### 7.4.1 Land acquisition

This is a major social impact of the proposed project .This study revealed that although majority of the Project Affected Persons (PAPs) are willing to give up part or all of their land if affected by the project almost all of them are not ready to give up their land without what they consider to be "adequate compensation". The consultant found at least 5 affected households have graves in their land near the basin. This figure may increase when the whole inundation area is investigated.

Relocation is a great fear among the host community. Dis-jointment of households from familiar relatives, neighbors and environments is a major social impact of the proposed project. Over 85 % of the interviewed PAPs preferred relocation to a place just near their existing homes and neighborhoods.

Relocation comes with changes in well-being and in 'sense of place' which are difficult to measure. As a result these impacts are often ignored. However the initiation of the Project will most probably have an impact on peoples' feeling of security and well-being. In discussions with landowners, land was repeatedly identified as their strength and security for the present and the future. The potential loss of agricultural land will change peoples' perspectives on their livelihoods and the possible future for their children. In other words the social equilibrium will be disturbed for the people to be displaced.

#### *Mitigation measures*

- Conduct a detailed Resettlement Action Plan for the project that must not in any way leave the affected persons worse off than they were before the project. It is recommended that communication between the project and the communities be maintained throughout the process.

#### 7.4.2 Potential conflicts

River Thuchi is a shared water resource between two counties, but the proposed project targets to provide water for irrigation for one county (Embu). This may bring about conflicts between Tharaka Nithi and Embu residents because the dam lies on both counties but only benefiting Embu County for agricultural use.

##### *Mitigation measures*

- Reasonable mechanism should be put in place to ensure that both Tharaka Nithi and Embu counties benefit from the dam, without compromising the quality and quantity available for consumers downstream.

### 7.5 Potential negative impacts during operational phase

#### 7.5.1 Hydrology

##### 7.5.1.1 Downstream changes

The flow regime of Thuchi River may change depending on the dam design. The flow varies by having high water levels during the rainy season and low levels during the dry season. With the dam construction, the flow downstream will most likely be regulated to a relative constant flow rate over longer durations of time as opposed to the current condition where flow varies. The hydrological implications to downstream environment will be:

- (i) Reduced average high water levels downstream the basin and hence minimal deposition of silt on the flood plain where ecological and limited food production takes place. Constant but reduced distribution of silt deposition (land fertility for downstream habitats) will be confined to a narrower flood plain since flood flows will be reduced and not enough to spread over the current flood plain.
- (ii) On the other hand, current aquatic ecosystems are likely to be compromised on the higher flood plain zones of the river basin thus slightly changing the basin characteristics
- (iii) One advantage is the reduced channel erosion during high peak flows and reduced water quality (turbidity and suspended matter)
- (iv) Upstream, Thuchi River and Kiajege stream will be permanently flooded all year around. This change in hydrological pattern will reduce scouring of the streambeds as well as controlled bank erosion. It will, however, create new habitats with new aquatic vegetation and possible animal species.

##### *Mitigation measures*

- Ensure compliance with the water resources regulations at all times. At least 30% of the base flow should always flow in the stream to sustain ecological and social requirements downstream.

- Have river gauging systems if they are not there to monitor the effects of the dam to the river basin over time as well as enable stock-taking of water balances at any given time against the rainfall in the catchments.
- It is proposed that the historical flow pattern be maintained for the residual flow throughout the life of the dam. Despite the reduced flow, mimicking the natural flow regime can support most of the ecological functions of the river flow regime such as triggering spawning of fish, flooding river banks to maintain the riverine vegetation and supporting water demands downstream.

### 7.5.2 Fish

Impacts during the operation phase can be grouped into two categories: 1) Impacts which affect fish directly 2) Impacts which affect fisheries environment (upstream river, reservoir and downstream river) in some manner that leads to a deterioration in fish biodiversity, fish stocks and/or fisheries production.

Category 1 impacts include the following:

- The dam constitutes a barrier to upstream migration for almost all fish species. This prevents brood stock from reaching their spawning grounds during the breeding season, resulting in massive failure of recruitment and eventual extinction of the stock above the dam. Downstream migration past the dam may also be difficult or impossible for many fish species especially trout. Fish migrating into the reservoir from Kiajege stream and Thuchi river may be unable to find their way to the dam site and subsequently downstream through discharge structures. This can affect spawning and recruitment.
- Fish passing downstream through discharge structures at a dam can suffer mortality or damage in a number of ways, including abrasion against rough surfaces, turbine blade mangling once hydropower is introduced, rapid pressure changes, water shearing effects and nitrogen super saturation in the stilling basin

Category 2 impacts include the following:

- Thermal stratification of reservoirs during the warm season can result in deoxygenating of the hypolimnion. Cool and/or anoxic water discharged from the hypolimnion can severely reduce water quality downstream and negatively impact fish stocks and fisheries. Fish may be eliminated from the river as far downstream from the dam as deoxygenating persists.
- If the dam produces low discharge flows downstream, it may lead to reduction in inundation of downstream floodplains. The reduced water level and duration and area of inundation severely limit fish production. Fish biodiversity will also suffer losses.
- Reservoir will trap sediments brought in by Kiajege stream and Thuchi River. The turbidity of outflow water of the dam is usually low and there is no deposition of nutrient-rich sediment downstream. This will reduce the fertility and productivity of downstream aquatic environments.
- In the case of sediment release from the reservoir, turbidity can become very high which can create severe problems for the downstream fauna and flora.

- Sediments trapped in the reservoir may be contaminated with pesticides and industrial chemicals from catchment sources, and residues can enter the reservoir food chain and taint fish.
- Infestation of the reservoir with floating macrophytes can cause a decrease in water quality in the reservoir and in downstream discharge. This is typically initiated by the release of nutrients from drowned vegetation and soil, resulting in a trophic upsurge of primary production and proliferation of floating plants during the first few years after filling. Large mats of floating macrophytes can lead to deoxygenation and acidification of the water column. Under such conditions fish biodiversity and production is reduced with only air breathing species able to survive. Deployment of most types of fishing gear becomes impossible.

In most cases, the construction of a dam results in changes in fish biodiversity and stock abundance. Usually, the number of fish species declines. Stocks of long distance migrating species and fast flowing water species decline while stocks of pelagic species and species that prefer slow moving water increase.

#### *Mitigation measures*

- Construction of fish ladders so as not to hinder the movement of the migratory fish which in this case is trout or if feasible, the hydraulic characteristics of the diversion tunnel should be designed to be as fish friendly as possible.
- The filling of the reservoir should take place in the wet season and the reduction in downstream flow should not exceed 30%
- The maintenance or restoration of downstream habitats can be supported by periodic opening of dam gates to create artificial floods that regulate sedimentation, allow migration and mimic the natural hydrological conditions of the river.

### **7.5.3 Water supply and water quality**

Water stored in a dam or reservoir is subject to undergo certain physical, chemical and biological transformations overtime caused by varying conditions. These phenomena are induced by climatic conditions (heat exchanges, extent of aeration etc.), chemical exchanges from geological formations, aquatic chemical reactions and material degradation among others as well as biological reactions associated with the organic materials decaying in the water (biomass and humic matter decomposition). Variations in weather conditions and exposure to atmospheric conditions are among other conditions with potential effect to water quality. Thuchi dam may be faced with such scenarios. Among the anticipated water quality aspects of interest for the dam would include:

- Residual fecal and organic matter from pit latrine, open-air toilets and waste holding sites from the displaced and residual homesteads and social locations. This would particularly impact on the health of the water consumers and their animals within the dam area as well as the ultimate piped destinations in the long-term,
- Nutrients (nitrogen, phosphorous potassium) among other trace elements in the soil are expected from the geological discharges, organic decompositions of plants matter and surface runoff discharges from farms and settlement areas around the dam. This could create potential for eutrophication of the dam water,

- Turbidity and suspended settleable matter of water from the inflows, surface runoff discharges and organic reactions among other sources is also a potential challenge to water quality. This situation may lead to limited light penetration that has got direct linkage to biological quality of the water,
- Limited water mixing, aeration and light penetration reduces available oxygen resulting into anoxic conditions at the lower layers of water in deep reservoirs. Anaerobic conditions in the lower layers of the water generate carbon dioxide, methane, hydrogen sulphide and create low pH scenarios, particularly if the organic content is high. Due to the lowered pH, the geologically held iron and manganese and other heavy metals are likely to be released into the water effectively changing the water quality,
- Implications on water quality would be felt by the water consumers in the immediate location of the dam as well as the community water project consumers. This will also increase cost for the consumers because they will have to treat the water.

*Mitigation measures:*

- Institute a broad water quality monitoring system such as to focus on the catchment sources, incoming flows, entire dam water quality variations, treated water and water downstream the dam location. Maintain appropriate records on water quality as required by law upon commissioning of the dam including the implications of the dam to the water quality downstream.
- The latrines in the area to be flooded should be treated using solid Chlorine so as to kill living bacteria, disease causing microbes and to curb the smell to some extent.
- All vegetation materials shall be cleared (live and dead) and removed before the reservoir area is flooded. This will ensure controlled release of organic matter into the dam water. Proliferation of aquatic macro-flora could be encouraged along the periphery of the dam to ensure natural aeration and purification of the water.
- Water treatment for community projects should be done. This can be done by dosing the water with chlorine so as to kill any form of bacteria in the water
- Establish sufficient wooded and non-cultivated buffer along the edge of the dam to trap sediments and nutrients that could be washed into the reservoir over time.
- There are many methods available to increase dissolved oxygen concentrations in reservoirs and tail waters including aerating reservoir waters with air or oxygen, installing advanced aerating turbine runners and constructing aeration weirs in the tailrace below the dam. However, such advanced techniques are expensive and have only been successfully deployed in the developed world.

#### **7.5.4 Air quality**

Part of the proposed project (reservoir) location is in a heavily forested area of tropical highland region that is critical for absorbing atmospheric carbon dioxide (CO<sub>2</sub>) and maintaining a healthy balance between CO<sub>2</sub> emissions and CO<sub>2</sub> uptake.

This dam project proposes permanent destruction of a part of the pristine Mt. Kenya tropical forest, thereby creating a disturbance that will alter the carbon budget. Tree offset calculation based on a tree planted in the humid tropics is projected to absorb an average of 22kg of carbon dioxide annually. The part of the forest set for

destruction cover an estimated 43.8ha (about 11,150 trees) that sequesters an estimated 245,300kg of carbon dioxide per year. This could be a significant contribution to environmental conservation at a local scale that should motivate us to conserve this ecosystem. However, if the entire Mt. Kenya forest is to be considered, it is a minor impact for carbon sequestration.

#### *Mitigation measures*

- Compensatory planting- NIB should purchase an equivalent acreage and plant indigenous species for conservation and not commercial purposes
- NIB should obtain an equivalent size of land allocated by KFS within the Mt. Kenya ecosystem for afforestation. Funds should be set aside to maintain the planted trees up to maturity or canopy cover and the planted trees should be similar to those cut down e.g. *Anthoclaesta grandiflora*, *Casearia battiscombei*, *Croton macrostachyus*, *Ehretia cymosa*, *Ficus sur*, *Myriathus holstii*

### **7.5.5 Water borne and water related diseases**

Dam reservoir provides habitat for waterborne diseases as well as parasite thrive (mosquito, snails). Mosquitoes are carriers of malaria but since this is a highland region the mosquitoes may not cause malaria because they don't carry the vector. There is also the likelihood of snails breeding which are carriers of schistosomiasis. Other water borne diseases are cholera and dysentery which may be as a result of contamination of water from the pit latrines within the reservoir area.

#### *Mitigation measures*

- Implement measures to assess the presence of vectors and control its and potential diseases.
- Creation of awareness, prevention and monitoring programs
- The latrines in the area to be flooded should be treated using solid Chlorine so as to kill living bacteria, disease causing microbes and to curb the smell to some extent.
- A detailed epidemiological study of the area should be undertaken and be implemented
- Develop and implement a clear HIV-AIDS policy for workers
- Engage / work with relevant community development organizations /NGOs

### **7.5.6 Infrastructure**

Parts of the infrastructure in the area are bridge across river Thuchi. These two will be submerged because they fall in the reservoir area thus movement of people from Chuka to Embu will be hindered.

Once the dam is complete, the electric fence has to be re-routed and moved upstream before the reservoir because water is a good conductor of electricity and the community members can be electrocuted if they touch the water. It will also have to be reinforced and go round the reservoir because the elephants will be attracted by water in the reservoir and may want to find their way there.

#### *Mitigation measures*

- Another bridge should be constructed for the locals so that their movement is not hindered

- The fence should be re- routed and go round the reservoir to keep off the elephants

## 7.5.7 Dam safety

### 7.5.7.1 World Bank Dam Safety

Thuchi Dam will be 84m high. According to the World Bank Operational Manual OP 4.37 - Safety of Dams, Thuchi Dam will be a large Dam.

The World Bank requirements on Dam Safety are summarized in the following table:

Table 7-4: World Bank Requirements on Dam safety

World Bank Requirements	Comments
For the life of any dam, the owner is responsible for ensuring that appropriate measures are taken and sufficient resources provided for the safety of the dam	Under Tana Water Services Board responsibility.
It requires that the dam be designed and its construction supervised by experienced and competent professionals	The supervision company will be chosen according to its experience on similar project and the resources involved will have to be competent
Reviews by an independent panel of experts (the Panel) of the investigation, design and construction of the dam and the start of operations	Under Tana Water Service Board responsibility.  An independent panel of expert will have to validate the different steps of the dam project  The cost of expert panel will have to be included in the global environmental costs during the full ESIA
Plan for construction supervision and quality assurance, an instrumentation plan, an operation and maintenance plan and an emergency preparedness plan	These plans will be prepared during design phase of the project and will ensure the management of dam safety
Prequalification of bidders during procurement and bid tendering	Proper tender documents should be prepared
Periodic safety inspections of the dam after completion	Tana Water Service Board Responsibility

## Dam break

The potential dam failure can result of fault in the design, use of sub-standard material during construction, deliberate sabotage, and landslide in the reservoir. According to the design, the dam is designed for the Probable Maximum Flood and with a return period of 1000 years. The design flood chosen makes the dam safe against flood.

### Mitigation measures

- Review the Dam design and Dam Construction by independent panel of experts
- Prepare relevant plans (Plan for construction supervision and quality assurance, an instrumentation plan, an operation and maintenance plan),
- Prepare an emergency preparedness plan
- Install proper instrumentation in the dam,
- Ensure frequent maintenance of the dam structures,
- Ensure use of high quality standard materials during construction phase

#### 7.5.8 Seismicity

The proposed Thuchi dam falls within the great eastern rift valley floor region and has an intensity of III MMI. This makes it exhibit similar earthquake intensities, seismic hazards and even the distribution frequencies within the entire regions. An occurrence of other schemes and dams around the region i.e. Kindaruma (**0°43'35.58"S 37°48'44.05"E**), Kamburu, (**37°50'11.67"E 0°48'29.0"S**), and Masinga (**0°52'50"S 35°35'20.8"E**) with which they share the same geographical floor area, conditions, climatic conditions, and even biophysical distributions makes it to stand a better chance of existence in engineering work.

#### 7.5.9 Modification of the Microclimate

The reservoir will cause some variations in the percentage of moisture available in the air temperature and air body movements. These alterations may not be harmful to humans but will have an effect on particular plants and animals. Considering the area the reservoir will cover, a lot of vegetation will be lost. The temperature of water, soil and oxygen distribution will change vertically as a consequence of reservoir formation. This may cause generation of new living aquatic species as a consequence of altered environment.

#### 7.5.10 Wildlife ecology

The projects site is part of Mt. Kenya forest which is part of Mt. Kenya National Park. The forest is a habitat for a number of birds and wildlife species. These species use the forest as their feeding, dispersal and breeding grounds. Once the area has been flooded, it will lead to a modified environment, which will interfere with these processes and may stress wildlife.

##### 7.5.10.1 Elephants

Elephants are classified as vulnerable by the International Union for the Conservation of Nature (IUCN). They play a key role in maintaining MKE habitats especially grasslands and bush lands. They are also a keystone species modifying habitat for other species to colonize. Elephants love to play and bathe in water and don't mind travelling long distances to find it. The forest is a wet area and chances of the elephants going to look for water in an open area are low.

The elephants have a high level of intelligence and will know when they have to move on and adjust to new habitats in order to continue surviving. They will therefore look for new pasture or follow their route to some old pastures.

The 43.8ha that will be under the reservoir will imply that the elephants' original grazing area will be reduced by a similar margin. This has the possibility of resulting into two scenarios: habitat degradation and interference with

their feeding habit. With assumed same number of elephants inhabiting the forest, a reduction in their dispersal and grazing area will mean that they all have to feed on a smaller area which may lead to over-browsing. Alternatively, once they exhaust their pasture they may opt to begin their migratory journey earlier than they had been previously accustomed to.

In the past, cases of elephants invading farms have been reported. The need for the elephants to move earlier might revive the human-elephant conflict that was once there. However, if the electric fence is re-routed and goes round the reservoir, these conflicts may be minimized or completely avoided.

#### 7.5.10.2 Mosquitoes

The dam will attract mosquitoes because they lay their eggs in stagnant water. Mosquitoes are known to be vector carriers for malaria. However, those that carry the vector are majorly found in the warm lowlands and the proposed dam site is in the cooler highland region. Increased incidences of malaria are therefore not expected to be one of the impacts associated with the construction of the dam. However, a high population of mosquitoes may still be considered as potential vectors for emerging mosquito related diseases such as the zika virus

Mosquitoes play an important role in the ecosystem because their larvae provide food for fish and the mosquitoes themselves are food for birds, spiders among others. Since the project will involve introduction of fish into the dam, the fish will therefore benefit because the mosquito larvae will be a source of food. If the fish adapt well and breed, they may feed on the larvae and control the mosquito population to levels that will not be alarming.

#### 7.5.10.3 Frogs

A new dam may attract frogs. This is because, just like mosquitoes, frogs prefer still water to lay their eggs and breed. The area around the dam also provides plenty of slugs, flies and other insects for the frogs to eat. They are referred to as environmental indicators because habitats with a variety of frogs are usually healthy. Therefore, monitoring frogs in the dam may allow environmentalists to keep check on the health of the dam. A healthy frog population will also attract frog predators such as herons, cormorants, egrets and snakes.

#### 7.5.10.4 Other dam beneficiaries

Healthy dams provide habitat for a great diversity of aquatic invertebrates especially the larval or juvenile stages of some insects as well as water spiders and flying insects such as dragon flies and damselflies. Many invertebrates provide food for fish, frogs and birds.

Certain species of birds will be attracted by the dam: those that are coming to wade, those feeding on fish and larvae. Visiting water birds will inadvertently introduce plant and animal life including weeds into the dam carried on their feet and in their feathers thus bringing change in the ecology of the area. This will result to increased biodiversity in the ecosystem

#### Mitigation measures

- The proponent could consider compensatory land acquisition in the neighborhood of the reservoir to maintain the elephants' current browsing range
- The electric fence should be re-routed and taken round the reservoir to avoid human-wildlife conflict

- In case the elephants invade the farms, the farmers should be compensated for any damage done the wildlife

### 7.5.11 Invasive weeds

Thuchi dam may be invaded by the water fern (*Salvinia molesta*) being the most probable one as it was identified along Kiajege stream during the field study. Thuchi dam may lead to an increase in the spread of the water fern that finds favorable conditions of growth and development around water bodies and swampy places.

#### *Mitigation measures*

- Monitor aquatic vegetation with the aim of early detection of invasive weeds. If detected, immediate measures should be taken to remove them.

## 7.6 Commissioning and operation positive impacts

1. Although limited, some jobs [permanent, skilled, unskilled, temporary, casual etc] will need to be filled. This will continue to support the economy of the local community as well as that of the country. Skills development and capacity building would result from onsite training efforts.
2. The facility will contribute to the local and national economy through provision of food through the irrigation schemes and will serve as a learning centre for students learning
3. Once operational, the plant will boost the government effort towards achieving food security for the country and achieving the pillars of Vision 2030
4. The facility will also contribute to the generation of electricity and thus enhance governments' effort towards rural electrification and economic development.
5. Enhanced cross-cultural relations. The PAPs interviewed are not totally against 'outsiders' working in their land. And they see this as an opportunity to relate closer and understand better people from other cultures.
6. Source of nutrition: The local community may venture into fishing and earn income or enhance their nutrition
7. The dam site will form a learning centre where students of geography [and other subjects] would visit to learn the effects of dams on communities
8. The dam will play a key role in boosting government efforts towards food security and production of electricity.

## 7.7 SUMMARY OF PROBABLE IMPACTS

PROBABLE IMPACT	TYPE	NATURE	PROPOSED ENHANCCEMEN T/MITIGATION	RESPONSIBILITY
Job creation	<b>Sociological</b>	+ ,ST,R	Priority to available /willing youth for qualifying cadres	Contractor
Skills development/capacity building		+ ,LT,P	Contact on-site training	Contractor
Improved food production		+ ,LT,P	Used for dam waters intended purpose only	NIB
Generation of electricity		+ ,LT,P	Give priority to rural electrification	Kengen/KETRACO
Improved Cross-cultural relations		+ ,LT,P	Engage Kenyans from other ethnic backgrounds	Contractor
Improved Infrastructural development		+ ,LT,P	Develop Site Access roads/Health /Education facilities	Contractor
Fishing/fisheries development		+ ,LT,P	Breed fish on the dam, train locals for fisheries	Ministry of fisheries/CBOs
Improved local trade	<b>Economic</b>	+ ,LT,P	Buy inputs such cement/stationary etc from local SMEs	Contractor
Learning centre	<b>Educational</b>	+ ,LT	Promote site as learning centre for Geography etc	Educationists, CGoE, MoT
Breeding of dangerous animals	<b>Sociological</b>	- ,ST,R	Crocodiles and hippopotamus should not be introduced	KWS
Re-routing of existing paths and routes		- ,LT,P	Build a bridge downstream to connect villages	Contractor
Misuse of site for homicide/suicide		- ,LT,R	Promote onsite security/perimeter wall/lighting	Contractor ,Kenya police ,Kengen
Rural moral degradation		- ,ST,R	Counselling, Civic education, Instruction	Parents, CBOs, schools, FBOs
Increased incidence/spread of HIV/Aids		- ,ST,R	Equip Health facilities with ARVS, workers,	Parents, schools, FBOs, Health workers
Risk of accidental drowning		- ,ST,R	Perimeter walling, Rescuers, Basic swimming skills	Schools, CBOs,
Relocation of persons		- ,LT,P	Resettle PAPs not too far from current homes	NIB
Land acquisition		- ,LT,P	Inform, involve, Compensate adequately	NIB

Increase in number of outsiders		-,ST,R	Inform, educate, embrace “others”	All stakeholder
Increased human/road traffic		-,ST,R	Expand /modernise local road system	Contractor, KERRA,
Stressed local infrastructure		-,ST,R	Expand capacity of existing health/education infrastructure	MoH, NGOs,
Relocation of graves		-,LT,P	Detailed consultation with leaders/elders on procedure	Elders, Opinion leaders, social services
Altered livelihood strategies		-,ST,R	Capacity building, training and motivation strategies	
Local vs. outsiders workers tension		-,ST,R	Civic education, implementation Kenya constitution 2010	
Reduced farm labour	<b>Agricultural</b>	_ST,R	Promote agribusiness, Improve tea prices	MoA, Entrepreneurs ,KTDA
Poor Waste Disposal	<b>Environmental</b>	+,LT,R	Construct dumpsite, build sanitation equipment	Contractor, NIB
Noise pollution		-,ST,R	Wear anti-noise protection,	Workers,contractor,NIB,
Air pollution by trucks and machinery		-,ST,R	Apply water on dusty roads regularly, Dust regulation	Contractor,workers
Spillage and Emissions on the river		-ST,R	Apply polluter pays regulation	Workers,contractor,proponent
Increase in water borne diseases	Health	-LT,R	Training on treating drinking water by boiling	Community,NGOs,MoH
Increased Poaching	<b>Ecological</b>	-	Increase surveillance	KWS, The police, community policing
Loss of vegetation		_,LT,R	Plant more trees at the acquired but non-inundated land	Contractor, NIB, Community
Eutrophication		_ST,R	Control amount of fertilizer-use in neighboring farms	Farmers
Reduced Silt flow downstream		_LT,R	Maintain 80% flow downstream	Contractor/Proponent
Invasive flora		_,ST,R	Do not introduce them, Remove them biologically	Proponent, Researchers
Fisheries development /nutrition		+,LT,R	Introduce fish after research, encourage consumption	MoF, Proponent

Changed water quality	<b>Chemical/ecological</b>	_ST,R	Regular quality tests	Proponent, consultant, contractor
Seismicity/risk for earthquake	<b>Geological</b>	_,LT,P	Exhaustive studies before commencement, Install sensors	Consultant, Proponent
Risk of land slides		_,LT,R	Reinforce walls ,barriers, Buffer	Consultant, proponent, community
Changed river flow/volumes	<b>Hydrological</b>	_, LT,R	Maintain 80% flow	Contractor, proponent

### Key

Serial	Acronym	Interpretation
1.	LT	Long term
2.	ST	Short term
3.	R	Reversible
4.	P	Permanent
5.	-	Negative
6.	+	positive

## 8 ENVIRONMENTAL AND SOCIAL MANAGEMENT PLAN

The Environmental and Social Management Plan (ESMP) is prepared to show how site specific concerns and mitigation measures are addressed through the design, pre-construction, construction and post-construction / operation phase of a project.

The ESMP has been developed with project knowledge and information available to date. Some of the Project's final details, such as actual locations of borrow areas to be used by the Contractor, disposal areas for construction debris among other issues, are unknown at the present time. As project commencement and scheduling plans are developed and changed, components of the ESMP might require amending. This is therefore a working document, which should be used as a basis for formulating more site specific Environmental Action Plans.

### 8.1 Objectives of ESMP

The Environmental and Social Management Plan (ESMP) describes the range of environmental issues associated with the Project and broadly outlines corresponding management strategies that will be employed to mitigate potential adverse environmental impacts. The ESMP conveys the project's environmental and social constraints.

The project will comply with all local laws and regulations, which seek to ensure that the construction work does not adversely affect the environment and social community resources. The Supervising Consultant may periodically revise the ESMP in consultation with the Contractor, and subject to the approval from NIB with copies to the National Environment Management Authority. Revisions may be made to accommodate changes in work, weather and site conditions. The ESMP should be made available to all project staff.

The objectives of the ESMP are:

- To bring the project into compliance with applicable national environmental and social legal requirements;
- To outline the mitigating/enhancing, monitoring, consultative and institutional measures required to prevent, minimize, mitigate or compensate for adverse environmental and social impacts, or to enhance the project beneficial impacts;
- To address capacity building requirements within the relevant ministries if necessary.

### 8.2 Institutional Arrangement

The responsibilities of implementation of Environmental Management Plan will be jointly shared between the Contractor and the NIB. Organization to undertake these responsibilities will need to be set-up and should employ two ways communication at all levels of management. There will be various institutions involved in the process of EMP planning and implementation. For effective environmental management and monitoring, it is proposed that NIB acts as the responsible institution but supported by an Independent Consultant and an Environmental Monitoring Unit to be constituted by technically competent people from key institutions. It is suggested that the TOR for the Contractor should include a resident Environment Manager who is to implement all the mitigation actions proposed in the ESIA.

### 8.3 Institutional Responsibilities

It is proposed that the institutional responsibilities for implementing the Environmental Management Plan shall involve:

- The Contractor, which shall include an Environmental Manager (EM);
- The NIB, which in addition to its own internal capacity, shall contract a Supervising Engineer (SE) with one or more qualified environmental specialists; and
- An Independent Consultant Firm contracted by NIB to support NIB in implementation and capacity development.
- The environmental Monitoring Unit, which shall consist of specialist organizations such as the Kenya Marine and Fisheries Research Institute, Kenya Medical Research Institute, Kenya Agricultural Research Institute, National Museums of Kenya, etc.
- The National Environment Management Authority (NEMA) and the representatives of all affected Counties

#### 8.3.1 Responsibilities of the NIB

As the project proponent NIB shall bear the greatest responsibility and will undertake the following tasks:

- Oversee the development and implementation of the Final EMP by the Environmental Management Unit (EMU) of the NIB and coordinated by the Independent Consultant.
- Oversee and facilitate the implementation of all time-bound (non-recurrent) environmental management measures in the Final EMP by the Independent Consultant.
- Make NIB staff available for environmental training, including working collaboratively with the Independent Consultant's personnel to implement particular environmental management measures.
- For environmental management measures specified in the final EMP that are recurrent – such as biota and water quality monitoring - provide the qualified staff to carry out these recurrent tasks, or ensure that they are carried out through operating agreements or contracts with other entities (see suggested composition of the EMU).
- Oversee the work of the Supervising Engineer and the Civil Works Contractor and associated subcontractors; facilitate adaptive responses that shall have been formulated by the EMU to any unforeseen environmental problems that arise during project construction; and apply all appropriate financial penalties in case of non-performance or serious non-compliance with the Final EMP or other environmental legal requirements.

#### 8.3.2 Responsibilities of the Independent Consultant

The Independent Consultant will be an internationally professional firm contracted to:

- Assist in developing those plans envisaged under the Environmental Management Plan during Year 1 of project implementation, before bidding begins on the civil works. In developing these plans, the Independent Consultant shall coordinate with the EMU.
- On behalf of and in close collaboration with NIB, assist in the development and the timely implementation of all plans and tasks, except for those tasks specifically assigned to other entities such as the Civil Works Contractor or Supervising Engineer.
- Train and otherwise build capacity within NIB and to some extent EMU to carry out those EMP activities that are recurrent or longer-term in nature, extending beyond the time horizon of the Independent Consultant's contract.
- Liaise with NIB to ensure that environmental flows recommendations are adequately reflected in the operating Rules for the Dam and that long term systems and capacity is in place for bio-monitoring.
- The Independent Consultant will provide periodic progress reports during implementation to NIB, NEMA and relevant County offices.

### 8.3.3 Responsibilities of the Civil Works Contractor

The main Civil Works Contractor shall be responsible for full compliance with the EMMP provisions, as well as health and safety measures specified in the Construction and Workers' Camp Management Plan that will comprise part of the Final EMP. The Civil Works Contractor and all associated sub-Contractors shall also ensure compliance with all Kenyan environmental laws and regulations, as well as international conventions.

The Civil Works Contractor shall appoint a Workplace Environment Manager (EM) and additional environmental specialists and staff as needed. The EM's expected to have at least 5 years relevant working experience regarding environmental management of infrastructure construction projects, and should be familiar with Kenya's environmental legislative requirements. The Contractor will be responsible for ensuring that all sub-contractors and workers are adequately informed and trained to comply fully with the letter and spirit of all environmental requirements specified in the Final EMP, the Environmental License(s) granted by NEMA and other Kenyan and international legal requirements.

### 8.3.4 Responsibilities of the Supervising Engineer

The Supervising Engineer will be a firm contracted by NIB to supervise closely the daily work carried out by the Civil Works Contractor and relevant sub-contractors, including the environmental, health, and safety aspects. The environment-related staff of the Supervising Engineer will include (at a minimum) an Environmental Supervisor, who will lead the supervision of the environmental aspects of civil works, in accordance with the Construction and Workers Camp Management Plan that comprises part of the Final EMP. The responsibilities of the Supervising Engineer include the following:

- Carry out regular environmental site surveillance to investigate the Contractors' site practice, equipment, and work methodologies with respect to pollution control and adequacy of environmental mitigation implemented, and to ensure that the Construction and Workers Camp Management Plan is complied with
- Monitor regularly the implementation of environmental mitigation measures and the Contractor's compliance with environmental protection, pollution prevention and control measures, and contractual requirements; advice to the Contractor and associated sub-contractors on environment improvement, awareness, proactive pollution prevention measures;
- Specify remedial mitigation measures that the Contractor must carry out, in the case of non-compliance with any part of the Final EMP or other environmental legal requirements. Oversee the implementation of remedial measures to reduce environmental damage;
- In conjunction with the supervising engineer, calculate the financial penalties that the Contractor will suffer for particular types and length of environmental non-compliance;
- Ensure that environmental, health and safety issues are prominently mentioned in the Supervising Engineer's periodic progress reports to NIB.

### 8.3.5 The Project Management Unit (PMU)

This unit will be the national body that will oversee implementation of all project activities including environmental mitigation measures. The unit will be established at least 1 month before the start of the Project and will operate as follows: 1 year for pre-construction, throughout the construction period and 3 – 5 years to monitor post impoundment impacts and take action where necessary. The operational costs of the unit will be factored into the project cost.

Specifically, the roles of the PMU are:

- Review and approval of all mitigation Action Plans.
- Provide organizational support and direction for the NIB.
- Liaise with GoK organizations on the national, County and district levels, including the allocation of roles and responsibilities for the field GOK agencies.
- Ensure compliance with GoK laws, regulations and policy.
- Liaise with the Contractor regarding concerns and priorities.
- Carry out national and International level consultations.
- Appoint a Panel of Experts as external monitors if necessary.

### 8.3.6 The Environmental Monitoring Unit (EMU)

This is the technical arm of the PMU and to be chaired by the NIB. The EMU will collect all kinds of environmental and social data, analyze and advise the PMU as appropriate. This committee will serve as a counterpart to the Contractor's Environment and Social Manager.

The tasks of the EMU will be to:

- Provide technical input to all environmental mitigation measures including resettlement and livelihood restoration and improvement.
- Formulate the technical protocol to be used in collecting monitoring data on environmental impacts and effectiveness of the proposed mitigation measures
- Monitor implementation of all environmental and social mitigation measures proposed in the ESIA and those that may emerge during project implementation
- Advise the PMU on adjustments required to improve environmental performance of the project
- Act as a link between the PMU and the Contractor, affected persons and the general public
- Report to the PMU

It is proposed that the EMU should be supported by specific committees that focus on key components of the project as follows:

## 8.4 Environmental Management and Monitoring process

It is proposed that the NIB sets up the Project Management Unit (PMU) to manage the project. The PMU will consist of technically competent staff from the NIB and Ministry of Regional Government.

The second tier and the most important unit is the Environment Management Unit (EMU). This a technical unit comprising of representation from technically oriented organizations. Proposed membership to include but by no means restricted to KEMFRI, KARI, KEMRI and the NIB. Similar organizations could be co-opted. This unit could create specialist committees and co-opt other specialist agencies and community representatives within it. The following are proposed:

- a. Resettlement and Compensation Committee (RCC)
- b. Downstream ecosystem and water quality committee (DEC)
- c. Catchment Conservation and Management Committee (CCMC)
- d. Livelihoods Committee (LC)

These two teams, the PMU and the EMU will form the institutional network to ensure smooth implementation of mitigation, management and monitoring measures during the construction and operation stages of project development, especially the resettlement activities in accordance with the law and the new Kenyan Constitution.

#### **8.4.1 The Catchment Conservation and Management Committee**

To be headed by the Zonal Forest Office of the Kenya Forest Service for Embu and supported by the Mt. Kenya area zonal manager: To assist with catchment conservation and management, provide extension services across the entire catchment.

This committee should initiate and develop a detailed **Integrated Catchment Management Plan** while taking the components of the project into consideration. The catchment management plans should encompass the following:

- Upper Catchment – This is upstream of the reservoir covering parts of Mt. Kenya Ecosystem
- Middle Catchment: This covers the middle section of the catchment
- Lower Catchment – Covers all the remaining catchment to the river mouth.

#### **8.4.2 Livelihoods Committee**

This committee will be responsible for overseeing the implementation of the social mitigation measures, including issues of equity, grievance and conflict resolution.

The Agriculture Offices within the affected Counties will be required to provide assistance in the form of agricultural extension workers and other inputs to resettlement and livelihood improvement programmes including in the irrigation areas.

In addition the sub-committee will be responsible for promoting, income generation programmes and marketing. The sub-committee will ensure that cultural issues are taken up and it will work with ethnic groups in the project area, especially within the new settlements for those relocated from the reservoir area to foster harmony.

During the relocation, cultural considerations, such as rituals for moving houses, relocating or appeasing graves and physical cultural resources, will need to be taken into account. At the local level this office will be the GOK organization responsible for 'chance finds' and archaeological studies. It will liaise with the National Museums of Kenya, regarding important cultural issues and items of importance discovered before or during construction.

#### **8.4.3 Reservoir Environment Committee**

Assisted by the independent consultant the committee will be responsible to monitor impacts related to inundation, fisheries and any other environmental effects, and assist with the preparation of reservoir management plan including management plan of fisheries in the reservoir area, monitor water management by the Operator and propose adjustments where necessary, monitor water quality at the reservoir, monitor the efficient implementation of the public health components of the Environment management Plan.

#### **8.4.4 Downstream Environment Committee**

Assisted by the independent consultant the committee will be responsible to monitor all ecological dynamics downstream including fish, monitor water management by the Operator and propose adjustments where

necessary, monitor water quality of river, Further the committee will be responsible in ensuring that the ecology of the river is not unduly degraded, the wetland functions are preserved and monitoring wildlife population dynamics.

#### 8.4.5 Resettlement and Compensation Committee (RCC)

The central task of the Resettlement and Compensation Committee is to provide leadership and coordination for GoK organizations involved in resettlement and compensation. The responsibilities of RCC the will be as follows:

- Coordination of all GoK organizations and ensuring resettlement and compensation priorities are addressed.
- Ensuring that GoK policies, procedures and regulations are being followed in implementing the RAP.
- Facilitating involvement in carrying out resettlement/compensation activities, such as consultations and formulating livelihood restoration programs.
- Monitoring and auditing funds that are earmarked for resettlement and compensation issues.
- Ensuring that everybody involved in the resettlement and compensation activities are aware of relevant regulations and have undergone proper orientation and training in gender, ethnic, poverty alleviation and participatory planning and implementation concerns.
- Ensuring prompt evaluation of land and assets (crops, production, market values, etc.) for compensation for project-affected persons and resettled populations
- Organization of County and District level meetings and consultations.
- Participation in and follow through of claims lodged via established Grievance Procedure.

Since the RCC is primarily a coordination body, and the relevant local Government offices at the County / District level are partners in implementation, it is recommended that the RCC be composed of the following members:

- RCC Manager - a senior, qualified manager with proven effective experience with resettlement, compensation and rural development issues. The appointment should be on a contract and is answerable to the REMC.
- Three Deputy Managers to oversee coordination of GoK agencies involved in resettlement, Catchment, Downstream and Project Construction Land areas respectively.
- Representatives of the Government at County levels of the following ministries: Ministry of Lands, Ministry of Social Services, the DC or County Governor representative, Security, Ministry of Education, Environment, Planning, Fisheries, Agriculture, Livestock and the NIB.

#### 8.4.6 Other working groups that can be considered

Institution / Organization	Participants	Tasks
Vegetation Clearing Committee for reservoir area	<ul style="list-style-type: none"> <li>▪ Zonal Forest Officer</li> </ul>	<ul style="list-style-type: none"> <li>▪ Determination of timber value</li> <li>▪ Monitoring of clearing process</li> <li>▪ Provide guidance and authorization of timber sale and or relocation, appoint contractor in timber handling activities</li> </ul>
Grievance Committee	<ul style="list-style-type: none"> <li>▪ Lands Officer</li> <li>▪ Local Administration</li> <li>▪ Community</li> </ul>	<ul style="list-style-type: none"> <li>▪ Determination, negotiation of value of land</li> <li>▪ Preparation of compensation guidelines</li> <li>▪ Monitoring of disbursement of compensation payments</li> </ul>

	<ul style="list-style-type: none"> <li>representative</li> <li>▪ NIB representative</li> </ul>	<ul style="list-style-type: none"> <li>▪ Participation in compensation committee</li> <li>▪ Certification of transfer of land ownership</li> <li>▪ Payment of compensation</li> </ul>
District Working Group	<ul style="list-style-type: none"> <li>▪ All relevant Government Offices of the affected districts</li> </ul>	<ul style="list-style-type: none"> <li>▪ Provide technical input to the resettlement and livelihood restoration and improvement process</li> <li>▪ Participate in capacity building for village facilitators</li> <li>▪ Provide human resource and informational input to livelihood activities, as required</li> <li>▪ Assist with training activities</li> </ul>
Host Community and settlers working committee Villages Level working Committee	<ul style="list-style-type: none"> <li>▪ Sub-location chiefs headman</li> <li>▪ Village Elders</li> <li>▪ Village Woman and Youth Organizations</li> <li>▪ Local Security</li> </ul>	<ul style="list-style-type: none"> <li>▪ Settlement of complaints on compensation payments, as well others arise from the project implementation discrepancies and conflicts</li> </ul>

#### 8.4.7 Relocated and Host Village-Level organizations

In each relocated and host village it will be necessary to delegate to an existing organization or propose the establishment of a Community Based Organization (CBO) or a Village Resettlement Committee the responsibility for formulating village policy on resettlement, overseeing the resettlement process, recruiting village facilitators, first line addressing of grievances, leading the community participation process and other identified tasks.

The Committee should act as the formal contact point with the community and the project management.

### 8.5 THE ENVIRONMENTAL MANAGEMENT PLAN

#### 8.5.1 KEY ENVIRONMENTAL ISSUES

Environmental issues are manifested in three areas within the project area; These are divided into two sections:

1. The reservoir area
2. The downstream of the dam

The project will potentially impact differently within each of these two zones.

##### Proposed Measures

The measures proposed in the EMP are related to mitigation and monitoring activities during both construction and operation, which constitute the core strategy of this plan.

Mitigation measures are proposed during both construction and operation phases. They include diversified activities as additional studies, technical sub-projects, and resettlement and compensation.

Monitoring measures are basically related to 2 types of activities: regular acquisition of additional data for the quantification of Project impacts and the follow-up of the appropriate implementation of the mitigation measures and Contractor's obligations.

The EMP is a dynamic document, which may be subject to change or modification as a result of project development or changes on the site. Any substantive changes to the EMP during project implementation shall be to be presented by EMU to the NEMA and County representatives for approval.

## Summary of Mitigation Plan

	Component	Potential Impacts	Mitigating Measure	Responsibility	Frequency of management
Design and Construction	<b>AIR QUALITY</b>				
	Vehicle and engine emission	Increase of air emission	<ul style="list-style-type: none"> <li>▪ Reduce vehicle travel distance between camp, material sites and work sites</li> <li>▪ Maintain vehicles engines</li> </ul>	Engineer	Monthly
	Dust emission	Increase airborne dust along the roads during dry season	<ul style="list-style-type: none"> <li>▪ Control with water spraying on unpaved access roads and work sites</li> </ul>	Contractor	When need arises
		Dust from crushing plants	<ul style="list-style-type: none"> <li>▪ Respiratory protection devices for workers at crushing site</li> </ul>	Contractor	Continuous
	<b>NOISE</b>				
	Noise by machinery and workforce	Disturbance to sleep for nearby residents Potential to impair hearing for workers close to blast sites	<ul style="list-style-type: none"> <li>▪ Provide ear protection devices to workers</li> <li>▪ Warn residents adjacent to blast sites</li> <li>▪ Avoid use of heavy machinery close to sensitive institutions</li> <li>▪ Acquire a license for emitting noise in excess of the required standards</li> </ul>	Contractor	Continuous
					Once
	<b>SOILS</b>				
	Land use	Loss of farm land and forest	<ul style="list-style-type: none"> <li>▪ Preserve top soil, rehabilitate and revegetate after use especially at disturbed sites and material sites</li> </ul>	Contractor / EM	
	Road construction	Alter drainage, cutting of slope, loss of vegetation cover, risk of erosion	<ul style="list-style-type: none"> <li>▪ Road design to satisfy national standards</li> </ul>	Contractor / Engineer	
			<ul style="list-style-type: none"> <li>▪ Construction methods to follow present best practice</li> </ul>	Contractor	Continuous
			<ul style="list-style-type: none"> <li>▪ Slope protection measures with revegetation</li> </ul>	Contractor	Continuous
	Quarry and borrow areas	Alter drainage, cutting of slope, loss of vegetation cover and farmland	<ul style="list-style-type: none"> <li>▪ Use spoil as backfill of borrow areas</li> </ul>	Contractor	
			<ul style="list-style-type: none"> <li>▪ Submit detail plan for quarry operation and rehabilitation prior to excavation</li> </ul>	Contractor	
			<ul style="list-style-type: none"> <li>▪ Fill borrow areas with excavated spoil from tunnel</li> </ul>	Contractor	
			<ul style="list-style-type: none"> <li>▪ Compensate farmers for loss of agriculture land</li> </ul>	EMU / EM	Once
	Temporary camps and permanent facilities	Alter land-use, loss of land and vegetation cover	<ul style="list-style-type: none"> <li>▪ Submit detail plan for approval before implementation</li> </ul>	Contractor	Once not unless there is a change in plans
			<ul style="list-style-type: none"> <li>▪ Compensate farmers for temporary or permanent loss of agriculture land and property</li> </ul>	Contractor / EMU	Once
<ul style="list-style-type: none"> <li>▪ Implement where possible temporary facilities within future reservoir limits to avoid net land consumption</li> </ul>			Contractor		
<b>WILDLIFE</b>					

Wildlife	Loss of habitats and local disturbance of breeding sites	<ul style="list-style-type: none"> <li>Organize animal rescue during clearing operation if deemed necessary</li> </ul>	KWS and forestry office	During clearing of the forested area
		<ul style="list-style-type: none"> <li></li> </ul>		
<b>AQUATIC</b>				
Water quality	Increased sediment load in river	<ul style="list-style-type: none"> <li>Trap sediments on construction sites</li> </ul>	Contractor	Continuously
	Water pollution during construction	<ul style="list-style-type: none"> <li>No direct runoff to river from vehicles/engines maintenance areas</li> </ul>	Contractor	Continuously
		<ul style="list-style-type: none"> <li>No direct runoff to river from toilet and waste disposal sites</li> </ul>	Contractor	Continuously
<b>SOCIO-ECONOMY</b>				
Workforce and population movement	Concentration of workers with associated risk	<ul style="list-style-type: none"> <li>Provide adequate housing facilities for camped workers</li> </ul>	Contractor	Continuously
		<ul style="list-style-type: none"> <li>Provide fair opportunities of work for local population especially women</li> </ul>	Contractor	Continuously
		<ul style="list-style-type: none"> <li>Recruitment and training of local residents as staff for project operation</li> </ul>	Local initiative	Bi annually (training)
		<ul style="list-style-type: none"> <li>Discourage antisocial behavior (prostitution, alcohol, drugs)</li> </ul>	Contractor	Continuously
	Uncontrolled settlements	<ul style="list-style-type: none"> <li>Strict control of settlement development next to workers camps</li> </ul>	Local Government	Continuously
		<ul style="list-style-type: none"> <li>Awareness campaign for temporary settlement of workers</li> </ul>	Contractor	Once
Public Health and safety	Introduction and spreading of disease	<ul style="list-style-type: none"> <li>Carry out workers pre-employment screening</li> </ul>	Contractor / district health office	When recruiting
		<ul style="list-style-type: none"> <li>Support health service both facilities and human resources in Thuci area</li> </ul>	MOH / District health office	Continuously
		<ul style="list-style-type: none"> <li>Non-formal education campaign for hygiene and prevention of sexually transmitted diseases (STD)</li> </ul>	MOH / Contractor	Twice
	Road accident cause by traffic congestion	<ul style="list-style-type: none"> <li>Proper road system design</li> <li>Control the driver behavior</li> <li>Appropriate signage</li> </ul>	Contractor	Continuously
	Worker injury during construction	<ul style="list-style-type: none"> <li>Elaboration and enforcement of safety regulation</li> <li>Implementation of an emergency evacuation procedure</li> </ul>	Contractor / EMU	Continuously

	Land tenure	Temporary or permanent acquisition of farmland	<ul style="list-style-type: none"> <li>Provide support for greater productivity of remaining land if partial acquisition from owner</li> </ul>	NIB	Once
			<ul style="list-style-type: none"> <li>Land acquisition and compensation</li> </ul>	Contractor (for contractor's camp and NIB for resettlement)	Once
	Education and Culture	Increase in students during construction	<ul style="list-style-type: none"> <li>Assist improving existing facilities to required standard and capacity to accommodate student population from workers families</li> </ul>	Contractor / project owner	Once
<b>AQUATIC CONDITIONS</b>					
	Hydrology	Dam will alter downstream discharges mainly in wet season	<ul style="list-style-type: none"> <li>Monitoring existing gauging stations</li> <li>Ensuring the prescribed flow regime is implemented</li> </ul>	Operator/EMU	Once a week
		Sudden changes in river Thuci flow (Minor impact)	<ul style="list-style-type: none"> <li>Awareness information among local people</li> </ul>	Operator / EMU	Once
	Water quality	Alteration of water quality after impoundment by flooded vegetation	<ul style="list-style-type: none"> <li>Total logging and clearing of the reservoir area of standing biomass</li> </ul>	Contractor / EMU	Once
	Fisheries	Disruption of upstream fish movement and possible reduction of some fish species	<ul style="list-style-type: none"> <li>Ensure flow dynamics that mimic the natural fish environment within the lower Thuchi River</li> </ul>	EMU	Continuously
<b>FORESTRY</b>					
	Forest cover	Flooding or clearing of part of Mt. Kenya forest (minor impact)	<ul style="list-style-type: none"> <li>Compensatory reforestation of degraded areas</li> </ul>	NIB	Once
<b>Ecological resources</b>					
		Maintaining the functionality of the riverine ecology to support the avifauna and other wetland dependent species	<ul style="list-style-type: none"> <li>Ensure no less than 30% flow regime is maintained that supports the ecology of the river system.</li> </ul>	Operator	Continuously
<b>SOCIO-ECONOMY</b>					
	Population movement	Uncontrolled settlements around the project area	<ul style="list-style-type: none"> <li>Strict control of settlement development</li> </ul>	EMU / RESMC	Continuously

Operation phase			<ul style="list-style-type: none"> <li>Monitor and control population movement in the neighbourhood of the project</li> </ul>	EMU	
	Education	Children drop out school	<ul style="list-style-type: none"> <li>Provide social amenities as detailed in the Resettlement Plan</li> </ul>	NIB	Once
		Disrupted livelihoods of the fisherfolk, changes in sources of livelihoods based on the wetland resources	<ul style="list-style-type: none"> <li>Encourage uptake of irrigation agriculture by the younger people</li> <li>Mount awareness campaigns of new opportunities brought about by expanded irrigation</li> </ul>	NIB	Twice
		Reduced livestock grazing areas especially dry season grazing fields within the irrigation areas	<ul style="list-style-type: none"> <li>Promote adoption of zero grazing by the local farmers</li> <li>Encourage a shift to better dairy breeds to improve income</li> <li>Encourage the uptake of high value irrigation crops to compensate for loss of large herds of livestock per household</li> </ul>	NIB	Once
	Water borne and water related diseases	Increase in water borne and water related diseases	<ul style="list-style-type: none"> <li>Implement measures to assess the presence of vectors and control its and potential diseases.</li> <li>Creation of awareness, prevention and monitoring programs</li> <li>The latrines in the area to be flooded should be treated using solid Chlorine so as to kill living bacteria, disease causing microbes and to curb the smell to some extent.</li> </ul>	NIB and Contractor	Quarterly Twice Once
	Infrastructure	Submergence of existing bridges	<ul style="list-style-type: none"> <li>Another bridge should be constructed for the locals so that their movement is not hindered</li> </ul>	NIB, Contractor and Resident Engineer	Once
		Electric fence	<ul style="list-style-type: none"> <li>The fence should be re-routed and go round the reservoir to keep off the elephants</li> </ul>	NIB, Contractor and Resident Engineer	Once

### 8.5.2 Estimated EMP Implementation Costs

The estimated costs of mitigation measures are presented in the table below.

<b>Environmental/Social Aspect</b>	<b>Description</b>	<b>Indicative cost estimate (KSH)</b>
Air quality	Emissions from machinery and construction traffic	
	Provision of respiratory protective devices for workers at the crushing site	Included in the BoQ
	Spraying of water on unpaved roads and work sites	Included in the BoQ
Soil	Use of plastic sheeting, sandbags or geo fabric approved by the RE to prevent the migration of fines through the edges of the fill into the river	1,300,000
	Compensate farmers for loss of agricultural land	Contained in RAP and BoQ
Noise	Provide ear protection devices to workers	Included in the BoQ
	Acquire a license for emitting noise in excess of the required standards	66,000
Water quality	Treatment of pit latrines in reservoir area with chlorine	270,000
	Water treatment for community projects within reservoir area	100,000 Initial set up + 50,000 per week
Workforce	Provide adequate housing facilities for camped workers	Included in the BoQ
	Training of local residents as staff for project operation	500,000
Public health and safety	Awareness campaign for hygiene and prevention of sexually transmitted diseases (STD)	350,000
Land tenure	Land acquisition and compensation	Contained in RAP and BoQ
Education and culture	Assist improving existing facilities to required standard and capacity to accommodate student population from workers families	Planning
Hydrology	Monitoring existing gauging stations	
Forest cover	Compensatory reforestation of degraded areas	25,920,000
Livelihoods	Mount awareness campaigns of new opportunities brought about by expanded irrigation	250,000

Solid waste	Proper waste handling and management practices	Best engineering practices
Liquid waste	Proper waste handling and management practices	Best engineering practices
Water borne and water related diseases	Implement measures to assess the presence of vectors and control its and potential diseases	2,200,000
Infrastructure	The fence should be re- routed and go round the reservoir to keep off the elephants	3,540,000

## 8.6 THE MITIGATION PLAN

After impoundment of the reservoir and the beginning of operation, several mitigation measures will be implemented under the responsibility of NIB. The main activities will be as follows:

- Manage the water regime so as to mimic the natural flow dynamics as far as possible.
- The maintenance or restoration of downstream habitats to be supported by periodic opening of dam gates to create artificial floods that regulate sedimentation, allow migration, rehabilitate wetlands and mimic the natural hydrological conditions of the river.
- Monitor as necessary the completion of the compensation procedure of those resettled from the reservoir area in case of grievance regarding their host community or compensation adequacy.
- Provide long-term financial resources for catchment conservation and reforestation of degraded areas around the project.
- Strict control of new settlement by immigrants seeking opportunities such as new fisherfolk around the reservoir area.
- An alert procedure should be set up as part of the safety operation guidelines of the project.
- Train the farmers within the new irrigation areas to adopt zero grazing livestock and use irrigation to grow pasture
- Locals to be sensitized on fact that irrigation agriculture can overcompensate for recession agriculture
- Involve KWS in campaigns against killing of crop destroying game (such as elephants, monkeys, birds) that could be viewed to be a setback to new gains from irrigated agriculture
- Improve catchment conditions by enhancing tree cover in general and better soil conservation measures within farmlands
- Establish sufficient wooded and non-cultivated buffer along the edge of the dam to trap sediments and nutrients

## 8.7 Grievance Procedure and Resolution

The detailed procedure is to be contained in the Resettlement Action Plan, which must be produced prior to project implementation. Below are just some of the highlights that could be considered.

The EMU will provide affected communities, through a proposed Community Mitigation Committee with representation from across all affected areas with standard Complaints Forms to be issued to all households. Household, or groups of households wishing to complain about the effects of construction works on their property, production systems, economic well-being, spiritual life, quality of water or air, health, safety, welfare or any other facet of their lives shall present their complaint using these Complaints Forms.

## 8.8 Sub-plans and Tasks

The Environmental Management and Monitoring Plan provides a framework for addressing the potential environmental issues identified as part of the assessment. It provides a series of measures to be adhered to during the construction process along with longer term measures that should be integrated in to the operations of the dam. Given these longer term objectives the EMP recommends a number of plans that need to be developed and implemented during the project. These should be done with the support of an independent, professional consulting firm to support the NIB and assist in enhancing the internal capacity for environmental and social management. Specific measures include the following:

- i) **Construction and Workers Camp Management Plan** to mitigate construction impacts, along with rigorous Environmental Supervision by the Supervising Engineer to ensure that the main Civil Works Contractor and all sub-contractors comply with the environmental requirements of the Final EMP;
- ii) **An Inundation Preparation Plan** prepared during the first year of project implementation and implemented prior to impoundment. This would include the following:
  - a. Removing most of above and below ground biomass prior to inundation
  - b. Identification and removal of potential sources of water contamination, such as garbage dumps and latrines;
  - c. Survey and salvage of physical cultural resources, including potential archaeological sites and fossils.
- iii) **A Reservoir Management Plan** to be prepared during the first year of implementation should include the following:
  - a. Environmental Zoning of the reservoir through a consultative process with all major stakeholders;
  - b. Patrolling designated sections of the Reservoir to reduce wildlife poaching risks, in collaboration with conservation area managers and local communities;
  - c. A program for the management of **Reservoir Fisheries**, based on sustainable harvests of the introduced fish species; and
  - d. **Invasive Aquatic Plant Management** to monitor and (if needed) control the spread of non-native aquatic plant species, notably the water hyacinth.
- iv) **An Environmental Flow and Bio-Monitoring Program** to confirm the validity of existing environmental flow estimates and provide feedback mechanisms for the Operating Rules for the Dam; and.
- v) **An Environmental monitoring Plan** for the monitoring of primarily water quality and sedimentation. These sub-plans and tasks are described in more details in the following sections.

## 8.9 Construction Phase Environmental Management Plan

### 8.9.1 Construction and Workers Camp Management Plan

The Independent Consultant will review and revise the specifications outlined below in the Construction and Workers Camp Management Plan, as needed and submit any revisions to NIB for approval.

The plan shall contain specifications for technical and management procedures for mitigating environmental

impacts from construction and workers camps, i.e. construction sites, workshops, temporary stockpile sites, fuel installations, other storage and work areas and workers accommodation.

#### 8.9.1.1 Objective

The objective of the Construction and Workers Camp Management Plan is to minimize the potential negative impacts of construction activities, including workers' camps and construction traffic, on host communities, wildlife and the environment.

#### 8.9.1.2 Specifications

Requirements for workers and construction camps and sites Construction camps includes all construction sites, workshops, temporary stockpile sites, fuel installations, other storage and work areas, required by the Contractor, subcontractors and suppliers.

The camps shall be constructed and operated so that nuisances of operations and pollution of air, soil, groundwater and surface waters are avoided or minimized. In addition the safety of workers and the local population shall be taken into consideration. Specific requirements for the construction and operation of the sites to fulfill this are outlined in the following.

#### 8.9.1.3 Locality and site plan

The Contractor shall submit a locality and site plan for all construction camps indicating the location of fuel supplies, stockpile sites, offices and the construction area for approval by Supervising engineer and the NIB prior to establishing any camps. Site offices and storage and workshops shall be located more than 200m from existing residential settlements and out of the future reservoir.

#### 8.9.1.4 Fencing of the sites

The "sites" here refers to all areas required for construction purposes. The boundaries of the site shall be demarcated prior to any work commencing on the site. It is the responsibility of the Contractor to decide on an appropriate system of protective fencing for the site. The site boundary demarcation fence shall be removed when the site is decommissioned.

The Contractor shall ensure that all his plants, labour and materials remain within the boundaries of the site and he shall ensure that materials used for construction on the site do not blow on or move outside the site and environs.

### 8.9.2 Materials Handling and Storage

In order to mitigate pollution of soil, groundwater and surface water the procedures for handling the storage of materials outlined below shall be complied with.

The Contractor shall ensure that information on all petroleum, chemical, harmful and hazardous substances are available to all personnel on site. The Contractor shall furthermore be responsible for the training and education of all personnel on site who will be handling the material about its proper use, handling and disposal.

**Fuel Storage.** Fuels required for use during construction shall be stored in an enclosed central depot at the construction camp at distances of at least 50 m from any water course, water body or well.

Fuel tanks shall be placed on a concrete, or similar impermeable, base surrounded by a brick bund without drainage points or other breaches. The bund shall have a volume of at least 110% of the maximum capacity of the tank. If more than one tank is stored within the bund, the system must be capable of storing 110% of the capacity of the largest tank or 25% of the capacity of all tanks.

Accumulated rainwater in bunds shall be pumped out of the bund to either drains or the ground if uncontaminated. In case of fuel spillage the spilled fuel should be recollected and contaminated bund treated by the absorbents: sawdust, sand or straw. All fuel/hydrocarbon dispensing nozzles are to be of a drip control design and securely locked when not in use.

Tanks containing fuels shall have lids and shall remain firmly shut. Only empty and externally clean tanks may be stored on the bare ground. All empty but externally dirty tanks shall be stored on an area where the ground is protected (e.g. concrete slab, covered store house, etc).

Gas and liquid fuel shall not be stored in the same storage area.

The Contractor shall take all the necessary precautions to prevent fires or spills at the fuel store. No smoking shall be allowed inside the stores and within 3 m of a bund.

The Contractor shall ensure that there is adequate fire-fighting equipment at the fuel stores.

**Lubricant Storage.** Lubricants shall be stored in drums or tins that are either sealed or have tightly fitting caps. All containers must be closed unless in use. Decanting of lubricants must be carried out in a specific area that has been previously identified and suitably protected.

Lubricants shall be stored under cover in a no smoking area.

All lubricant impregnated cotton waste and rags shall be promptly disposed of and handled as hazardous waste.

**Explosives.** Explosive materials storage must be away from residential areas, administrative areas or other public areas, the location of the storage must be accepted and approved by Commissioner of Mines and must comply with existing Kenyan regulations.

#### 8.9.2.1 *Servicing and Refueling of Construction Equipment*

The Contractor shall ensure that all servicing and/or refueling of vehicles and equipment takes place within the construction camp at a designated area situated more than 50 m from any water course, water body or well. Vehicles must not be left without supervision during refueling.

The ground under the servicing and refueling areas shall be protected against pollution caused by spills and/or tank overfills. The method of protecting the ground shall be identified by the Contractor and agreed in writing with the supervising engineer prior to being installed. All waste shall be collected, contained on site and stored in water-tight containers prior to disposal off-site as hazardous waste at a site approved by the supervising engineer. All equipment that leaks shall be repaired immediately or removed from the site.

#### 8.9.2.2 *Accidental spills*

The Contractor shall take all reasonable precautions to prevent the pollution of the ground and/or water resources on and adjacent to the site as a result of his activities. Such pollution could result from the release, accidental or otherwise, of chemicals, oils, fuels, sewage and waste products, etc.

The Contractor shall be responsible for establishing an emergency procedure for dealing with spills or release of petroleum, chemical, harmful and hazardous materials. He shall ensure that the relevant construction personnel are familiar with these emergency procedures.

All spills or accidents involving such materials are to be recorded. The clean up of spills and any damage caused by the spill shall be for the Contractor's account.

The Contractor shall ensure that no oil, petrol, diesel, etc. is discharged onto the ground. The Contractor shall remove any spill or oil-soaked soil immediately and shall dispose of it as hazardous waste.

#### 8.9.2.3 Cement and Concrete Operations

Cement and concrete shall be regarded as materials that are potentially damaging to the natural environment on account of the very high pH of the material, and the chemicals contained therein. The Contractor shall ensure that all operations that involve the use of cement and concrete are carefully controlled.

Concrete mixing shall only take place in the construction camp or in agreed specific areas on site. Concrete must not be mixed directly on the ground.

Water and slurry from concrete mixing operations shall be contained to prevent pollution of the ground surrounding the mixing points. Old cement bags shall be placed in wind and spill proof containers as soon as they are empty. The Contractor shall not allow closed, open or empty bags to lie around the site.

Where exposed aggregate finishes are specified the Contractor shall collect all cement laden water and store it in conservancy tanks for disposal off site at an approved disposal site.

All visible remains of excess concrete shall be physically removed immediately and disposed off as waste. Washing the visible signs into the ground is not acceptable. All excess aggregate shall be removed.

#### 8.9.3 Solid Waste Management

The Contractor shall institute a waste control and removal system for the site.

All waste shall be disposed of offsite at an approved landfill site. Burning of waste on any construction site is forbidden.

The Contractor shall supply waste bins/skips throughout the site at locations where construction personnel are working. The bins shall be provided with lids and an external closing mechanism to prevent their contents blowing out and shall be scavenger-proof to prevent baboons and other animals that may be attracted to the waste. The Contractor shall ensure that all personnel immediately deposit all waste in the waste bins for removal by the Contractor. Bins shall be emptied on a daily basis and the waste removed to a temporary storage site where it shall be properly contained in water and windproof containers until disposed of. The bins shall not be used for any purposes other than waste collection.

It shall be forbidden to mix non-hazardous waste with hazardous waste. Petroleum, chemical, harmful and hazardous waste throughout the site shall be stored in enclosed areas. The enclosed areas shall be clearly marked. Such waste shall be disposed of off-site at a hazardous waste disposal site.

The personnel involved in the handling of hazardous and non-hazardous waste shall undergo specific training in:

- Waste handling;
- Waste treatment; and
- Waste storage.

#### 8.9.4 Waste Water Management

**Discharge of Construction Water.** The contractor shall construct and operate the necessary collection facilities for wastewater to prevent pollution. The Contractor shall dispose of collected wastewater in a manner

agreed with the Authorities.

The Contractor may discharge “clean” silt laden water overland and allow this water to filter into the ground. However, he shall ensure that he does not cause erosion as a result of any overland discharge.

All washing of plant/equipment/concreting equipment etc. shall take place within the construction camp. Water from washing operations shall be collected in a conservancy tank removed from the site and disposed of in the agreed manner. The Contractor is encouraged to recycle dirty wash water to minimize the amount required to be removed off-site.

Kitchen wastes shall be disposed into soak pits. Wastewater from campsites will be discharged and disposed in a kitchen sump located at least 15 meters from any water body. Sump capacity should be at least 1.3 times the maximum volume of wastewater discharged. The bottom of the pit should be filled with coarse gravel and sides shored up with board, etc. to prevent erosion and collapse of the pit.

Sanitary wastes shall be disposed into septic tanks.

#### 8.9.4.1 *Run-off from Construction Camp*

Natural run-off shall be diverted away from any camp. Storm water drainage systems to discharge all surface run off from the camp site to a silt retention pond which shall be sized to provide a minimum of 15 minutes retention for storm water flow from the whole site. Silt ponds shall be maintained in an efficient condition for use throughout the construction period with trapped silt and soil particles being regularly removed and transported and placed in waste material disposal site. All discharges from the silt retention pond shall be channeled to natural water.

All run-offs from working areas, which contains sediment, should be collected in settling ponds before being discharged from the premises. Water from washing, screening, or dust reduction plants should be treated in a like manner. Accepted methods for removal of sediment from run-off include settling ponds, aggregate filters, wetlands (shallow ponds planted with suitable swamp plants). For borrow pits in vegetated areas, run-off should be directed through vegetation prior to reaching any watercourse to enable further filtering of sediment.

#### 8.9.5 **Erosion Control**

Erosion control measure shall be applied during construction activities to prevent increased runoff into the watercourses. Special attention shall be given to erosion control of the excavation at the dam site and along the river channel.

Contractor will plan all excavations, topsoil and subsoil storage so as to reduce to a minimum any runoff. Contractors will be required to organize and cover material storage areas and to isolate wash down areas from watercourses by selecting areas that are not free draining into any watercourse.

Where any area of the spread is at risk from silt pollution washing off into a watercourse or water body, effective measures will be put in place to ensure that such pollution does not occur. Such measures include:

- Use of silt fences
- Use of straw bales to deflect and filter water
- Use of a system of bunds and grips to prevent water from entering watercourses, etc.

#### 8.9.6 **Stockpiles, Borrow Pits and Quarries**

Borrow pits shall be prohibited where they might interfere with the natural or designed drainage patterns.

Riverbed locations shall be prohibited if they might undermine or damage the riverbanks, or require works in the wetted area, which carry too much fine material downstream.

Ideally the borrow pits should be located within the future inundation zone of the raised reservoir. If this is not possible the following measures must be taken. The Contractor shall ensure that all borrow pits used are left in a trim and tidy condition with stable side slopes, and are drained ensuring that no stagnant water bodies are created which could breed mosquitoes.

In any borrow pit and disposal site, the Contractor shall:

- Identify and demarcate locations for stockpiles and borrow pits, ensuring that they are at least 15 meters away from critical areas such as steep slopes, erosion-prone soils, and areas that drain directly into sensitive water bodies (except the sites designed with rock wall to cover the surroundings).
- Limit extraction of material to approved and demarcated borrow pits. Stockpile topsoil when first opening the borrow pit. After all usable borrow has been removed, the previously stockpiled topsoil should be spread back over the borrow area and graded to a smooth, uniform surface, sloped to drain. On steep slopes, benches or terraces may have to be specified to help control erosion.
- Excess overburden should be stabilized and re-vegetated. Where appropriate, organic debris and overburden should be spread over the disturbed site to promote re-vegetation. Natural re-vegetation is preferred to the extent practicable.
- Once the job is completed, all construction-generated debris should be removed from the site.
- Alternatively the borrow pit could be rehabilitated into shallow wetlands that are attractive to birds, fish, amphibians, reptiles and other fauna such rehabilitation should include:
- Re-shaping of the pits so that they have gentle slopes in order to facilitate livestock to drink and that they have a relatively natural shape.
- Introduction of native fish species to facilitate development of a wetland ecosystem and control mosquito numbers.

The contractor shall provide a specific method statement subject to approval by NIB and NEMA.

### 8.9.7 Control of Noise and Air Pollution

Construction machinery and vehicles generate noise and air pollution in the form of exhaust gasses. Dust from transported and stockpiled material also contributes to air pollution.

**Noise and Exhaust Gases.** The Contractor shall employ Best Practicable Means to control all noise generating activities. The Contractor shall identify all noisy activities together with appropriate control mechanisms.

Mitigations of impacts of noise and exhaust gasses can be achieved through the following measures.

- Confining operations to reasonable operating hours. This is the simplest means of avoiding unreasonable noise impacts. Another effective means is to provide appropriate separation distance to enable the noise to decay to acceptable levels;
- Establishing enclosures around stationary noisy activities. Solid barriers, such as bund walls and topographical features, provide the most effective 'in line' reduction of sound levels;
- Avoid using any vehicles, either on or off road with grossly excessive, exhaust or noise emissions; and

- Regular maintenance of engines to ensure that emissions are minimized, for example by cleaning fuel injector. Routine maintenance will be high standard to ensure that vehicles are safe and that emissions and noise are minimized.

**Dust.** The following measures should be applied to minimize dust nuisances:

- The speed of vehicles is an important factor in the generation of dust. The speed of all construction-related traffic should be at or below 15 km/h on roads within 200 m of the site; In addition, where transport routes are along unsealed roads, it may be advisable to slow down in the vicinity of residents along these routes.
- The nature of the material being transported and its potential to emit dust should be considered in the loading of trucks. Generally, the highest point of the load should not exceed the height of the tray walls, unless the load is covered.
- Spray water at the site, and on dirt roads, cut areas and soil stockpiles or fill material as needed to minimize dust levels at areas close to housing areas
- Stockpiles, work areas and dirt roads can be sprayed regularly with water which reduces dust development.

### 8.9.8 Sanitation

The Contractor shall provide the necessary ablution facilities for all site personnel.

The Contractor shall supply an adequate number of suitable and approved toilets throughout the site where construction personnel will be operating.

Toilets shall be easily accessible and where applicable shall be capable of being relocated.

The Contractor shall ensure that any chemicals and/or waste from the toilets is not spilled on the ground at any time. The contractor will be required to provide a suitable and approved and to remove accumulations of chemicals and waste from the site and dispose of it at an approved waste disposal site or sewage plant base at his own expense.

Answering call of nature anywhere other than in the toilets shall not be permitted. The Contractor shall be responsible for cleaning up any waste deposited by personnel.

### 8.9.9 Site Restoration

The Contractor shall ensure that all temporary structures, equipment, materials, waste and facilities used for construction activities are removed upon completion of the project. Any oil and fuel contaminated soil shall be removed and buried in waste disposal areas, soak pits and septic tanks shall be covered and effectively sealed off and the sites shall be grassed and the site shall be restored to a similar condition to that prior to the commencement of the works or to a condition agreed to with the owner of the land.

The Final EMP will also specify occupational health and safety measures to be followed during project construction and operation, including measures to prevent the spread of HIV-AIDS and other communicable diseases.

### 8.9.10 Environmental Rules for Civil Works Contractor

The Civil Works Contractor shall inform all its workers and sub-contractors of Chance Finds Procedures for

physical cultural resources that will need to be followed during every phase of project construction. Under these procedures, if any construction worker or other project-related employee or contractor discovers any potential archaeological relics, fossils, human remains, or other items or sites of potential cultural interest, they must immediately notify the Environmental Supervisor or other staff of the Supervising Engineer. The Supervising Engineer will promptly examine the evidence and, if warranted, (i) order the temporary suspension of construction activities that might otherwise harm the item or site in question and (ii) promptly notify the relevant authority responsible for physical cultural resources, to obtain further guidance regarding whether and how the item or site in question should be salvaged, protected, and/or documented.

The Civil Works Contractor (and any associated sub-contracts) shall enforce a Workers Code of Conduct.

### **8.9.11 Environmental Emergency Procedures**

Prior to construction commencement, the contractor shall prepare an Environmental Emergency Plan specifying actions in the event of accidental leaks, spills or emissions. The plan shall be reviewed on regular basis and updated if necessary.

In the event that accidental leakage or spillage of diesel/chemicals/chemical wastes takes place, the following response procedures shall be followed immediately by the Contractor(s):

The person who has identified the leakage/spillage shall immediately check if anyone is injured and shall then inform the Environment Manager.

- The EM shall ensure any injured persons are treated and assess what has spilled/leaked;
- Should the accident /incident generate serious environmental pollution (e.g. spillage / leakage of toxic or chemicals, large scale spillage / leakage, or spillage / leakage in nearby water bodies Contractor should immediate inform NIB through the resident engineer;
- The Contractor shall arrange maintenance staff with appropriate protective clothing to clean up the chemicals/chemical waste.
- Spilled chemicals must be flushed to local surface drainage systems.

The possibility exists for environmental emergencies of an unforeseen nature to occur during the course of the construction and operational phases of the project. By definition, the nature of such emergencies cannot be known. Therefore, the Contractor shall respond on a case-by-case basis to such emergencies and shall initiate event-specific measures in terms of notifications and reactions.

The Contractor shall prepare a report on the incident detailing the accident, clean-up actions taken, any pollution problems and suggested measures to prevent similar accidents from happening again in future.

### **3.2.5 Environmental Awareness Training**

The Contractor should ensure that all concerned staff are aware of the relevant environmental requirements as stipulated in NEMA environmental legislation and the Contract specifications. The Contractor is responsible for providing appropriate training to all staff. This should be tailored to suit their level of responsibility for environmental matters. The Contractor should also ensure that all site staff members are aware of the emergency response procedures. All staff should receive environmental induction training and managerial staff should receive additional training.

All those responsible for the management and operation of any aspect of the EMP shall be adequately trained

for their role. Evidence of training should be maintained on site, for inspection / auditing purposes.

Training should be conducted for, as a minimum:

- Hazardous Substance Management and Emergency Procedures;
- All staff involved in the handling and use of chemicals, fuel and explosives must be trained in handling, spill and emergency procedures. Evidence of training should be kept for inspection / auditing purposes;
- Concrete management;
- All staff involved in the manufacturing, transport and handling of concrete and asphalt must be trained in handling, spill, dust, water management and emergency procedures. Evidence of training should be kept for inspection / auditing purposes;
- Sediment Control, and Control of Discharges. Training shall be provided by a third party, or provide evidence of previous training, for the construction, maintenance and monitoring of environmental protection and discharge treatment devices. Evidence of training should be kept for inspection / auditing purposes; and
- Traffic Management and Driver Education. Training shall be provided by a third party, or provide evidence of previous training, for the safe control and driving of heavy road-construction vehicles. Training shall also be provided for the management of traffic (including pedestrians) in and around the project construction areas, to ensure safe passage during and after working hours. Evidence of training should be kept for inspection/auditing purposes.

#### **8.9.12 Community Relations**

To enhance adequate community relations the Contractor shall:

- Inform the affected community about construction and work schedules, blasting schedules, interruption, of services, traffic detour routes and provisional bus routes, and any other information as appropriate.
- Limit construction activities at night. When necessary ensure that night work is carefully scheduled and the community is properly informed so they can take necessary measures and mitigation measures for construction methods can be agreed to by all parties.
- All community infrastructures such as roads, bridges, water supply systems, etc. affected during construction must be restored to the satisfaction of the communities and approved by the NIB.
- All local roads used or by-passed by the Contractor will need to be rehabilitated to their original conditions.
- Establish and maintain a unit to receive, process and reach resolution on community complaints arising from construction activities. Records of such complaints and their resolution must be kept.

#### **8.10 Inundation Preparation Plan**

In preparation for inundation of the reservoir area behind the dam, the Independent Consultant will prepare an Inundation Preparation Plan. This will be prepared during the first year of the project and be implemented before impoundment. The plan will outline all activities that need to be completed prior to inundation. The Independent Consultants will assist the NIB in the execution of the plan.

Based on the findings of the EIA, the Inundation Preparation Plan will include at a minimum the following component activities:

**Pollution Removal** - All sources of pollution will be identified and removed from the areas to be inundated when the full level of the Reservoir is reached. The main objective of this plan is to minimize any harm to reservoir water quality from the inundation of contamination sources such as latrines and rubbish dumps. The Inundation Preparation Plan will identify the specific location of each garbage dump, latrine, or similar contamination source. Depending on the structure of the main contract, the Independent Consultant may have to manage and contract for the removal or capping of waste at each potential contamination source to be carried out by a qualified sub-contractor.

**Vegetation Clearance** - In preparing the Inundation Preparation Plan, the Independent Consultant will also assess how best to remove all standing trees from the future reservoir inundation zone. Since the entire reservoir area is occupied by legitimate land owners, and virtually the entire reservoir zone has not public owned forest or woodland, the removal of trees or other biomass will be done by land owners so that they can sell the harvests as timber, poles or fuelwood.

In preparing the inundation Preparation Plan, the Independent Consultant will assess the extent to which it might be desirable and cost-effective to remove trees that have not been harvested by land owners prior to inundation.

**Transplant Threatened Plant Species** - During preparation of the EIA Report, the Consultant was not able to survey the future reservoir area thoroughly from a botanical standpoint, due to the tight schedule. To address this gap, the Inundation Preparation Plan will include a botanical survey of the future reservoir area, to determine if there are some tree or plant species that are endangered. The Independent Consultant will manage this work, ensuring that well-qualified botanists and appropriate equipment are mobilized when needed for this work.

**Salvage of Physical Cultural Resources** – The social Impact Assessment has identified grave sites across the reservoir, based on local community input. These graves will be relocated as part of the Resettlement Action Plan (RAP).

## **8.11 Operation Phase**

This phase will mainly be driven by monitoring of the performance of mitigation measures that have been proposed for minimizing environmental and social impacts. The pressure-state-response (PSR) framework is proposed for developing a set of interconnected performance indicators that should assist in assessing environmental performance against the set targets that will be developed for all the mitigation actions. The PSR framework provides a feedback mechanism that allows adjustments to be made to the corrective actions that have been set, and also actions that are proposed to enhance positive environmental impacts.

### **8.11.1 Description of the Pressure State Response (PSR) Framework**

**Pressure:** Environmental pressure refers to both direct and indirect pressures exerted on the environment, including natural resources, by human activities. Typical pressures encompass water use and abstractions, changes in land use downstream, ecological dynamics, Irrigation water demand.

**State:** Environmental state refers to the quality of the environment and the quality and quantity of natural resources. Indicators of environmental conditions or state include contaminant concentrations in water and soil, exceedance of critical loads, human health effects from exposure to pollutants or as a consequence of degraded environmental quality, and environmental impacts relating to the status of aquatic flora and fauna and

condition of natural resource stocks.

Response: Response refers to designed actions and reactions intended to mitigate, adapt to or prevent negative effects on the environment, halt or reverse environmental damage already inflicted, and preserve and conserve nature and natural resources. Responses can variously involve alterations in expenditure on environmental protection from an earlier estimate, changes in action plans and general environmental management. By highlighting links between pressure, state and response the PSR framework helps decision makers see how environmental and other issues as interconnected.

To achieve the objectives of a the PSR framework for Environmental Performance Assessment (EPA), the following are required:

- Institutional capacity and continuous commitment by the NIB;
- Development of reliable database from which to estimate indicator state and trends and;
- linking EPA results with socio-development plans to ensure environmentally soundness.

The overall goal is to enable NIB to assess the performance of mitigation measures through a continuous review process.

Capacity building and database development which includes, inter alia, should commence early in the planning stage of the project. To be engaged are NIB technical personnel and key institutions that will form the Environmental Monitoring Unit.

### **8.11.2 Identification of priority issues**

For EPA to be useful, the number of priority concerns cannot be overly large. This is for both practical and statistical reasons. Worldwide experience suggests that a total of around fifteen priorities may be the maximum that can be realistically considered in countries where the process of EPA is starting. An important statistical consideration is that as the number of indicators increases so does the possibility that they are interrelated, rendering one or more unnecessary. For example, a strong correlation typically exists between incidence of diarrhea among children and microbiological contamination of drinking water. In such cases it may be unnecessary to compile data on both indicators. Simply monitoring water quality will indicate whether drinking water quality standards intended to safeguard human health are being achieved. Although both sets of data are functional, especially with respect to the actual provision of public health services, only one may be strictly necessary for EPA purposes.

Caution is advised in adopting aggregate measures of environmental performance. Stressing that EPA is intended as a communication tool, it is essential that indicators chosen communicate results to intended audiences. In the foregoing drinking water quality example, incidence of infant diarrhea is immediately relevant and understandable to affected families and government health care officials. A balance must therefore be achieved between simplifying EPA through adoption of a small number of common indicators and accepting a larger number of indicators more directly linked to particular concerns.

### **8.11.3 Environmental Performance Indicator Selection**

Environmental performance indicators (EPI), are tools for assessing environmental performance. Comparison of the value achieved for a well-chosen indicator against a quantifiable and specified target provides a useful indication of the degree of success in reaching said targets. Selecting the most suitable indicators of performance corresponding to priority concern is therefore of prime importance. Key considerations in selecting indicators are their policy relevance, analytical soundness and measurability. Additional considerations relating

to the credibility of indicators are data availability and quality.

Emphasis should be given to quality rather than quantity in selecting indicators. Factors that will determine indicator quality are policy relevance (or correlation with policy targets) and measurability (availability of data and cost of filling data gaps). With respect to policy relevance an environmental indicator should: (i) provide a representative picture of environmental conditions, pressures on the environment or management responses; (ii) be simple, easy to interpret and able to reveal trends over time; (iii) be responsive to changes in the environment and related human activities; (iv) provide a basis for international comparisons; (v) be applicable to Thuchi River basin environmental issues and (vi) have a threshold or reference value against which to compare it, to allow the significance of the values associated with it to be assessed. With respect to measurability, the data required to support the indicator should be: (i) readily available or made available at a reasonable cost; (ii) adequately documented and of known quality; and (iii) updated at regular intervals in accordance with reliable procedures.

Table 8-1 EPIs as identified in the ESIA

Environmental concern	Type of Indicator		
	Pressure	State	Response
Land degradation	<ul style="list-style-type: none"> <li>Population density</li> <li>Land use changes in irrigated area</li> <li>Human-induced soil degradation</li> </ul>	<ul style="list-style-type: none"> <li>% of vulnerable farmed areas</li> <li>Value of non-irrigated agricultural output</li> <li>Average yields</li> <li>Rate of topsoil loss</li> </ul>	<ul style="list-style-type: none"> <li>Expenditure on promoting sustainable farming programs</li> </ul>
Threats to aquatic flora and fauna	<ul style="list-style-type: none"> <li>Water diversion for irrigation</li> <li>Changes to water chemical and physical quality</li> </ul>	<ul style="list-style-type: none"> <li>Threatened species</li> <li>Habitat loss</li> <li>Frequency, duration and extent of water flow below the minimum threshold for environmental performance</li> </ul>	<ul style="list-style-type: none"> <li>Adjustments to environmental flows</li> <li>Expenditure on downstream management</li> <li>Expenditure on reservoir management such as weed control</li> </ul>
Downstream water protection	<ul style="list-style-type: none"> <li>Contaminant discharges &amp; ambient concentrations in reservoir and downstream of reservoir</li> </ul>	<ul style="list-style-type: none"> <li>Incidence of waterborne diseases</li> <li>Recorded exceedances of water quality standards</li> </ul>	<ul style="list-style-type: none"> <li>Expenditure on catchment management, possible wastewater treatment.</li> </ul>
Toxic contamination (during construction)	<ul style="list-style-type: none"> <li>Presence &amp; generation of hazardous wastes</li> <li>Discharge onto the river</li> <li>Consumption of water containing</li> </ul>	<ul style="list-style-type: none"> <li>Inorganic contaminant concentrations in water &amp; soil</li> <li>Area of contaminated land</li> <li>Quantity of hazardous wastes generated</li> </ul>	<ul style="list-style-type: none"> <li>Inventory of toxic waste and disposal mechanism</li> </ul>

	hazardous wastes or posing a hazard		
Air pollution by stationary sources and mobile sources during construction	<ul style="list-style-type: none"> <li>• Volume of SO<sub>2</sub> and PM emissions</li> <li>• Emissions of PM</li> </ul>	<ul style="list-style-type: none"> <li>• SO<sub>2</sub> and PM concentrations exceeding NEMA air quality standards</li> <li>• % of dischargers in violation of permit conditions</li> </ul>	<ul style="list-style-type: none"> <li>• Expenditure on air pollution abatement measures</li> </ul>
Water resources	<ul style="list-style-type: none"> <li>• Irrigation water consumption per capita</li> </ul>	<ul style="list-style-type: none"> <li>• Access to safe potable water</li> <li>• Frequency, duration and extent of low flows below environmental and social requirements</li> </ul>	<ul style="list-style-type: none"> <li>• Adoption of full-cost water and wastewater charges</li> <li>• Expenditure on water saving measures and programs</li> </ul>
Forest resources	<ul style="list-style-type: none"> <li>• Rate of deforestation</li> <li>• Per capita fuel wood consumption</li> </ul>	<ul style="list-style-type: none"> <li>• Forest cover</li> <li>• Market price of timber</li> <li>• Gathering level-of-effort or domestic price of fuel wood</li> </ul>	<ul style="list-style-type: none"> <li>• Percentage of protected forest in total forest area</li> <li>• Percentage of new afforestation efforts in total forest area</li> <li>• Percentage of harvested areas successfully regenerated or afforested</li> <li>• Expenditure on forest conservation &amp; management</li> </ul>

#### 8.11.4 Data Requirements

A challenge in adopting EPA as an effective environmental management tool relates to data quality and availability. Missing or poor quality data represented a major limitation in the selection of indicators, with the consequence that theoretically superior indicators are often overlooked in favour of indicators that are more readily quantifiable. Broader partnerships involving relevant national organizations especially research bodies such as KEFRI are considered necessary for data gathering and overall success of EPA. The Thuchi Miriu HEP management should also be engaged in order to access data gathered so far. It will be important to integrate all relevant know-how and databases in order to improve data availability and quality.

#### 8.12 Environmental Monitoring Plan

As part of project implementation, the EMU with coordination offered by the Independent Consultant will assist NIB in the preparation and implementation of an Environmental Monitoring Plan. This will be based on the

following:

The Objective of the Monitoring Plan is to document the monitoring and reporting procedures for potential environmental impacts of the inundation and operation of the dam.

The Monitoring Plan does not include procedures for dam safety, flood warning systems, emergencies, structural integrity monitoring and other instrumentation monitoring as part of the scheme operations. These procedures are the responsibility of the scheme operators.

The following effects will be monitored:

- 1 Monitoring of water quality sedimentation, sediment quality and aquatic/riparian flora and fauna in the Thuchi River upstream of the reservoir, within the reservoir and downstream of the reservoir;
- 2 Monitoring of water quality, sediment quality and aquatic/riparian flora and fauna in the Thuchi River downstream of the reservoir to assess impacts of reduced flow and increased erosion.

### **8.12.1 Contents of the Monitoring Plan**

The Environmental Monitoring Plan provides guidelines on the minimum shall detail methods and procedures for each part of the monitoring programme, including:

- Monitoring parameters;
- Methods for sampling, laboratory analysis and statistical analysis of data;
- Sampling locations;
- Sampling frequency;
- Reporting requirements;
- Timetable; and
- Budgets.

### **8.12.2 Specifications of the Monitoring Plan**

It is proposed that a final monitoring plan be developed during construction phase but to be applied in the operational phase shall include detailed programmes for:

- Monitoring of water quality, sedimentation and water quality and flora and fauna upstream of the reservoir;
- Monitoring water quality within the reservoir;
- Monitoring of stratification in the reservoir; and
- Monitoring of water quality, sedimentation, sediment and water quality and flora and fauna at the outlet, at points downstream the reservoir to assess any effects of flow changes and downstream erosion.

The monitoring plan shall be prepared based on the specifications outlined below.

### **8.12.3 Monitoring Upstream of the Reservoir**

#### *Methodology*

The monitoring shall include the following elements:

- River topography profiling and sediment monitoring;
- Water quality and water flow monitoring; and
- Flora and Fauna Monitoring.

### **8.12.4 River topography profiling and sediment monitoring**

Any induced sedimentation shall be monitored by:

- Measuring river channel cross sections using survey equipment to provide profiles of the entire transect of the bed (dry and wet areas), and the depth profile of the river; and
- Collection of sediment samples and analysis of parameters such as grain size distribution. The samples shall also be analyzed for pollutants including selected heavy metals.

### **8.12.5 Water Quality and water flow monitoring**

#### *8.12.5.1 Parameters*

The following water quality parameters shall be measured pH , temperature, electrical conductivity, turbidity, suspended solids, clarity, dissolved oxygen, BODs (Biological Oxygen Demand), COD (Chemical Oxygen Demand), dissolved reactive phosphorus, nitrite, nitrate and ammoniac nitrogen.

#### *8.12.5.2 Methods*

International standards for sampling, sample preservation and laboratory analysis for each parameter shall be applied. Unstable parameters, principally temperature, dissolved oxygen, pH and electrical conductivity, shall be determined in the field using portable equipment. Samples for the analysis of other parameters shall be collected in clean glass or polypropylene bottles for transport via chilled containers to the laboratory

River flow rates shall be monitored and if necessary new gauging stations established along the different sections of the river below and above the reservoir.

Data from the hydro- meteorological station to be established at the dam shall be collected (The hydro-meteorological station will be specified by the Engineering Consultant).

The flora and fauna monitoring shall include:

- Survey of riverine and riparian vegetation encompassing emergent aquatic vegetation and vegetation in the riparian areas
- Sampling and identification of aquatic macro-invertebrates.
- Sampling and identification of fish.

#### *8.12.5.3 Monitoring sites*

Monitoring of all these parameters shall be carried out in at least five sites, namely upstream of the reservoir, the reservoir, and several points downstream of the irrigated area.

The final monitoring plan that shall have been developed by the EMU will propose the specific sites for appropriate types and intensity of monitoring.

#### *8.12.5.4 Monitoring frequency*

The monitoring of River morphology, sediment quality, flora and fauna shall be carried out continuously at a frequency to be determined by the EMU. The monitoring shall be initiated prior to the construction works, carried out during the construction phase and continued into the future until the NIB is satisfied that the environmental impacts of the reservoir are fully understood.

### **8.13 Monitoring Reservoir Area**

The current river that will be inundated serves as an informal source of water supply for many of the surrounding local communities and following completion of the dam will provide water for the greater downstream areas and possibly the adjacent communities to the reservoir. It provides important breeding habitats for fish and water birds,

water points for livestock.

Given the various, and sometimes conflicting demands (e.g. using the same water for laundry and for domestic use), there is a need for a consultative and consensus led process to agree on appropriate zoning of the reservoir to facilitate the multi-purpose utilization and maximize the derived benefits as proposed for irrigation. This is the responsibility of NIB. The Reservoir Management Plan that will include at minimum the following elements.

### **8.13.1 Monitoring and Management of Invasive Aquatic Plants**

These are measures to address the potential introduction and spread within the reservoir of non-indigenous aquatic plants. Measures shall include:

- Monitoring of invasive aquatic non-indigenous aquatic plants to detect a potential infestation;
- A contingency plan for the removal of these invasive plants in case they become a problem; and
- Training the NIB personnel in the identification and control of invasive species.

#### *8.13.1.1 Methodology*

Visual assessment of weed growth shall be made by boat. Species will be identified and percentage cover per species shall be assessed.

#### *8.13.1.2 Monitoring sites*

Monitoring should be done in such a way that it covers the entire reservoir.

#### *8.13.1.3 Monitoring frequency*

Monitoring should be a continuous process, but deliberate attempts should be made at least every second month for the first two years after completion of works. The frequency of monitoring would be reviewed and adjusted thereafter.

#### *8.13.1.4 Removal of invasive plants*

The EMU will review existing mechanical and biological methods for control of invasive aquatic species and prepare a contingency plan to be implemented, in case the monitoring of weeds in the reservoir show that infestation is a problem.

#### *8.13.1.5 Training*

The Independent Consultant, assisted by government organizations such as Kenya Marine and Fisheries research Institute. Kenya Agriculture and Livestock Research Organization, National Museums of Kenya shall ensure the training of NIB personnel in (i) identifying the different species of invasive aquatic weeds, (ii) recognizing when they might spread enough to pose environmental or other problems in the reservoir, and (iii) familiarity with different approaches for control and physical removal of these plants.

### **8.13.2 Reservoir Zoning**

The reservoir will ultimately provide important breeding habitats and ecological areas for water birds, fish along with watering and grazing for livestock. The emergent fishing communities will require to establish fish landing sites around the reservoir

The Reservoir Management Plan will provide community based enforcement mechanisms and consultative forums should be explored to assist in enforcement and where applicable measures outlined to provide for routine boat patrols of these areas by NIB or other collaborating EMU entities.

Development of the Reservoir Management Plan will be facilitated by the Independent Consultant with strong participation from nominated EMU entities. They shall assist NIB in establishing a consultative forum that will contribute to development of the plan. This will include representatives from the local authorities, fishing communities, local community representatives, and relevant government ministries.

### **8.13.3 Monitoring Water Quality in the Reservoir**

#### *8.13.3.1 Parameters*

The following water quality parameters shall be measured: pH, temperature, electrical conductivity, turbidity, suspended solids, clarity, dissolved oxygen, BODs (Biological Oxygen Demand), COD (Chemical Oxygen Demand), dissolved reactive phosphorus, nitrite, nitrate ammoniac nitrogen.

#### *8.13.3.2 Methods*

International standards for sampling, sample preservation and laboratory analysis for each parameter shall be applied. Unstable parameters, principally temperature, dissolved oxygen, pH and electrical conductivity, shall be determined in the field using portable equipment. Samples for the analysis of other parameters shall be collected in clean glass or polypropylene bottles for transport via chilled containers to the laboratory.

#### *8.13.3.3 Monitoring sites*

Monitoring of water quality shall be carried out at sites selected by the relevant water experts from the NIB and other bodies.

#### *8.13.3.4 Monitoring frequency*

The monitoring shall be carried out annually and initiated prior to the construction works and continued until three years after the completion of the works. Subsequently, it shall be decided whether the monitoring shall continue.

### **8.13.4 Monitoring Downstream of the Dam**

The dam will reduce the downstream flow immediately downstream of the dam. Due to decreased sediment content of the flow in this section, scouring of river bed is also expected. That may further affect riparian vegetation that may be described as largely modified, implying also altered faunal composition and a fish fauna that is moderately modified.

The monitoring programme shall be designed to elucidate any further impacts and adjusted mitigation actions through a feedback process.

#### *8.13.4.1 Methodology*

The parameters and methodologies described for the monitoring of effects and induced sedimentation in the River upstream the dam shall be employed. River flow rates should also be monitored, as appropriate and feasible.

#### *8.13.4.2 Monitoring sites*

Two monitoring sites shall be established one immediately downstream the dam and one at the irrigation canal wier (intake).

### 8.13.4.3 Monitoring frequency

The monitoring shall be carried with a view to capturing major seasons notably the dry, rainy and the short rains season. However, continuous monitoring is recommended. Monitoring to be done during construction and thereafter until determined by the specialist unit of the EMU.

## 8.14 THE OVERALL MONITORING PLAN

### 8.14.1 Construction Phase

During the construction phase, the monitoring activities will mainly focus on the regular follow-up of EMP measures for compensation with performance standards. These activities will be based on a day-to-day follow-up and various levels of technical reviews.

Substantial monitoring activities will be related to specific monitoring, for the acquisition of additional technical data which were not obtained during the EIA and which are deemed necessary for eventual quantification of impacts or mitigation measures. Areas where there is inadequate data include:

- Aquatic life within the river including fish
- Water quality – both physical and chemical parameters
- Hydrology, especially water flow downstream of the dam

#### 8.14.1.1 Proposed Plan for Regular Monitoring

##### Day-to-Day monitoring

Monitoring on a day-to-day basis will be implemented by the Environment Manager (EM) appointed by the Contractor but supervised by the Project Proponent (NIB). Other more technical parameters such as water quality and aquatic ecosystem could be monitored by relevant Government agencies mainly, Ministry of water development, Ministry of Fisheries, Forestry, Lands and Agriculture. The main tasks for the ESM will include:

- General follow-up of all tasks of EMP
- Preparation of the Environmental Plans.
- Maintenance of appropriate records of the monitoring results.

These monitoring activities will be partly complemented by the monitoring obligation of the Proponent.

The agriculture and forestry extension office and land office will mainly monitor the progress and implementation of the land acquisition and compensation process

##### Quarterly or 6 Monthly Reviews

When carrying out the monitoring, the EM will be assisted by the EMU. However, the Independent Consultant will provide the expertise for a critical review of results obtained during the last period and a re-adjustment, when required, of the monitoring and mitigation strategies, methodologies and work plan.

Each review will include basically:

- The review of published data, reports, guidelines and plans available at the time of the review.
- The setting-up of monitoring criteria and the selection of quantitative and qualitative indicators.

- Field inspection including direct observations and data collection, interviews with selected local and project groups, individuals.
- Evaluation and comment on Project performance, with recommendations and remedial actions.
- Definition of the scope of work for the period before the next review
- Recommendations for additional tasks or changes to the present EMP.

### **Annual Review**

The annual review will involve, in addition to the representatives from the project, the PMU and representative from lenders (if any).

The annual review will be combined with one of the 3 monthly or 6 monthly reviews every year.

### **Audit**

Government of Kenya through NEMA, NIB, WRMA and any other that will be identified may visit the project site at any time and when deemed necessary during the construction period.

### **Personnel Involved**

The consultant Engineer will provide one qualified Environmental Specialist who will assist informally the EM and will participate in the monthly, half yearly and annual reviews.

This specialist will be assisted where necessary by other specialists having expertise in forestry, agriculture, extension, wildlife, water, social science, civil engineering (construction practices, slope stability, drainage, run-off and silt control), fishery and watershed management.

## **8.14.2 Reporting**

Day-to-day monitoring activities will be recorded in daily, weekly and monthly reports by the EM.

Reviews will involve the production of Review Reports which will be supplied to the Contractor, NEMA, NIB, WRMA and other relevant Government Authorities.

The basic format for the report will include:

- Overview of the review
- Specialist personnel involved
- Status of work progress
- Overall conclusion
- Specific points requiring attention
- Performance indicators for the monitoring
- Specialist reports, if any

### **Compliance**

Compliance will be evaluated through the adherence to the mitigation measures, to other criteria also presented in the EMP and to the Contractor environmental obligations as detailed in the last section of this report.

### 8.14.3 Reporting Structure

Reporting must satisfy three objectives:

1. To provide a regular update on implementation of mitigation measures and identification of unforeseen impacts
2. To set up a formal framework for performance achievement evaluation
3. To assist a fast decision making procedure in order to implement within the shortest time any decision taken by concerned parties

The proposed system is based on 7 types of reports:

- (a) **Day to day report:** filled by the Environmental and Social Manager (ESM) in order to take formal notes of daily events, decisions, actions. These reports are only marked for further consultation when necessary,
- (b) **Weekly report:** prepared by the ESM and submitted to the Project Manager (PM). This is a concise summary of daily reports.
- (c) **Monthly report:** prepared by the ESM for submission to PM, the reports will summarize:
  - Activities carried out during the month, tasks completed, personnel involvement, schedule of activities,
  - Problems encountered, decisions taken,
  - Major issues under consideration, proposed solutions,
  - Proposed activities for the coming months,
  - Budget situation: expenses, invoices, fund reallocation etc
  - List of major meetings held during the month,
- d) **Meeting reports:** minutes of monthly (or ad-hoc) coordination meetings held to be prepared by Secretary of the EMU of NIB for submission to Project Manager.
- e) **Review reports:** to be submitted to NIB and lender (if any), every three months the first 2 years and every 6 months after. These reports will summarize major issues addressed, major achievements, major pending problems, budget situation, recommended strategy and work plan until the next review. They will be prepared by the review team.
- f) **Annual review report:** to be submitted by EMU and EM to the NIB, the line ministry and lender (if any), summarizing the progress of environmental mitigation and monitoring activities during the last 12 months of activity and presenting strategy and work program for coming 12 months.
- g) **Technical report:** prepared by EMU, sub-contracted Agencies or consultants and submitted to NIB according to schedule.

Table 8-2: Summary reporting program

Report Types	By:	To:	Purpose
Daily Report	EM	Project files	Registration of daily events. For consultation

			only
Weekly Report	EM	PM	Follow-up of social and environmental activities
Meeting Reports (monthly and ad-hoc)	EM / EMU	PMU	Signed by concerned parties & summarized in monthly report
Technical Reports	EMU, Independent Consultants	PMU	According to technical requirements
Monthly Report (Project)	EM	PMU	Monitoring of EMP implementation
Interim Review Reports (3 to 6 monthly)	EMU	PMU lenders (if any)	Progress in EMP implementation, issues & Achievement
Annual Review Report	EMU	PMU Lenders (if any)	Annual status of EMP Achievement

## 9 CONCLUSION AND RECOMMENDATIONS

The proposed Thuchi Dam will comprise a small reservoir to store water for irrigation purposes. It will necessitate hiving off of some 48 ha of the forest to create the reservoir. The Kenya Forest Service has been consulted and is willing to cede the land as long as the right procedures are followed. It is proposed that compensatory tree planting be undertaken for at least a minimum of 43 ha and this could be done in degraded parts of the forest using indigenous species.

The main source of adverse impacts relate to alteration of downstream water flow that could impact on a range of parameters including downstream riverine ecology, aquatic life and livelihoods. A range of mitigation measures that have been proposed include maintaining a minimum residual flow of 30% at any given time but increasing this flow during the dry season. Impacts on fish found in the river include provisions in the dam design to allow for fish migration up and downstream. Other impacts relate to water quality issues occasioned by contamination of reservoir by inundated pit latrines and submerged organics which can increase both COD and BOD. The findings of the ESIA conclude that these negative impacts can be avoided or reduced by applying the prescribed mitigative and compensatory measures, particularly taking into consideration the large socio economic benefits that will accrue from the dam. This EIA also presents a robust environmental and social management plan that prescribes a framework for applying the mitigation measures to ensure effectiveness. However, permanent impacts that are related to acquisition of land and conversion from a terrestrial to an aquatic environment cannot be reversed. The EMP has proposed an elaborate process of monitoring environmental performance both during the construction and operational phases of the dam. The Pressure State Response approach has been proposed to aid in assessing environmental performance of the project. Further a detailed management plan has been proposed to avoid or minimize the identified impacts. This permanent impact is common to all dam projects. Dam safety has been emphasized and the design engineers are aware of this important aspect.

The dam will lead to acquisition of land and even property to create room for construction of the dam axis and the reservoir. The reservoir will mainly cover a deep gorge and therefore the horizontal expanse is relatively small. The potentially affected persons are mainly farmers and loss of land and homesteads would have a very strong adverse impacts on their families and livelihoods. It is therefore very strongly recommended that a detailed Resettlement Action Plan be prepared.

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# **ANNEX 1**

# **PUBLIC CONSULTATIONS REPORT**

**ANNEX 1A**

**PUBLIC CONSULTATIONS**

**REPORT**

**(WORKSHOP 1)**



# FEASIBILITY STUDY, DETAILED DESIGN AND PREPARATION OF TENDER DOCUMENTS FOR THUCHI DAM, EMBU COUNTY

Contract No. NIB/T/015/2013-2014



## STAKEHOLDERS' WORKSHOP No.1 REPORT

JULY 2014



NATIONAL IRRIGATION BOARD  
P.O.BOX 30372-00100  
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## **EXECUTIVE SUMMARY**

The National Irrigation Board has appointed Kiri Consult Limited to carry out a feasibility study, detailed investigations and Engineering design for the development of Thuchi dam on River Thuchi. This also includes a study of River Thuchi Water Resources, review of Kagaari-Gaturi Irrigation project and related subjects.

The consultancy services Term of Reference among other things required Kiri Consult Limited in collaboration with the National Irrigation Board to organise two consultative workshops for stakeholders during the course of the assignment as follows:

- The first workshop during interim study stage to inform the stakeholder of the project its requirement and their involvement
- The second workshop to inform the stakeholders the finds, record and incorporated their opinions

This workshop was to inform the stakeholders of the project.

The target was the opinion leaders that included: County Governor's officers, County Commissioner's officers, Water Resources Management Authority officers, Mount Kenya Forest, Kenya Wildlife Service and Forest Service's officers, National Environmental Management Authority officers, County Assembly members, Kagaari-Gaturi farmers executives and None Governmental organisation Officers involved in water and forest conservation.

The workshop was held on 11<sup>th</sup> July 2014 and divided into five sessions namely: arrival and registration of participants, opening session involving Governor and Member of Parliament , presentations by National Irrigation Board and the Consultant and open discussion and comments by participants and finally the closing session.

The workshop was attended by more than 100 people who include all the target groups. The participants actively contributed to the proceedings as evident from the contributions in the attached proceedings.

It was noted that the participants supported the project and requested for thorough sensitization of the general public to be done to ensure full involvement of all the stakeholders for the success of the project and elimination of water conflicts in the area.

## LIST OF ABBREVIATIONS

NIB:	National Irrigation Board
HE:	His Excellency
CEM:	County Executive Member
DIO:	Director of Irrigation
CIO:	County Irrigation Officer
D.C.C:	Deputy County Commissioner
C.D.F:	Constituency Development Fund
WRMA:	Water Resource Management Authority
NEMA:	National Environment Management Authority
KFS:	Kenya Forest Service
KWS:	Kenya Wildlife Service
NGAWASCO:	Kagaari Water and Sewerage Company
M.C.A:	Member of County Assemblies
MP:	Member of Parliament
A.C.C:	Assistant Catchment Conservancy
V.C/M:	Vice Chairman
NGOs:	Non Governmental Organisations
Q:	Question by a participant
A:	Response to a query raised by a participant
C:	Comments by a participant

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# 1. REPORT FOR THE WORKSHOP HELD ON 11<sup>TH</sup> JULY 2014 AT KYENI CATHOLIC HALL, RUNYENJES TOWN

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## 1.1 Present

<b>NAME</b>	<b>ORGANISATION &amp; DESIGNATION</b>
Nicholas Mocho	WRMA - WCO
Peter K. Ngubu	WRMA TANA; Regional Tech. Manager
Patrick Gatumu	WRMA - WCO
Eng. Stephen R. Njiru	Embu County Govt.
Tom G. Macheneri	Dep. County Commissioner
Eng. Mungeria Kirimania	Project Director ; Kiri Consult
Fides Rwamba	Sub - Area
Emily W. Ngari	Embu County – County Cultural Officer
Richard M. Gatumu	Farmer
Francis M. Kasungu	Sub – County Agric. Office Runyenjes
Mark N. Karangi	Chief; Kagaari N. West
Gerald Muturi	M.C.A Rep.
Henry Njeru	C.D.F. Kianjokoma
E.M.K. Nyaga	Ndamunge phase 2
Alfred G. Monga	Farmer
Joseph Bullut	D.C.C. Embu North
Ruth Lorete	A.C.C. Runyenjes/Kyeni Div.
Hon. Mercy Mbae	County Assembly Of Embu
Dedan Kivuti	Farmer
Joseph N. Gicheru	County Director Of Agriculture Embu
John Wairangu	County Directo Of Irrigation
Moses Njuku Njeru	Chief: Gaturi North Loc.
Moses N. Nyaga	Kyeni N. East Loc. Chief
Morris N. Ndwiga	Kyeni South Loc. Ag. Chief
Peter M. Ngurukiri	Chief; Kyeni North West
Japhet M. Ngari	Chief – Kagaari South West Loc.
Emilio Kariuki	Farmer
Elijah N. Karangi	V. C/M Mukui
Salesio Nthumi	Farmer
Paul Ileri	V. c/m; Kieni South
Mathew Nderi	Farmer
Jafferson Kittu	Kenya Forest Service – Ecosystem Conservator- Embu
Christopher Muchiri	NEMA 1 – County Environment Officer, Embu
Evanson Murimi	Farmer

<b>NAME</b>	<b>ORGANISATION &amp; DESIGNATION</b>
Catherine Nyaga	Farmer
Emily W. Njiru	Farmer
Mark N. Karangi	Chief – Kagaru West Loc.
Jim M. Njuki	Driver Embu North
James Wachira	Driver – Director of Agriculture
Mary Mbere	Farmer
Irene Marigu	Farmer
Kennedy Mugendi	Farmer
Benson Njeru	Farmer
Benson Mwaniki	Farmer
Gideon Njeru	Farmer
Esther Njogu	Farmer
Felisio N. Njuki	MP – staff
Emily Wanjuki	MP - Staff
Catherine Mukami	MP – Staff
Evangeline Njeri	Farmer
Kariuki Erick Murimi	Farmer
Javan Omiti	Civil Engineer – Kiri Consult Ltd.
Timothy M. Njue	Ass/ Chief
Madrice I. Mwatha	Ass/Chief – Kanja North Sub-Loc.
Alphan G. Mugoh	Ass/Chief – Kanja South.
John Njiru Nyaga	Ass/Chief
Albert K. Mugo	Ass/Chief
Davis N. Job	Ass/Chief
David M. Nyaga	Ass/chief – Mukuuri
Hezekiah N. Njeru	Ass/Chief
Peter N. Mwangi	Ass/Chief
Thomas N. Ireri	Ass/Chief
Suleiman Njeru	Executive
Monica Wambura	Farmer
Ignatius Mwangi	Ndamunge Water Project
Briget Marigu	Ndamunge Water Project
Njeru Ngururi	Mufu Water S.H. Group
Gibson N. Gitewa	Njeruro Rep.
Maina Nyaga Murani	Chairman Mufu Sub-Loc
Lucy Njoki	Ass/Chief
Maritha Muthoni	Sub-Area – Nyagari
Joseph K. Kagoe	Ag. Chief Kagaari N.E
Njiru Ngari	C.D.F

<b>NAME</b>	<b>ORGANISATION &amp; DESIGNATION</b>
Bosco Ileri	Asst. Chief – Mugui
Robert Ndwiga	Farmer's Rep.
John N. Kiringa	Farmer's Rep.
Jenifer Kagendo	Farmer's Rep.
Roseanne Ndwiga	CDF Rep.
Peter K. Mago	C/Man
Margaret Muthoni	Member
Dominic N. Njue	Chairman CDF Kavutiri Sub
Evans Njeru	Water Project Chairman
Regina Nyagah	Ndamunge water project Vice Chairlady
Alvans Ngugi	CDF Chairman Nduuri
Njeru Samuel	Chairman of water Project
Elias M. Njoka	Snr. Ass/Chief
Cyrus Njoka	C/man Ngajaha Co.
Joseph K. Njagi	C.O.F Chairman Iriari
Alex K. Nthiga	Kariru Representative
Mercy J. Wahu	Asst. Chief
Njagi Njue	Director NGAWASCO
Andrew Kinyua	Director NGAWASCO
Emily Wangari	Asst. Chief
Robert Njiru	Farmer
Joseck M. Ngari	Farmer
Dennis Mugendi	farmer
Edward Mwaura	Farmer
Francis M. Kathi	Farmer
Esther Wanjira	Farmer
Nicerate Giaku	Sub – Area Mufu
Jane M. Njue	Chairlady Group Gichiche
Muoka Cornelius	KWS Embu County Warden
Gideon M. Njeru	Asst. Chief Mbuinjeru
Henry Njeru	CDF Kianjokoma Chairman
Ezra Njeru	Kyeni Kathianjuri Irrigation Water Project
Jerevasio Ileri	Chairman ;Itimbogo Irrigation Project

## 1.2 Introduction

National Irrigation Board (NIB) has a mandate to develop, promote and manage all national irrigation schemes in the country. In line with this mandate, NIB is currently managing seven national irrigation schemes and four research stations in various regions of the country while undertaking the implementation of new irrigation and drainage infrastructural projects in other parts of the country.

The main objectives of the proposed Thuchi dam on River Thuchi is to conserve water during the rains and release it for irrigation purposes during the dry months of a season. It shall support 6600ha of irrigation in Kagaari- Gaturi Irrigation project areas. When the dam structure shall be in place the following shall also be benefits:

- Generate on firm 1.8mw of power.
- Stabilise flow downstream by maintain at least 80% exceedence of the location it shall be build.

More details on the scope of project is in the project brief in Appendix 2 and the workshop programme is in Appendix 1

## 1.3 Objectives

The workshop is a mandatory requirement in the Consultant's terms of reference for the assignment. The following are the objectives of the workshop:

- This is the first full contact with all the stakeholders for the consultant to familiarize himself with them and gather vital social economic information.
- To disclose as much as possible the extent of the project, complimentary projects under construction and planned.
- To disclose as much as possible conflicting project under construction and proposed.
- Explain to the stake holders the consultants programme of work and explain to the stakeholders the assistant that he may require

The workshop is also used to gauge the stakeholders' awareness of the project and other related projects that are on progress in their varying phases.

## 1.4 Courtesy call to the Embu County Governor

The workshop was preceded by a courtesy call to the Governor to brief him on the project and introduce the project team in his explanation the project manager gave the following as the status of the project:

- Kagaari-Gaturi Irrigation project is on the implementation stage with phase 1 complete and benefitting 1900 famers.
- Phase 2 of the project is at tendering stage while phase 3 designs are complete.

- River Thuchi is known to have a lot of water during the wet season while the flow is low during the dry season and as such it cannot be relied upon for irrigation purpose during the drought.
- The proposed Thuchi dam shall solve this problem including the proposed Thuchi hydro project which is conflicting with the irrigation project.

The Governor complemented the financiers of the project and reported that this would go a long way in solving some of the perennial farming problems in the county. He reported that he would have liked to participate in the workshop but he had other commitment and directed his Director of Water Land and Irrigation to represent him.

### **1.5 Address by the Member of Parliament, Runyenjes Constituency**

The Member of Parliament gave the background of the project from its inception using CDF money, area survey using the assistance of geosurvey to the current status where phase one of the project is complete and about 2000 families are benefiting. She reported that she has invited the president to participate in the inauguration of the project.

She informed the participants that the currently Engineering assignment shall solve the problem of the conflicting hydropower project downstream of the irrigation project intake and requested the participant to sell the project to the stakeholders who could not attend the workshop.

### **1.6 Address by the Governor's representative, Director for Water Land and Irrigation**

The Director of Water land and Irrigation for the Embu County informed the participants that the Governor was committed on other projects of equal importance and was to represent the Governor on his request. He explained the related projects that are on progress in the county and reported that the Governor was in the process of providing treated and piped water to all public institutions from where each and every member of the county shall be able to tap water from. He also enumerated the other projects that the County government is in the process of implementing.

He expressed the need for storage for irrigation and asserted the tremendous impacts of the proposed Thuchi dam on the economy of the county. He promised that the County government would help the farmers secure markets for the farm produce. The county government is also committed to providing domestic water the residents of Embu.

He wound up by requesting for active participation in the workshop and all the activities involving the project when invited for the success of the project and declared the workshop opened.

### **1.7 Address by the Provincial / County Irrigation Office**

He highlighted the challenges experienced in the county which include funding of agricultural projects. He stated that the county had more than 100,000ha of land available for irrigation and within the project area more than 40,000 ha is suitable. He explained the problem with rain feed agriculture which range from growing of similar crops and at the same period which result to market flooding when the rains are good and come at the appropriate time and failure of crop associated with variation of rains in consistency to amount.

He requested the beneficiaries of the irrigation systems to form co-operatives in order to command the market for their produce as well as buying of inputs.

He enumerated the benefits of the proposed dam for irrigation that would include employments and steady income for Embu County farmers. The two major proposed projects on Rupianzi and Thuchi Rivers will be of great benefits to the region.

He requested the participants to fully participate in the workshop to gain the knowledge and disseminate it the people who were not lucky to have been invited.

### **1.8 Brief by the Deputy County Commissioner**

The County Commissioner Mr. Joseph Bullut informed the meeting the challenges that the Embu County and in particular Embu North Sub County was experiencing in security matters. He associated this with lack of employment and explained that if the irrigation project is it would employ most of the resident and this shall solve the current security challenge.

### **1.9 Remarks by NIB representative**

In line with the mandate to develop, promote and manage all national irrigation schemes in the country, NIB representative expressed their intention to design and develop the proposed Thuchi dam on River Thuchi to conserve water during the rains and release it for irrigation purposes during the dry months of the year. The dam shall support 6600ha of irrigation land in Kagaari - Gaturi Irrigation project area

He informed the workshop that Kiri Consult has been chosen by the NIB to conduct studies and design the Thuchi dam and requested for active participation in the workshop and all other activities on the project as requested. He wound up by mentioning the various benefits of developing the project. Appendix 2 and 3 give more details on the project.

### **1.10 Presentation by Kiri Consult Ltd., consultant**

The Managing Director Kiri Consult Ltd. introduced the consultancy and explained what they are involved in. He gave the background of the project with the following key points:

- Irrigation project completion status,
- Expected benefits of the proposed Thuchi dam,
- Objective of the Engineering Service
- Scope of the work and duties of the Consultant
- Workshop expectations

He informed the workshop that the stakeholders shall be informed of the proposed project (study) so that from then going forward they shall understand what is being done and allow the study team in their community and assistance them in understanding the project better.

He further informed the workshop that more details shall be provided in the next workshop expected in August 2014 where their opinions shall be listened to, Recorded and incorporate in final design See full details in appendix 7.

## 1.11 Presentation by project team leader

The team leader took the workshop through current understanding of the project and the following were the main topics:

- Main weather and rainfall station within the irrigation project and the proposed Thuchi dam catchment area.
- Recorded raising of temperatures and fall of rainfall in the main rainfall seasons over time.

From these records the participants were informed that only irrigation shall enhance resilience of climate change/global warming.

He also took the workshop through the consultant scope of services in the following topics:

- Interim study:
- Feasibility study.
- Detailed hydrological analysis for River Thuchi.
- Detailed topographical survey
- Detailed Geotechnical Investigation.
- Detailed design for embankment abutments draw off works, diversion works and spillways, diversions and draw down towers
- Tender documents of the dam.
- Environmental and Social Impacts Assessment.

He explained the criteria for the design of the proposed dam in the following:

- Service provision
- Safety
- Sustainability

The team leader explained that the next stage of the assignment is feasibility study and preliminary design where all the possible dam sites shall be ranked according to their benefit and cost and that a workshop to explained this to the participants shall be held and their opinions shall be recorded and incorporated in the final design. See full details in appendix 4.

## 1.12 Presentation by project Irrigation expert

The irrigation expert took the workshop through the possible irrigation areas from each dam and the expected challenges on each however the participant were informed that more details shall be availed in the next stage to enable them query the design and give their opinions. See full details in appendix 5.

### 1.13 Presentation by project the sociologist

The sociologist explained that Kagaari -Gaturi irrigation project was at advanced stage of completion and every is benefitting from either employment, income ,or steady and cost effective food supply and hence each of the community leaders should own the project and assistance in bringing the remaining parts to their completion by doing the following:

- Allow the study team access to various sites
- Assist with explanations where called upon
- Be willing to accommodate diverse opinions
- Participate in future workshops

See full details in appendix 6.

### 1.14 Discussions and Comments

**Participant 1, S. Njoka (Chairman Kagaari water supply and sanitation Co.):**

**Q:** Where is the exact position for the dam location? Earlier studies proposed a dam upstream of the existing intake

**A:** The upstream location was a very preliminary proposal that was found to be inadequate in terms of storage volumes after additional studies. The new and recommended location(s) for the dam are downstream of the existing river intake as indicated on the project map

**Q:** If the dam is downstream of the existing intake, how will the upper section of the irrigation area will be supplied?

**A:** The upper regions that cannot be supplied by the dam will be supplied by the existing river intake and downstream compensation done at the dam.

**Participant 2, Moses Njeru**

**Q:** For the domestic water supply, will storage tanks be provided?

**A:** The scope by this project is limited to making allowance for an off-take for extraction of domestic water from the dam. Future projects can be carried out by relevant institutions to extract the water, provide treatment and distribution to the domestic users

**Participant 3, Mr. Nyaga, (Kyen Water)**

**Q:** What phases will benefit from the proposed Dam water supply and will the current phase 1 be included?

**A:** All the phase of Kagaari-Gaturi irrigation project shall require and shall benefit from the dams water supply either directly or downstream compensation. Currently, without the dam irrigation is supposed to be stopped at a certain stage during drought.

**Q:** Tea growers are unhappy with the dam because it will reduce water for hydro power proposed downstream, how will this be addressed?

**A:** The proposed dam has the capacity to provide the power needed by the tea growers and water for irrigation by other crop farmers hence this is the solution of the current conflict.

**Participant 4, Dominic Njue:**

**Q:** Sought to know how Gaturi North and Kagaari shall benefit from the project

**A:** All the phases of Kagaari- Gaturi Irrigation project cannot receive water throughout the dry season but this shall change with construction of the dam.

**Q:** Since Kiri Consult is not saying the same thing Bundia, what is the relationship between the studies carried by the two Engineers should be clarified

**A:** It was explained that Bundia associate consulting engineers carried out a study of the irrigation infrastructure while Kiri Consult is carrying out a study of the dam that can support the irrigation project.

**Participant 5, Peter Mwasi and Participant 6, Mr. Nyaga**

**C:** Expressed support for the project and said it would benefit every one

**Participant 7, Elijah Nyaga**

**C:** Expressed support for the project but stated that a lot of sanitization needs to be done since most stakeholders do not know what is being done in the project

Requested that the affected persons to be identified

**Participant 8, V. Njeru (Asst. Chief)**

**C:** Expressed support for the project

**Q:** Sought to know how soon the farmers can start receiving water from the dam

**Participant 9, Joseph Nyaga**

**C:** Expressed support for the project and stated that with the growing population demand of irrigation water shall increase

**A:** It was explained that at this stage it is not possible to know.

**Participant 10, Magdaline Muthoni (Kyeni South Chairlady)**

**C:** Expressed support for the project

**Participant 11, Possible Ileri**

**C:** Expressed need for sanitization on the ground

**Participant 12, Robert Gitonga**

**C:** Expressed support for the project and reported that he would like to participate actively

**Participant 13, Joseph (Ministry of Agriculture)**

**C:** Reminded the participants that Embu has vast agricultural potential and outlined the various steps planned by the ministry to improve agricultural activities in the area.

**Participant 14, Mercy Kanini (MCA)**

**C:** Expressed support for the project and highlighted the various plans and allocations by the county government towards improving water supply in the area.

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## 2. APPENDICES

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## 2.1 APPENDIX 1: WORKSHOP PROGRAMME

# Feasibility Study, Detailed Design and Preparation of Tender Documents for Thuchi Dam Irrigation Development Project, Embu County

## Consultative Workshop No.1 on Inception/Interim Study Report

**Venue:** Kyeni Catholic Hall, Runyenjes Town

**Date:** Friday, July 11, 2014

### PROGRAMME

Time	Activity
<b>Session 1: ARRIVAL AND REGISTRATION</b>	
9:00-9:45	Arrival and registration of participants
<b>Session 2: OPENING</b>	
9:45-10:00	Prayer and introductions
10:00- 10:20	Address by CEM for Water and Irrigation to invite honorable Member of Parliament to address the workshop and give a brief on the irrigation project
10:20-10:30	Member Of Parliament to invite HE The Governor, Embu County, to officially open the Workshop
10:30-10:45	Introductory Remarks by National Irrigation Board (NIB) Representative
10:45-11:00	<b>TEA BREAK</b>
<b>Session 3: PRESENTATIONS</b>	
11:00-11:15	Brief on Irrigation Activities in Embu County – County Director Irrigation
11:15- 11:30	Brief on the consultancy – Project Director
11:30-12:15	Progress of stage 1 (Inception) Activities - Team Leader
12:15-13:00	<b>Discussion and comments by participants</b>
13:00-14:00	<b>LUNCH BREAK</b>
<b>Session 4: PRESENTATIONS CONT</b>	
14:00-14:20	Potential Irrigation areas – Team Leader
14:20-14:50	Stakeholder Participation - Irrigation Water Uses Expert
14:50-15:20	Work plan for stage 2 Activities – Consultancy Experts
15:20-15:50	<b>Discussion and comments by participants</b>
<b>Session 5: CLOSING</b>	
15:50-16:30	Remarks by Chief Officer, Water and Irrigation, Embu County to invite The County Commissioner, Embu County to officially close the Workshop
16:30-17:00	<b>TEA BREAK AND DEPARTURE</b>

## 2.2 APPENDIX 2: PROJECT BRIEF

## THUCHI DAM, EMBU COUNTY

### Background

Kaagari-Gituri Irrigation project has more than 12000 farmers and covers a total area of about 6600ha. It falls in the following wards:

- Kagaari South
- Central
- Gaturi North
- Kagaari North and
- Kieni

The irrigation project is at construction stage and the following is the status of Kagaari Gaturi Irrigation Project:

1. Phase III: This covers an area of 2970ha (7325 acres). Its construction is complete and it is benefiting the farmers
2. Phase II: This covers an area of 2640ha (6,600 acres). This is at tender stage
3. Phase I: It covers an area of 990ha (2475 acres)

From hydrological study the water flow in Thuci River can hardly sustain irrigation in phase III during the dry season and hence the need of a dam.

### Thuci Dam

The proposed Thuci dam shall conserve water during the River's high flow and release it for irrigation purposes during the dry months of the year. It shall also provide for other demands that the wider community may require after the dam is constructed.

Upto this stage detailed Thuci River water resources study have been done and allocate water to the various competing demands and propose a dam that shall incorporate these demands in the long run.

It is also noted that the dam has a potential of providing the following other benefits to the wider community:

- Domestic Water supply
- Hydropower
- Tourism
- Water sport

It is estimated that the 23million m<sup>3</sup> of water shall suffice to irrigate the 6600ha of irrigation land in Kaagari Gaturi Irrigation project area

## **Objective of the Engineering Service**

The objective of the engineering assignment includes an interim study of Thuci River Water Resources up to the lowest possible water intake for Kaagari-Gaturi Irrigation project. At this study stage some of our core consideration has included but not limited to the following:

- Relocation of people and social economic impact as well as cost,
- Displacement of forest cover and subsequent consequence in terms of cost replacement and or environmental impact
- Cost of relocating the intake to the dam and the consequent cost of pressure reduction in the Irrigation scheme,
- Impounded volume Visa vis the water volume required for the scheme and other competing demands.
- Possibility of hydropower generation

All the possible dams' locations shall be ranked using the above consideration at feasibility study stage and the report presented to the stakeholders where their views shall be recorded and incorporated in the final feasibility study report.

## **Scope of the work and duties of the consultant.**

The scope of the work is listed as the following:

- Feasibility study.
- Detailed hydrological analysis for Thuci River. This shall including effects of climate change based on National Adaptation programme Action (NAPA) on climate change.
- Detailed topographical survey at the dam embankment, Borrow area and impounding area delineating the areas as well as providing coordinated reference points to be used at construction stage.
- Detailed Geotechnical Investigation.
- Detailed design for embankment abutments draw of woks, diversion works and spillways.
- Environmental and Social Impacts.
- Financial and Economic analysis.

## **Workshop expectation.**

In the workshop the stake holders shall be informed of the proposed project(study) so that from then going forward they shall understand what is being done and allow the study team in their community and assistance them in understanding the project better.

More details shall be provided in the next workshop expected in August 2014 where their opinions shall be listened to, Recorded and incorporate in final design

## 2.3 APPENDIX 3: STACKEOLDERS ATTENDANCE LIST

## 2.4 APPENDIX 4: KIRI CONSULT LTD TEAM LEADER'S 1<sup>ST</sup> PRESENTATION

# **FEASIBILITY STUDY, DETAILED DESIGN AND PREPARATION OF TENDER DOCUMENTS FOR THUCHI DAM, EMBU COUNTY**

**Contract No. NIB/T/015/2013-2014**

## **PROGRESS OF STAGE ONE**

**BY TEAM LEADER**

# INTRODUCTION

The proposed Thuchi dam on River Thuchi is to support 6600ha of irrigation land in Kaagari-Gaturi Irrigation project area.

River Thuchi is at the boundary of Embu and Nithi Counties within the Mt. Kenya forest region.

It is 15km from Runyenjes Town along Embu-Meru road.

River Thuchi basin is on the Eastern side of Mt. Kenya and is part of the bigger Mutonga river catchment and River Tana .

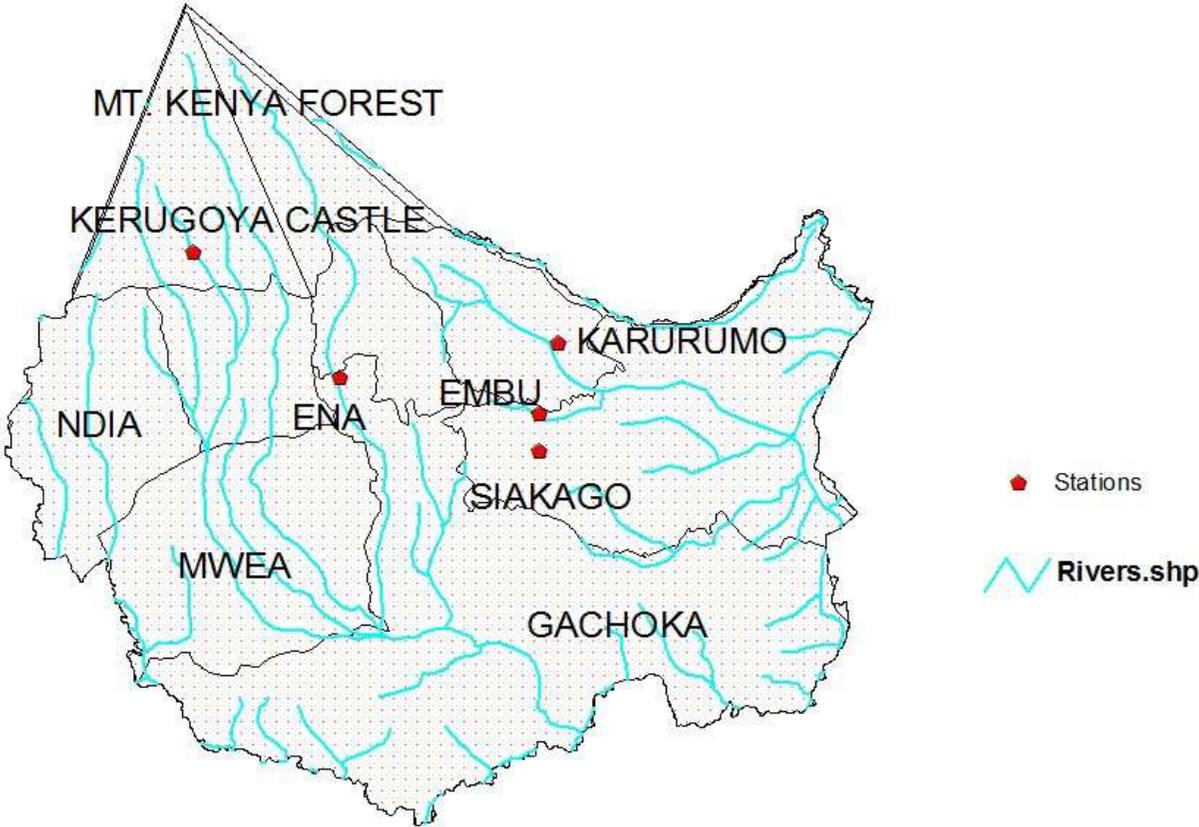
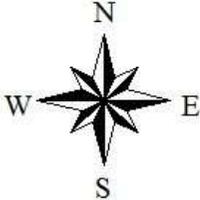
# BackGround

- Kagaari-Gaturi is the proposed irrigation area which is in the Embu(Mount Kenya east) ecosystem.
- It is characterized by 2 rainy seasons March April, May(MAM) and October, November December (OND) and varying temperature.

Rainfall and temperature are the two weather parameters that define the agricultural potential of a region and these are observed and recorded in many stations in the area

Below is the region with rainfall station and Embu metrological station shown

# Thuchi Catchment

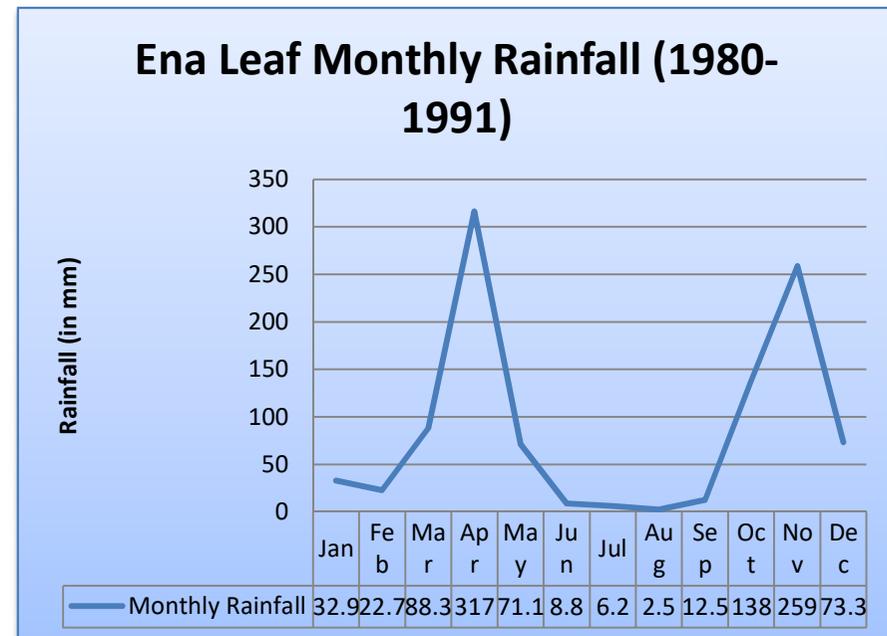
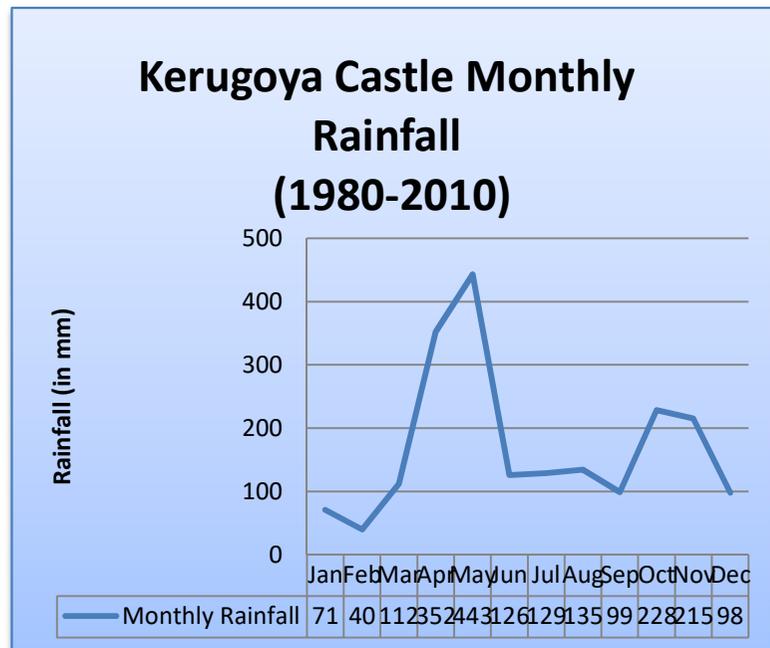


# Main Weather and rainfall stations

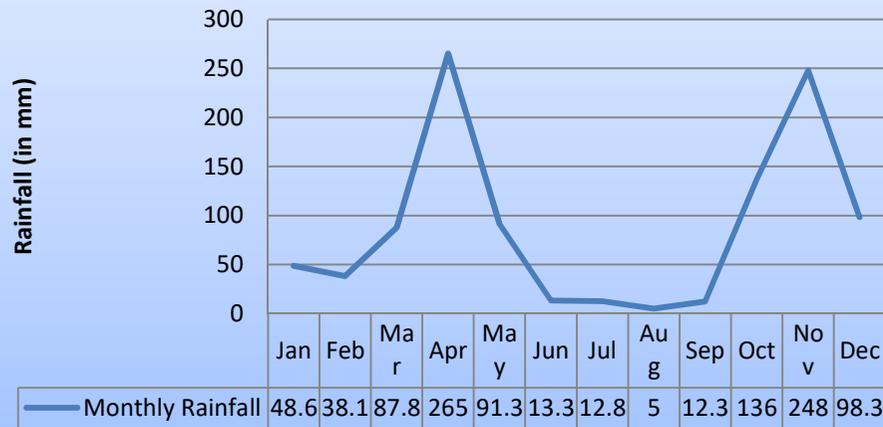
Embu metrological station is the only station that record all weather parameters including temperatures in the region.

Kirugoya castle station was found suitable to present the forest region.

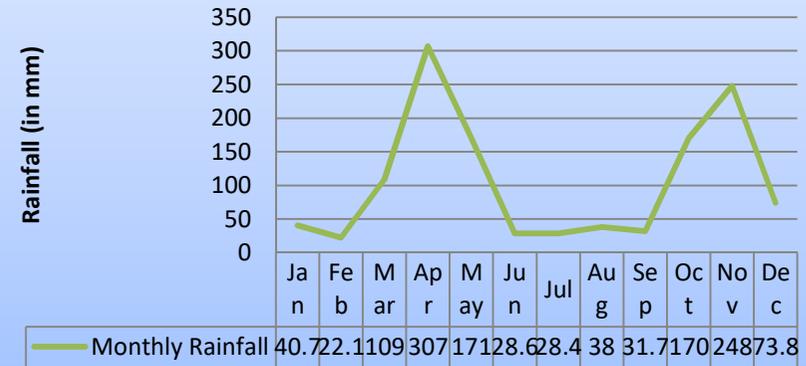
Irangi Forest rainfall station to represent tea growing area, the Ena leaf station coffee growing region while Karurumo was found suitable the cotton growing area. Below are graphical representation of long term average rainfall of these stations



### Karurumo Monthly Rainfall (1980-1991)

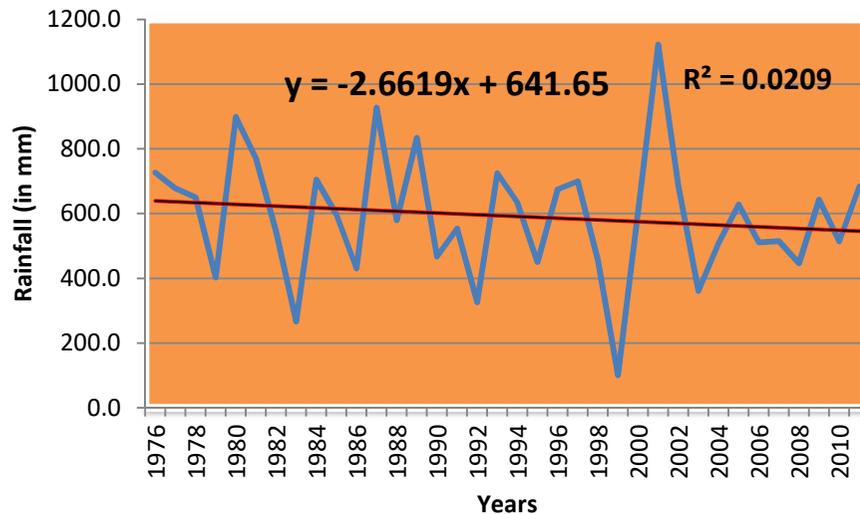


### Embu Monthly Long term Rainfall (1980-2010)

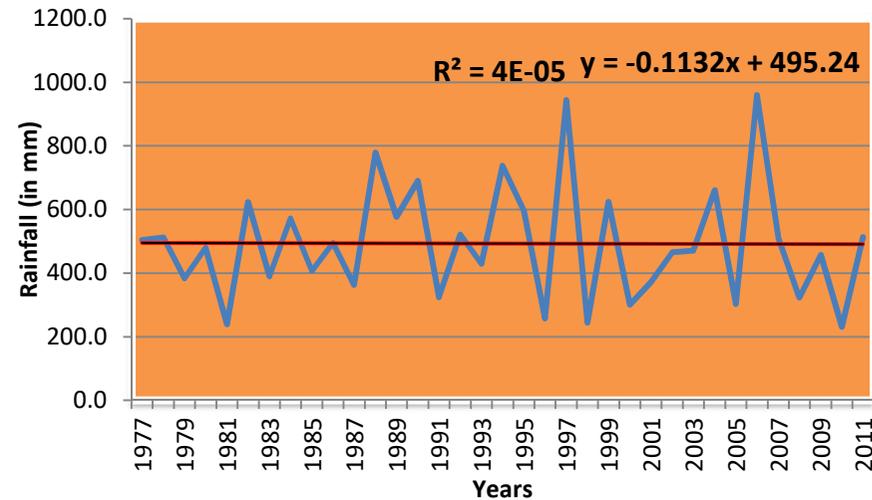


Below is the long term trend of rainfall observed in these stations.

#### MAM RAINFALL TREND AT EMBU



#### OND RAINFALL TREND AT EMBU

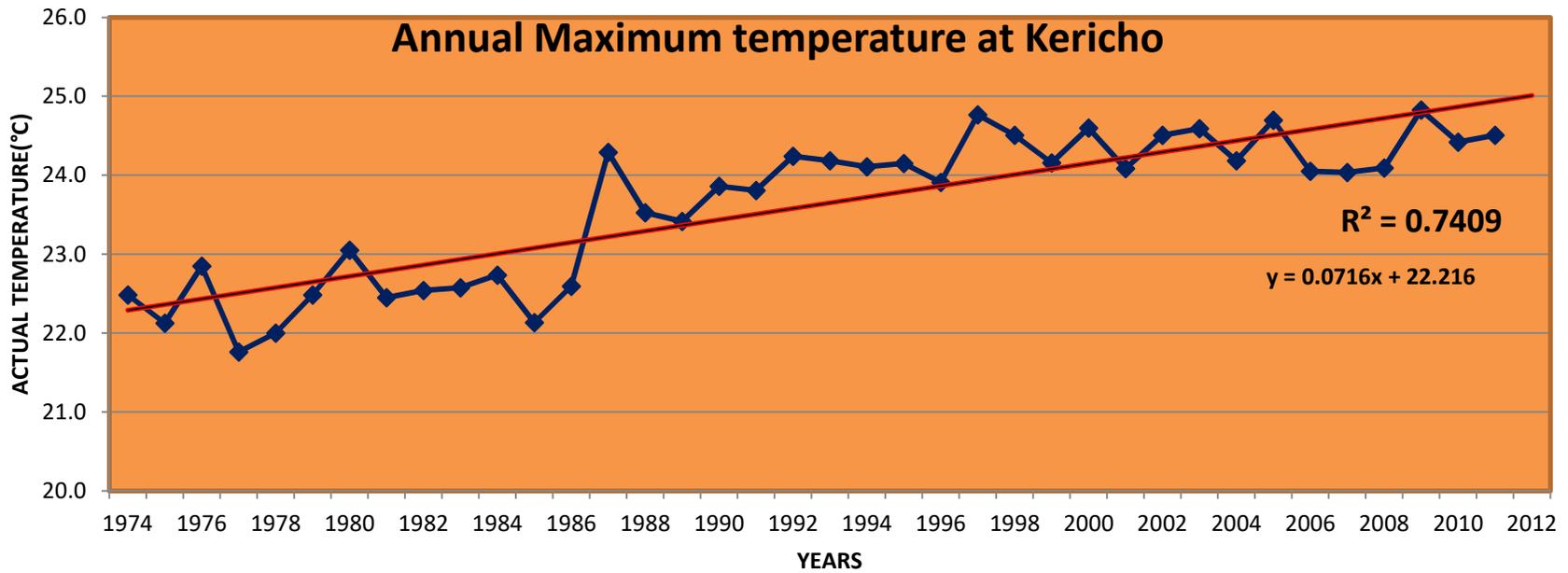
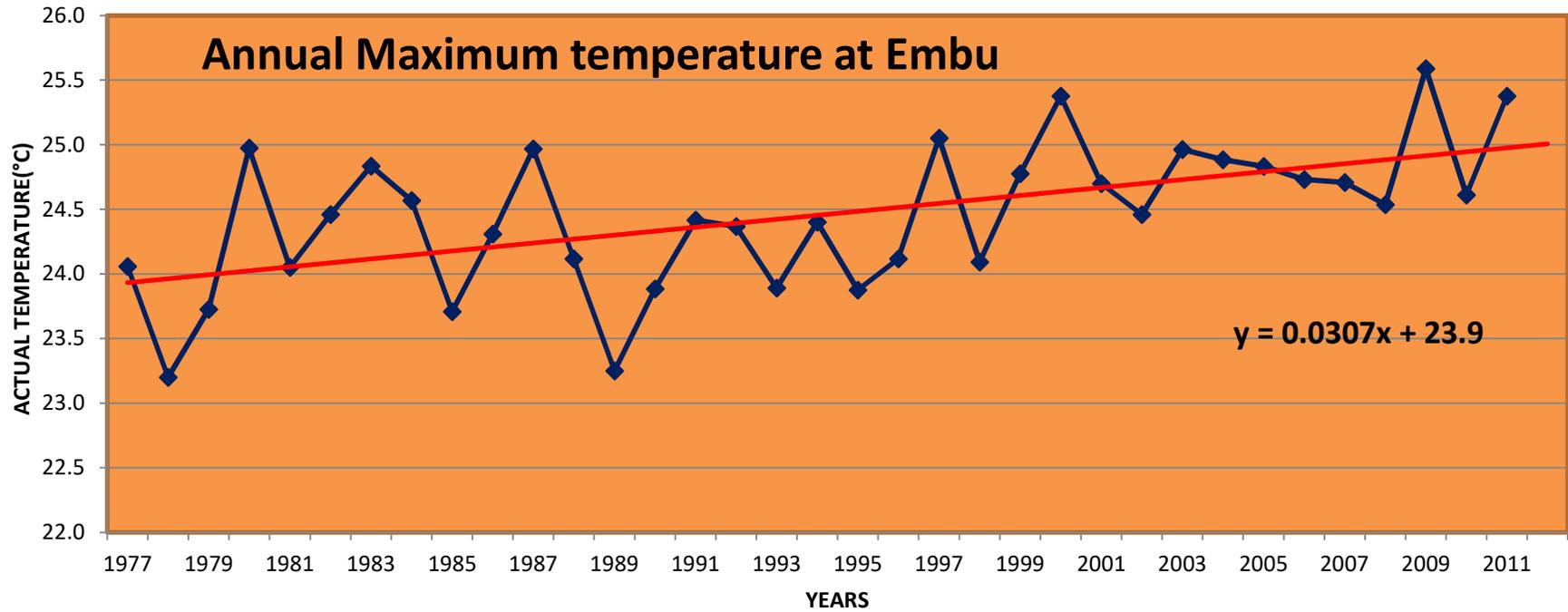


These graphs shows that there is a slight decline of rainfall in MAM and OND rainfall and the rains starting dates were also found to be shifting shifting.

## **Temperatures,**

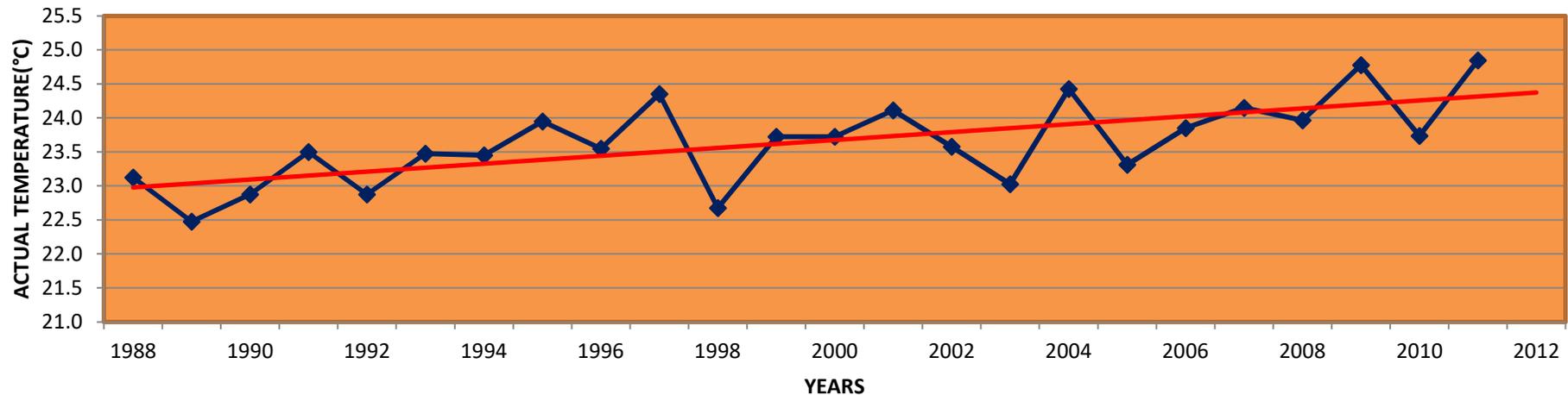
Temperatures are recorded in Embu metrological station in the region however comparison of rainfall trend and amounts of the following metrological stations were found to be fair representatives of Tea, coffee and cotton growing areas:

- Kericho for tea growing areas
- Machakos (Katumani) for Cotton growing area



## Annual Maximum Temperature trend in Machakos

$$y = 0.058x + 22.92$$



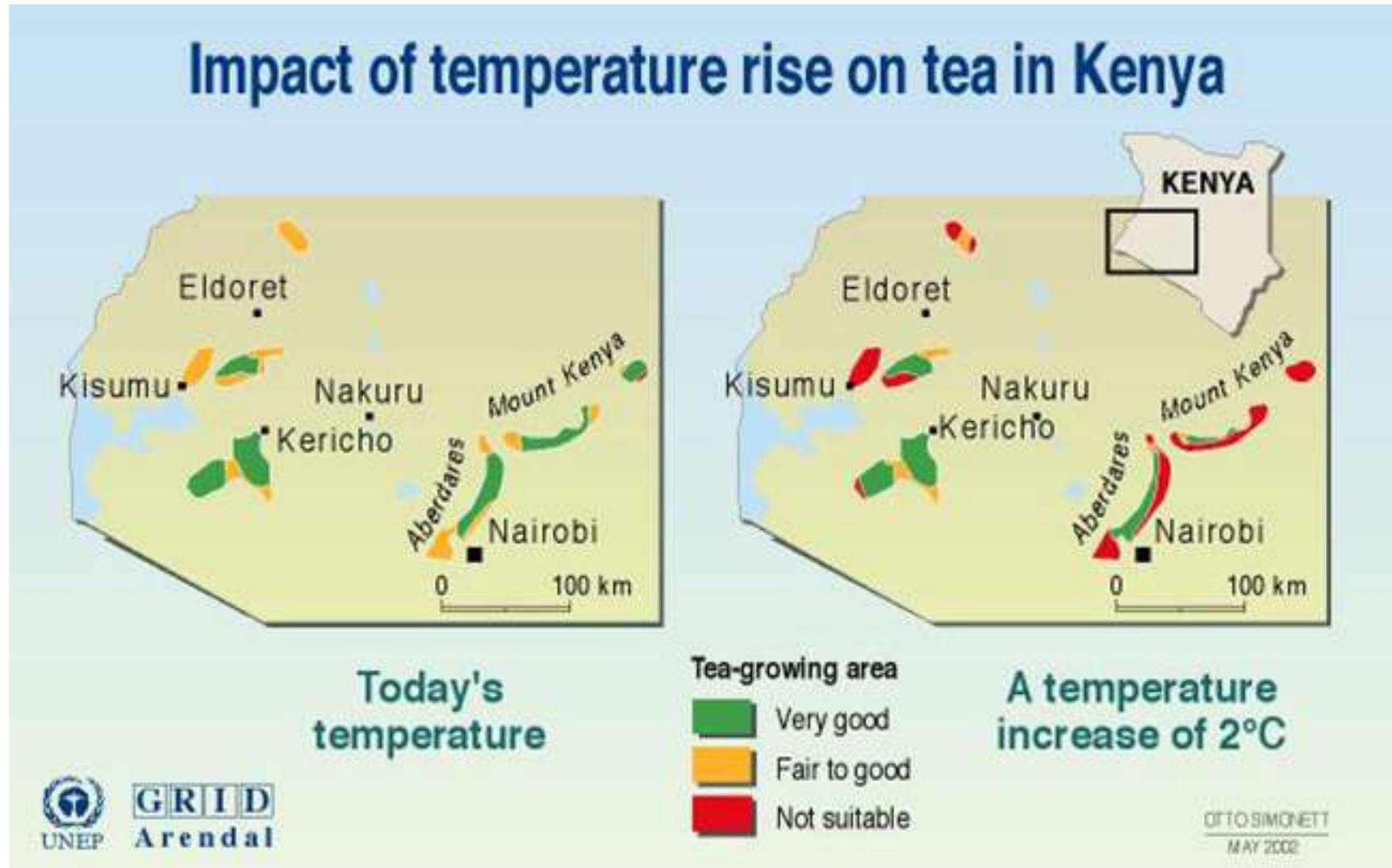
From these long term observation it is clear that this region:

- \*Rainfall is expected to fall slightly

- \*Temperatures are expected to raise by 1-1.5degrees in 20 years and 2-3 in 50 years.

Agricultural potential shall change from what it is to day in less than 20 years

Below is a graphical comparison of tea growing potential in Kenya today and in feature (50yrs) as predicted by Otto Simonett

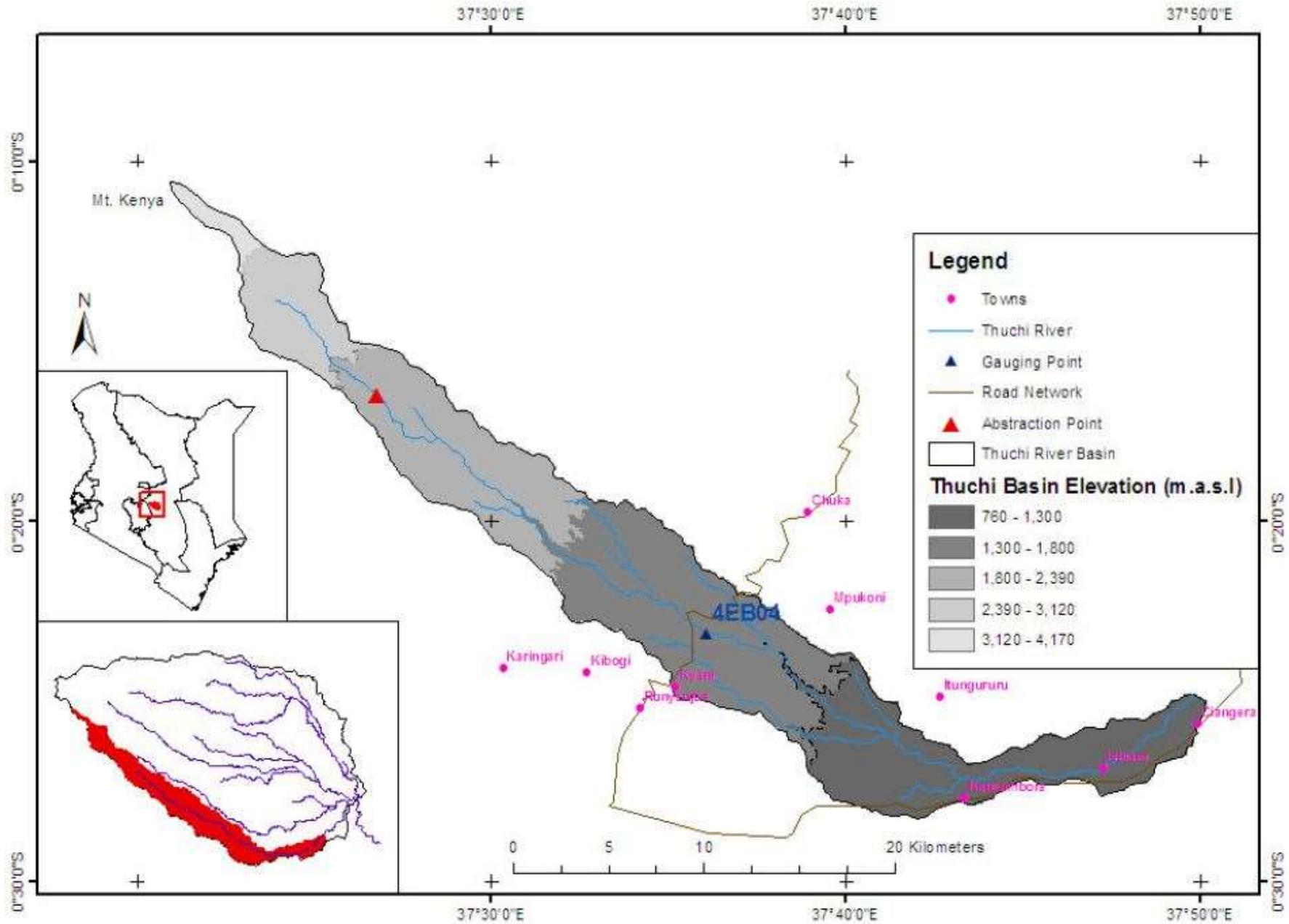


Source: Otto Simonett, *Potential impacts of global warming*, GRID-Geneva, case studies on climate change. Geneva, 1989.

From the foregoing, it is clear that climate change/global warming is a reality we have to embrace and plan to leave with.

The current irrigation trend is one of the ways we are developing resilience in our food production and the proposed Thuchi dam is part of this development proposed by the government and we request you to support it.

# Figure 1: Thuchi River Basin



# Scope of services

The following are the main scope of the service

- Interim study:
- Feasibility study.
- Detailed hydrological analysis for River Thuchi.
- Detailed topographical survey
- Detailed Geotechnical Investigation.
- Detailed design for embankment abutments draw off works, diversion works and spillways, diversions and draw down towers
- Tender documents of the dam.
- Environmental and Social Impacts Assessment.

# Specific duties of the Consultant

Review of previous studies and data collection for Kagaari, Kyeni and Gatari irrigation development project.

The following are the major reports that are available so far:

Draft Final Detailed Design Report

- ESIA) project report for Kagaari - Gatari irrigation project: Draft Final Report
- National and Regional Reports and Studies, WRMA strategic plans

2. Topographical Survey shall be done in a wide area initially to establish a suitable dam site. That shall be followed by the following:

- Detailed topographical survey of
- The dam embankment area,
- Spillway, abutments area,
- The reservoir, silt zones and 500m buffer area ,
- The potential access road, construction camps and permanent housing

### 3. Hydrological study of the catchment up to the proposed dam sites

- Correct and fill missing information and establish its consistency.
- Designing the spillway, other components.
- Establish the seasonal flow in River Thuchi.
- Design of dam safety components.
- Establish annual water balance.
- Estimate sediment carrying capacity. Establish dead storage and life expectancy of the dam
- Establish the most likely scenarios and incorporated climate change in design in accordance to NAPA.
- Demand and dam release to confirm the effectiveness of the dam.

### 4. Geological and Geotechnical studies.

- Vertical Electrical Sounding

- Detailed study done by borehole drilling and recovering for the foundation strength, permeability , foundation treatment.
- At borrow sites: trial holes: embankment construction material.
- determine the likely safety of the borrow.
- tender document for detailed dam geological investigation.

4. Design and Engineering Studies,

5. Environmental and Social Impact studies

6. Application for the necessary National Environmental Management Authority and Water Resources management Authority approvals,

7. Engineer's Cost Estimates,

8. Detail engineering design, for all the components

9. Prepare Design Reports and drawings

# Design Criteria and Approach

Based on the design of dams hand book by United State Bureau for Reclamation (USBR) and provisions in the International Commission of Large Dams(ICOLD)

Criteria for the design of the dam can be categorized as related to:

- Service provision
- Safety
- Sustainability

## SERVICES PROVISION

**Satisfaction of demands:** Service Provision Criteria for Different Water Demands

Demand	Percentage of Demand to be Met in 75% Driest Year	Percentage of Demand to be Met in 90% Driest Year
Human Consumption (Domestic, Institutional and Commercial)	100%	100%
Environmental flow	100%	100%
Livestock	100%	80%
Irrigation	80%	50%
Aquaculture	100%	80%

## Safety

Structural integrity and stability.	The structural integrity and stability of the structure under normal and temporary loading conditions will be checked for acceptable factors of safety.
Safety against earthquakes	A seismic risk assessment will be undertaken for the dam site and earthquake loads corresponding to and Operation Basis Earthquake (OBE) and a Maximum Credible Earthquake (MCE) will be estimated..
Safety against floods	A design flood and a, more extreme, safety check flood will be estimated. The spillway structures will have to be able to pass the former without damage and latter passed without failure of the dam but some damages is acceptable.

Safety for downstream areas during operation	The design of the dam and its associated structures shall consider the safety of downstream areas close to the river during the operation of the project. A key criterion should be that the design for operations does not lead to increased risks downstream.
Safety of dam during operation.	Adequate instrumentation and monitoring structure (e.g. seepage structure) should be provided by the design to allow monitoring.
Security Issues	A dam is both a hazardous and a high value structure and, therefore, security threats should also be taken into account.
Safety during construction and first impoundment.	Temporary structures such as cofferdams, diversion flow conduits etc. must be safe for impounding water and passing floods of appropriate return period.

## 2.5 APPENDIX 5: KIRI CONSULT LTD IRRIGATION EXPERT'S PRESENTATION

**FEASIBILITY STUDY, DETAILED DESIGN AND  
PREPARATION OF TENDER DOCUMENTS FOR  
THUCHI DAM, EMBU COUNTY**

**Contract No. NIB/T/015/2013-2014**

**IRRIGATION POTENTIAL**

**BY IRRIGATION EXPERT**

# BACKGROUND

The main objectives of Thuchi dam on River Thuchi is to conserve water during the rains and release it for irrigation purposes during in the dry season.

The major consideration at this stage is to abstract irrigation water and maintain environmental flow in the river

To sustain Irrigation in 1 in 5 years drought, we estimate that a 23 million m<sup>3</sup> storage is required taking into consideration the existing water rights issued by Water resources Management Authority and maintaining at least 80% exceedence flow throughout the year.

At this stage, the study aims at firming up the required storage from previous studies and establish possible reservoir locations. It should also highlight the main social and environmental impact that might affect the project negatively.

# REVIEW OF PREVIOUS STUDIES AND DATA COLLECTION

**Previous study estimated irrigation Water Available** at 80% “reliability” at  $0.51\text{m}^3/\text{s}$  . It concluded that the flow was low and hence a 90 days storage would be necessary.

**It also identified the following zone of irrigation:**

- Upper Zone (tea Growing) with irrigation demand of 3.3mm to cover 15% of total area.
- middle Zone( coffee Growing) with irrigation demand 3.51mm to cover 40% of total area.
- Lower Zone (cotton Growing) with irrigation demand 3.69mm to cover 45% of total area.

With irrigation efficiency of 72%, it estimates 90days irrigation required 26million  $\text{m}^3$  water for the worst case scenario but concludes that 16million  $\text{m}^3$  storage shall be sufficient.

## **Preliminary Investigation and conclusion**

- Tea, Coffee and Cotton zones with 15% in tea, 40% in coffee and 45% cotton zones are fair categorisation.
- more metrological data was required to establish the irrigation water demand
- further catchment investigation was necessary
- need to investigate the proposed dam site further in order to confirm its suitability.

## **Data Collection and Data Gaps**

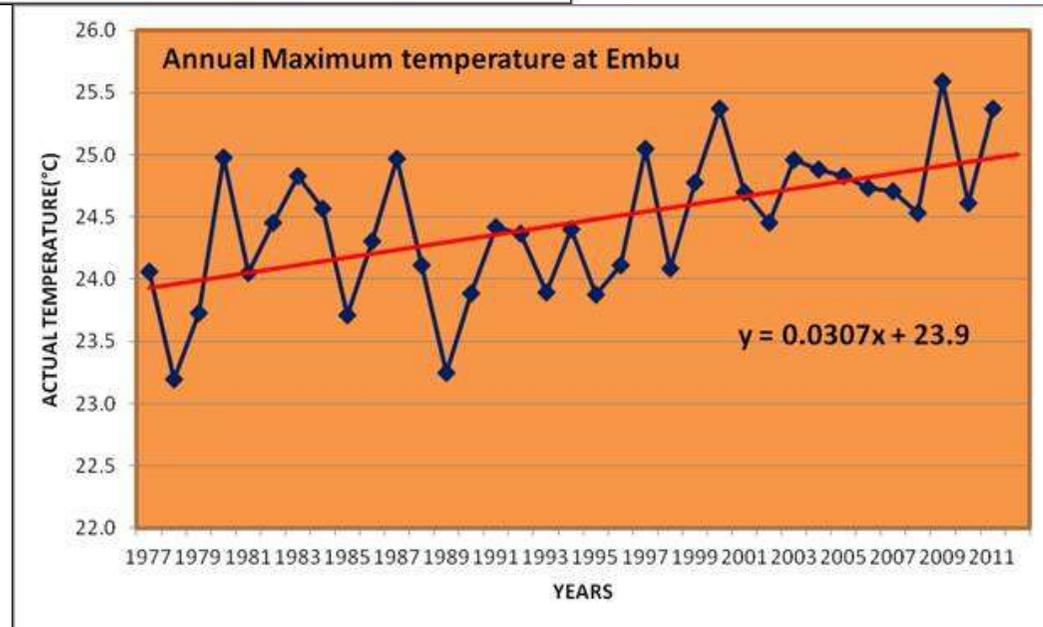
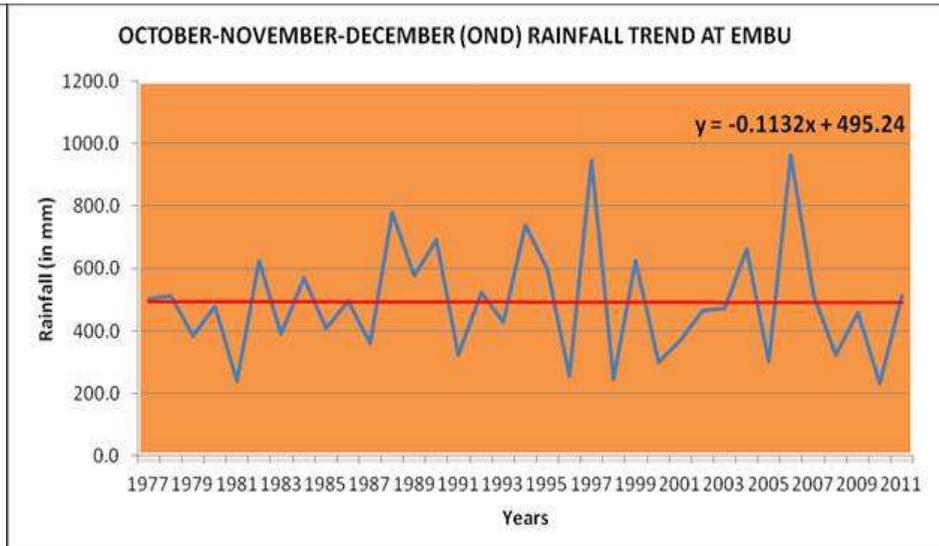
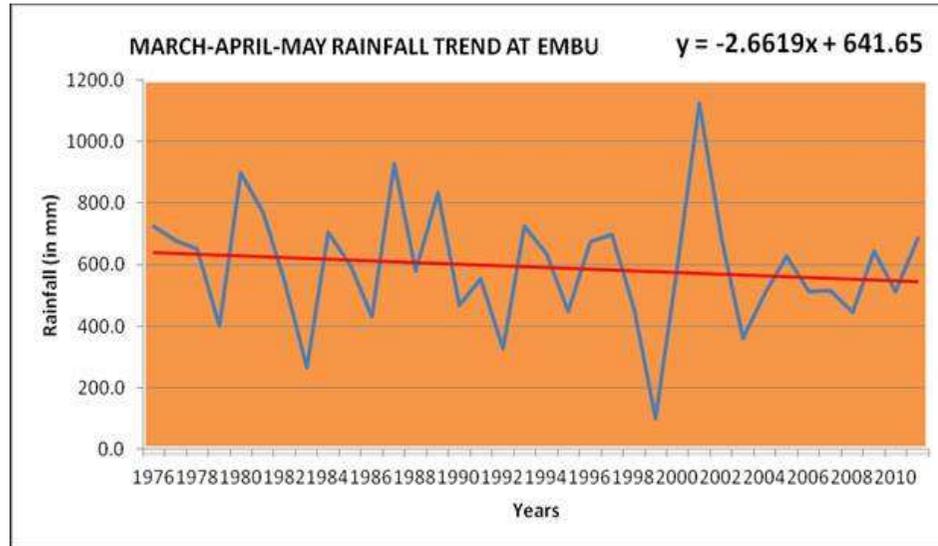
Metrological data collection was done but the limitation was period corrected and gaps within the period, the following stations were found with fair periods and fewer gaps:

- i. River Thuchi Catchment area- Kiroguya castle (30 years),
- ii. Tea growing zone -Irangi forest rainfall station(10year),
- iii. Coffee growing area- Ena rainfall station 10 years and
- iv. Cotton growing area- Karurumo rainfall station(10years)

# On climatical analysis

- Only Embu metrological station was found to have records of temperature, sunshine,
- humidity, wind speed and radiation .
- good correlation of data was found in the following stations:
  - Embu and Ena leaf stations
  - Irangi and Kericho
  - Karurumo and Machakos
- Embu, Kericho and Machakos metrological stations were used to make synthetic stations for Coffee, tea and cotton growing areas respectively

# Climate change



## Climate change Continued

### Probable Impacts of Climate Change

Increase in temperature of 2 ° C may lead to some areas which are ideal for tea and coffee to lose their potential as depicted by earlier research done by Otto Simonnet, on both tea and coffee areas

*“Potential Impacts of Global Warming “, a case study on Climate Change, Geneva, 1989*

But in adaptation, coupled with high temperatures, irrigation intervention always lead to reduction in the growing period of a particular plant.

### Conclusion

Rainfall in the irrigation and catchment area shall have very little variation  
However, temperatures are expected to increasing by a factor of about 0.03°C per year and hence about 1.5 °C in 50years

.

## REVIEW OF WATER DEMANDS

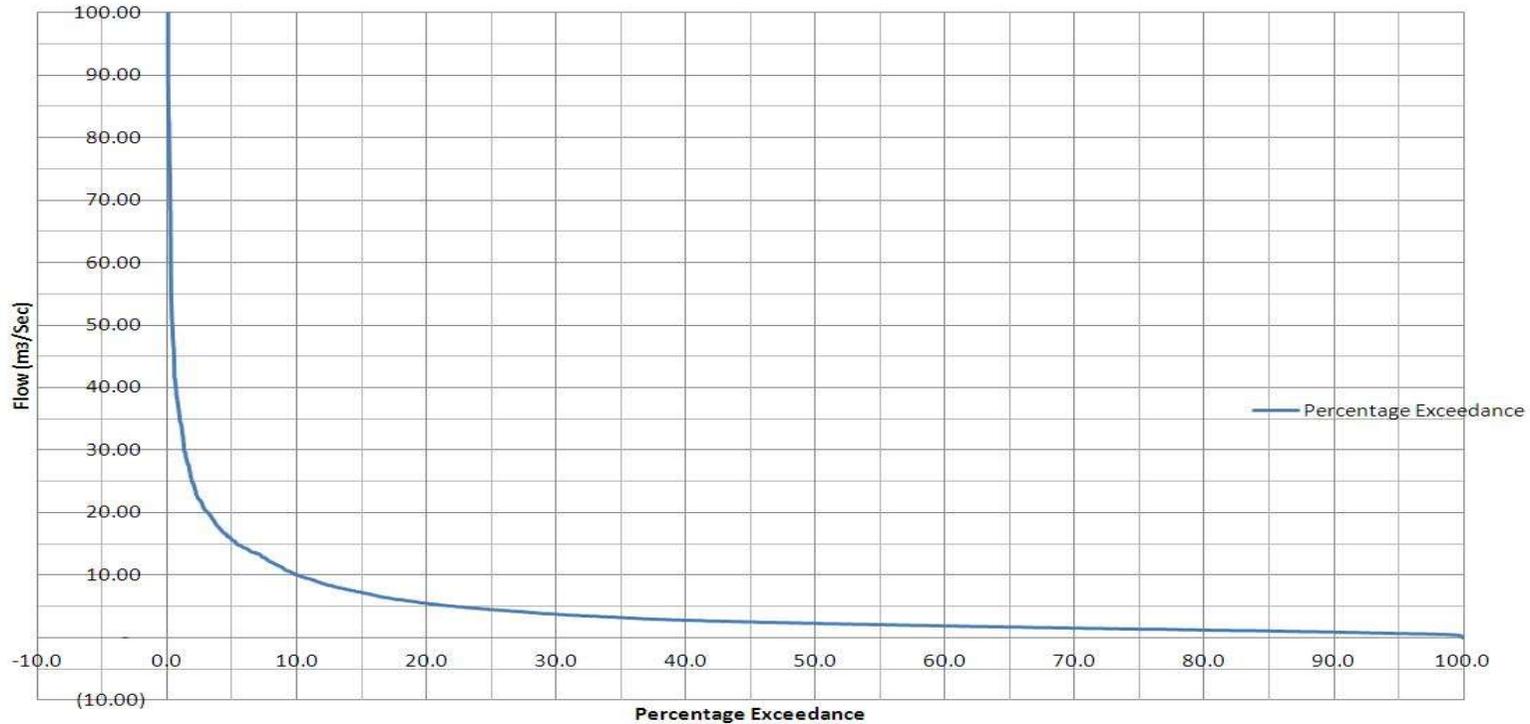
Water Demand was estimate for domestic and irrigation requirement.

Dam design year was taken as 2015 with live expectancy of 50 years 2065(ultimate year) when population is expected to be 390,267. Commercial and livestock demand was done proportionally.

- Domestic water demand was estimated to be 43,890 m<sup>3</sup>/day
- Irrigation Water Requirement: was based on a 6,600 ha scheme: using CROPWAT 8.0 modelling software and representative crops in various climatically zones as detailed under

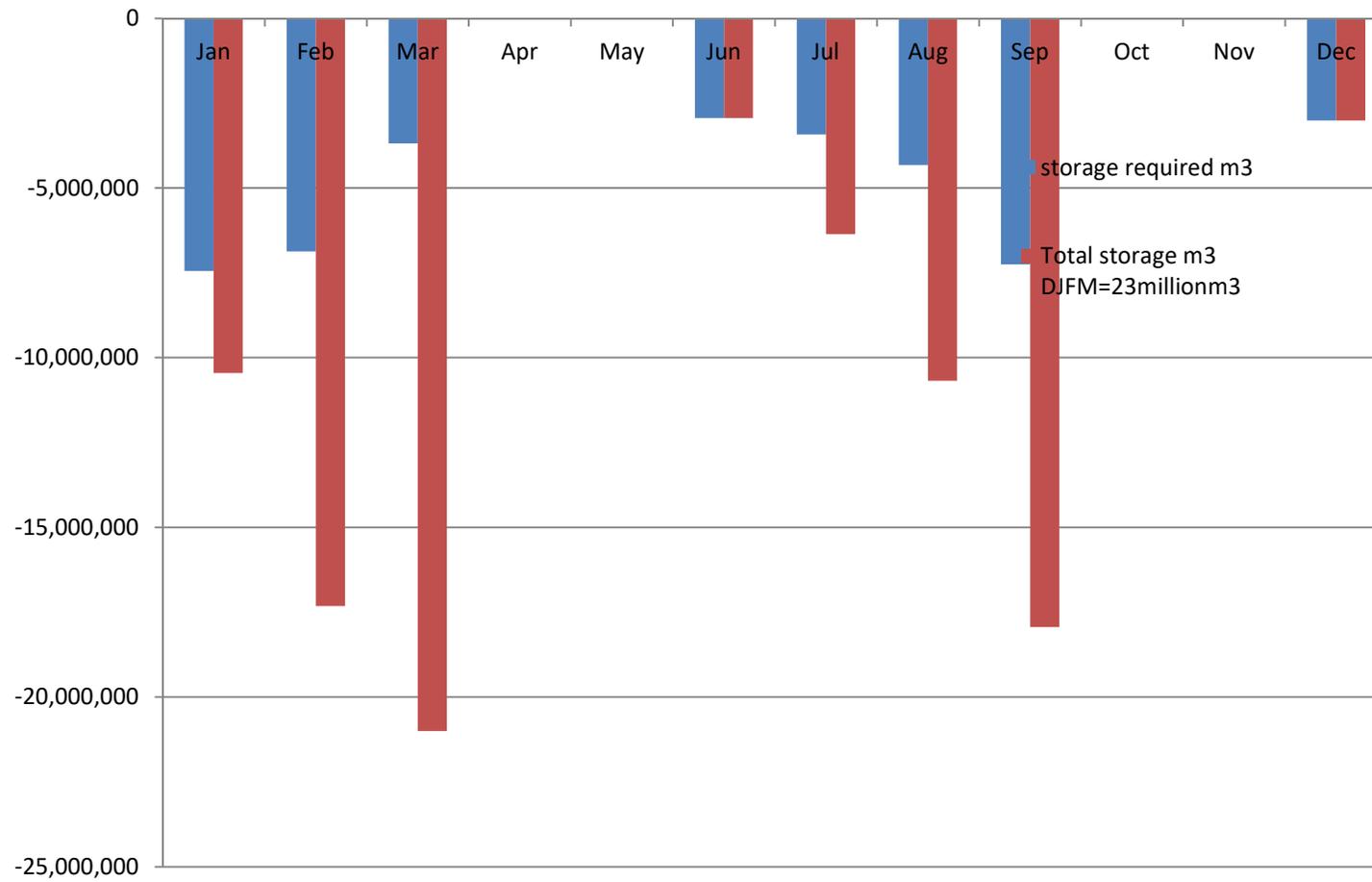
<b>Climatic/ Crop zone</b>	<b>Representative crop for analysis</b>	<b>Base station</b>
Cotton zone	Maize	Karurumo (phase III)
Coffee zone	Banana	ENa (phase II)
Tea zone	Cabbages	Irangi Forest/I

# FLOWS (M3/S) REGIME AT RFGS 4E04 AND EXCEEDENCE LIMITS

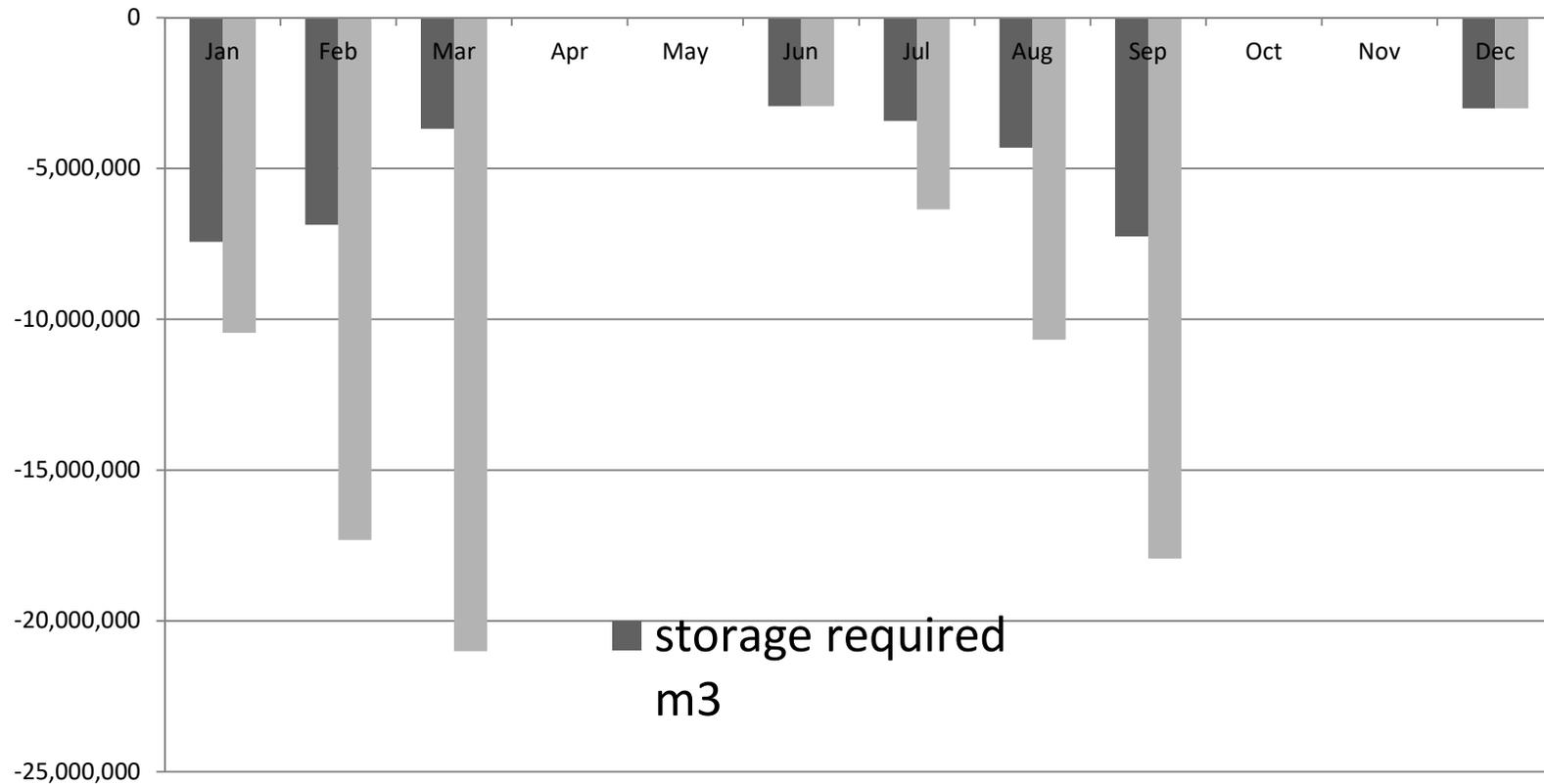


Percentage Exceedance(%)	10	20	30	40	50	60	70	80	90	95	100
Flow (m <sup>3</sup> /Sec)	9.6	5.5	3.8	2.8	2.3	1.9	1.5	1.26	0.94	0.69	0.021

# Monthly Irrigation Requirement and available flow

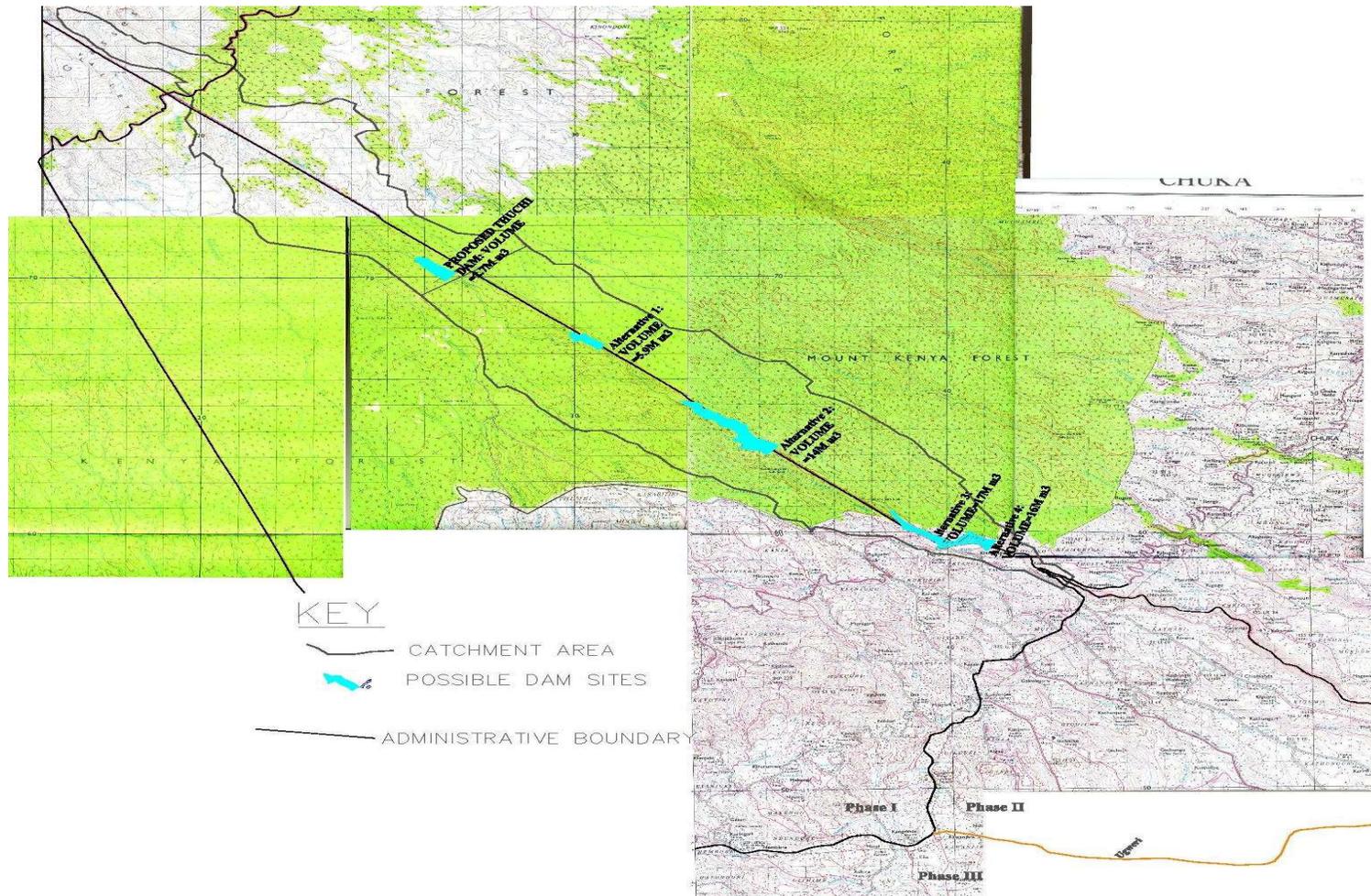


# Storage requirements



# POSSIBLE DAM STORAGE AND LOCATION

FROM PRELIMINARY SURVEY AND SATELLITE IMAGERIES, THE LOCATIONS SHOWN THE MAP WERE ESTABLISHED TO HAVE SOME CAPACITY FOR DAMS.



# Potential dam sites

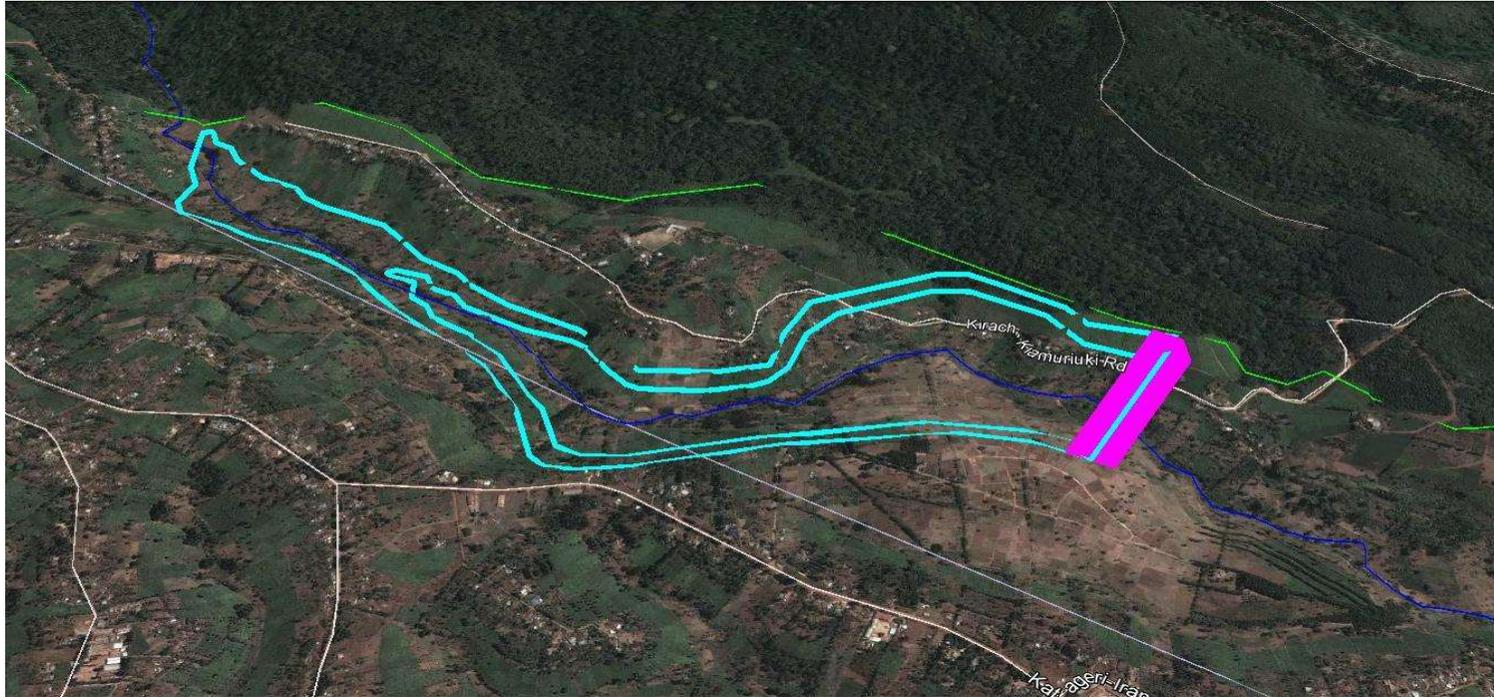
**Alternative 2. : Approx. 4.0 Km into the Forest Mt. Kenya Forest**



**Alternative 3: dam outside forest, impounded water partly into the Mt. Kenya forest area**



## Alternative 4 : dam outside forest, impounded water in inhabited area



The following were the basis of determining the storage requirement.

1. To service all demands in a drought of 1 in 5 years.
2. Allow usage or storage only when 80% exceedence is surpassed

# ENVIRONMENT AND SOCIAL CONSIDERATIONS

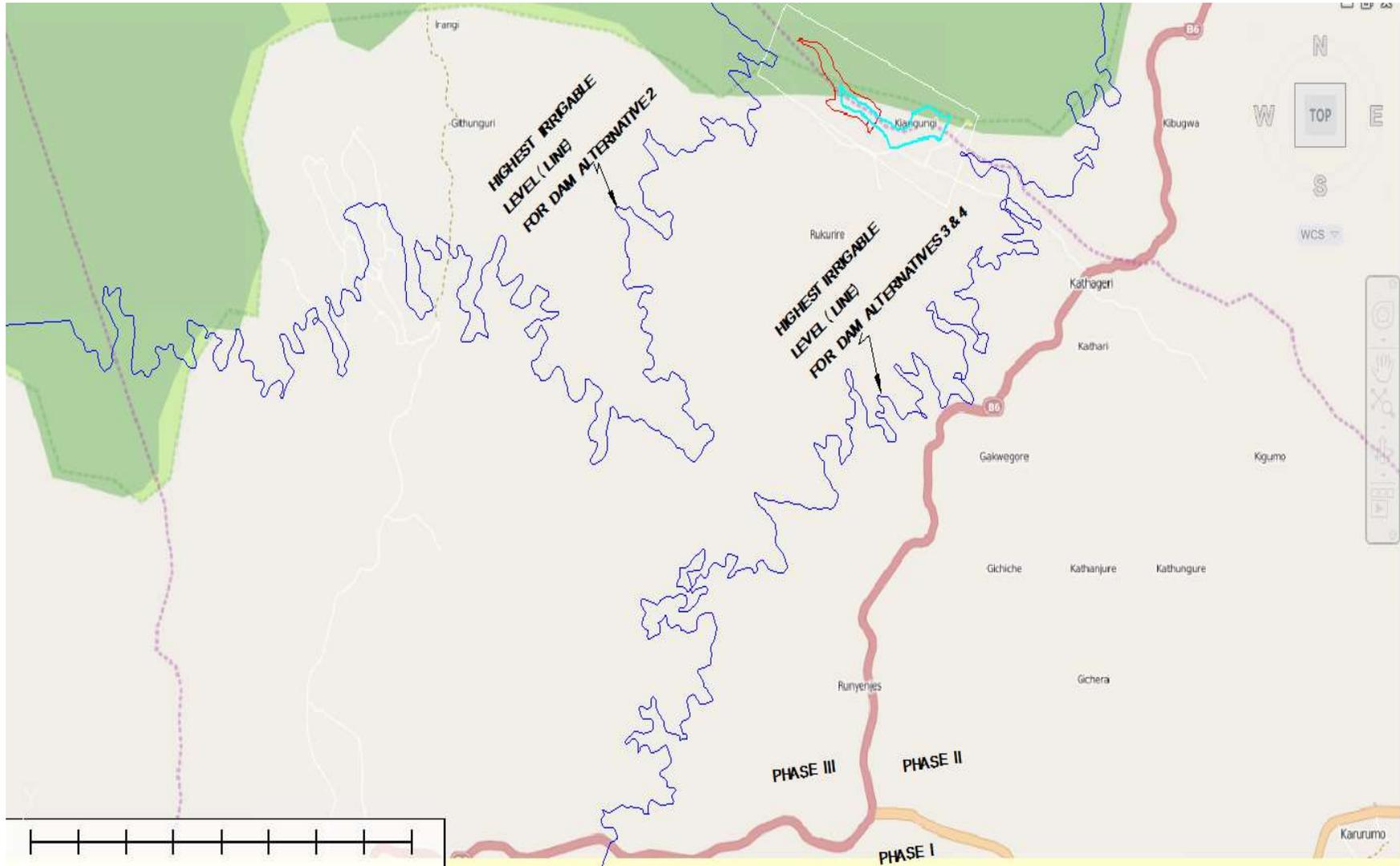
**Environmental Impact** Is a big Concern particularly for dam site displacing gazetted /protected natural forest. This shall take about 100ha.

## Socio-Economic impacts

For the dam sites outside the forest areas social displacement shall be of big concern Below is Summary estimates of the expected displacements.

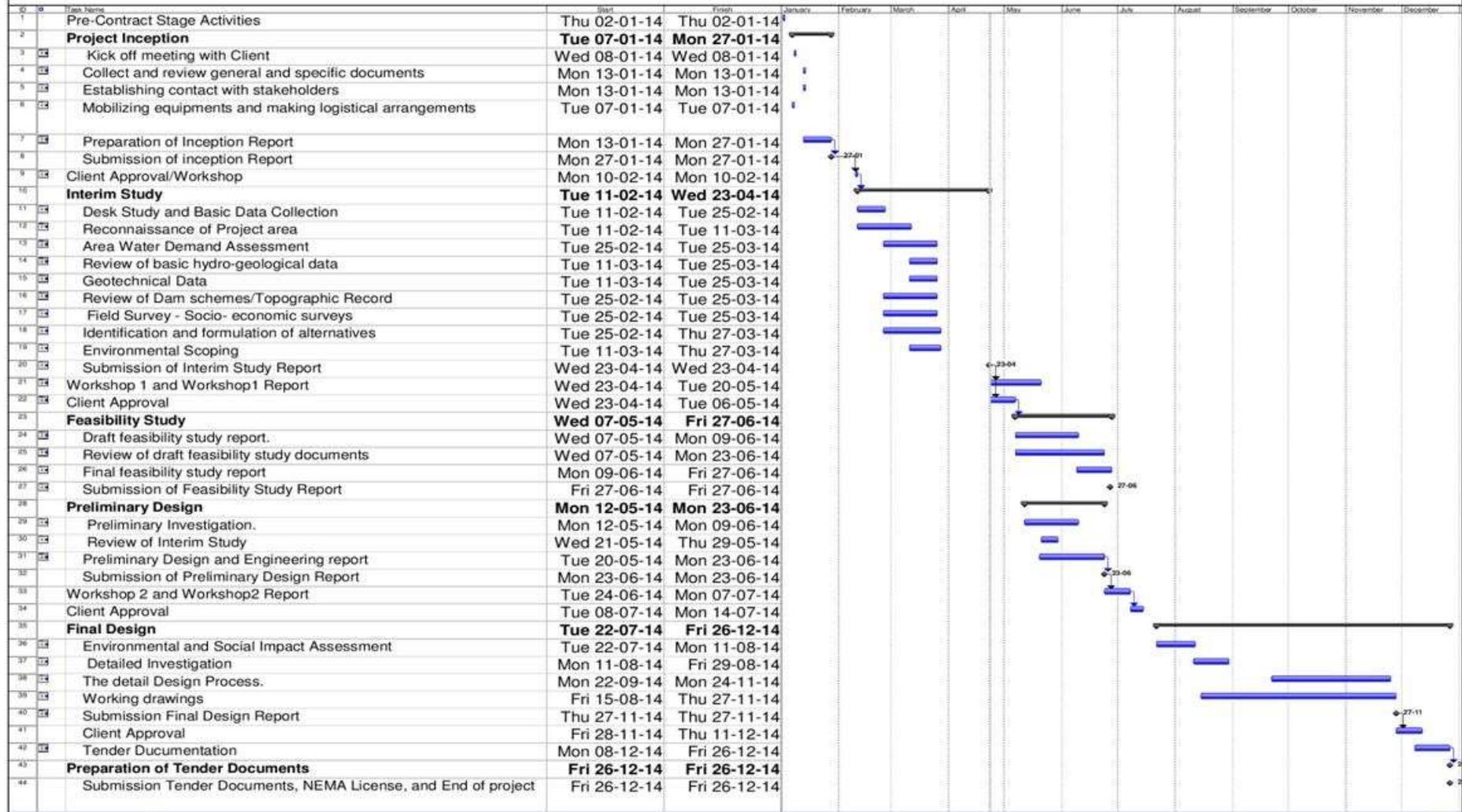
	Upper site	Lower site
Homesteads(No.)	57	53
Area under tea(Ha)	33.7	39.1
Area under other crops(ha)	23.4	51.0
Mt.Kenya Forest Area(ha)	30.1	none

# POSSIBLE IRRIGATION AREAS



# WORK PLAN

## FEASIBILITY STUDY, DETAILED DESIGN AND PREPARATION OF TENDER DOCUMENTS FOR THUCHI DAM: ACTIVITY SCHEDULE



**PRESENTED BY:**

**KIRI CONSULT LTD.**

*Thank You for your time*

## 2.6 APPENDIX 6: KIRI CONSULT LTD SOCIOLOGIST'S PRESENTATION

# **FEASIBILITY STUDY, DETAILED DESIGN AND PREPARATION OF TENDER DOCUMENTS FOR THUCHI DAM, EMBU COUNTY**

**Contract No. NIB/T/015/2013-2014**

## **STAKEHOLDERS PARTICIPATION**

**BY SOCIOLOGIST**

# OWNERSHIP

Kagaari Gaturi water project is at an advance stage of completion and some people are already benefiting however, the water shall not be enough and more people may not benefit without the dam.

Hence they(kagaari Gaturi) owners must see the dam project proceed Water resources management Authority shall also benefit greatly from the revenue expected from supply of water and downstream flow stabilisation.

Hence they also must own the dam project.

Each an every member of this community shall benefit from either employment, reduced and or steady suply of food and industrial material.

Hence all of us must own and support the project

# Stakeholders contribution

Since all of us are owners of this project we request the following:

- Allow access to our consultant to the sites while carrying out survey and investigation.
- Give the consultant information regarding agriculture production and expectation.
- Participate fully in future workshop and give your honest opinion without fear or favour and at the same time respect other peoples opinion.
- Be willing to accommodate other peoples opinion in order that we can reach a concesors.

## 2.7 APPENDIX 7: KIRI CONSULT LTD TEAM LEADER'S 2<sup>ND</sup> PRESENTATION

# **FEASIBILITY STUDY, DETAILED DESIGN AND PREPARATION OF TENDER DOCUMENTS FOR THUCHI DAM, EMBU COUNTY**

**Contract No. NIB/T/015/2013-2014**

**WORK PLAN IN 2<sup>ND</sup> STAGE**

**BY TEAM LEADER**

## WORK PLAN IN 2<sup>ND</sup> STAGE

The second stage of this project is to evaluate the identified possible dam sites in a two pronged study that shall include.

- Preliminary design
- Feasibility study

# PRELIMINARY STUDY

This shall involve the following: for each dam possible dam site

- Confirm the location of the possible dam sites on the ground.
- Carry out preliminary survey to confirm levels and dimensions.
- Carry out geotechnical investigation by Vertical Electrical Sounding and
- Carry out investigation of possible borrow sites by excavation of trial holes and correcting samples for testing.

# ***Feasibility study***

Feasibility study shall involve the following:

- Carrying out a study of the current agricultural production without irrigation.
- Establish the social economic infrastructure in the beneficially area.
- Establish the willingness to accommodate the project and cost of doing so.
- Establish the benefits that shall gained by building the dam.

## Output/Product

From analysis of all cost and benefits we shall be able to rank the dams in order of their effectiveness.

With this data we shall call for a workshop where all of us shall agree on the best dam that can be constructed for adoption.

## 2.8 APPENDIX 8: WORKSHOP PHOTOS



*Figure 1: Participants introducing themselves*



*Figure 2: Presentation and discussions underway*



*Figure 3: Presentation and discussions underway*



*Figure 4: Workshop underway, afternoon session*

**ANNEX 1B**

**PUBLIC CONSULTATIONS**

**REPORT**

**(WORKSHOP 2)**



# FEASIBILITY STUDY, DETAILED DESIGN AND PREPARATION OF TENDER DOCUMENTS FOR THUCHI DAM, EMBU COUNTY

**Contract No. NIB/T/015/2013-2014**



## STAKEHOLDERS' WORKSHOP No.2 REPORT

NOVEMBER 2014



NATIONAL IRRIGATION BOARD  
P.O.BOX 30372-00100  
NAIROBI



KIRI CONSULT LIMITED  
P. O. BOX 4125 - 00506  
NAIROBI

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## **PREAMBLE**

The National Irrigation Board has appointed Kiri Consult Limited to carry out a feasibility study, detailed investigations and Engineering design for the development of Thuchi dam on River Thuchi. This also includes a study of River Thuchi Water Resources, review of Kagaari Kyeni Gaturi Irrigation project and related subjects.

The consultancy services Term of Reference among other things required Kiri Consult Limited in collaboration with the National Irrigation Board to organise four consultative workshops for stakeholders during the course of the assignment and the following two have been conducted so far:

- The first workshop during interim study stage to inform the stakeholder of the project its requirement and their involvement
- The second workshop to inform the stakeholders the findings, record and incorporated their opinions in the final design report.

This is the second workshop, which was to inform the stakeholders of the progress of the project its findings and to collect and collate their comments and opinions on the project for incorporation.

The target group was opinion leaders that included: County Governor's officers, County Commissioner's officers, Water Resources Management Authority officers, Mount Kenya Forest service's officers, and Wildlife Service officers, National Environmental Management Authority officers, County Assembly members, Kagaari Kyeni Gaturi farmers executives and None Governmental organisation Officers involved in water and forest conservation.

The workshop was held on 28<sup>th</sup> November 2014 and was divided into five sessions namely: arrival and registration of participants, opening session involving Governor and Member of Parliament, presentations by National Irrigation Board and the Consultant and open discussion and comments by participants and finally the closing session.

The workshop was attended by more than 100 people who include all the target groups. The participants actively contributed to the proceedings as evident from the contributions in the attached proceedings.

It was noted that the participants supported the project. Based on the three dam site tabled by the consultant, the about 75% participants choose dam site 1 that is inside Mt Kenya forest, their reason was that there will be no relocation and compensation of the affected people around the other two remaining dam sites.

## LIST OF ABBREVIATIONS

NIB:	National Irrigation Board
HE:	His Excellency
CEM:	County Executive Member
DIO:	District Irrigation Officer
CIO:	County Irrigation Officer
D.C.C:	Deputy County Commissioner
C.D.F:	Constituency Development Fund
WRMA:	Water Resource Management Authority
NEMA:	National Environment Management Authority
KFS:	Kenya Forest Service
KWS:	Kenya Wildlife Service
M.C.A:	Member of County Assemblies
MP:	Member of Parliament
A.C.C:	Assistant Catchment Conservancy
V.C/M:	Vice Chairman
NGOs:	Non-Governmental Organisations
Q:	Question by a participant
A:	Response to a query raised by a participant
C:	Comments by a participant

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# 1. REPORT FOR THE WORKSHOP HELD ON 28<sup>TH</sup> NOVEMBER 2014 AT ST MARYS WOMEN TRAINING CENTRE, KYENI

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## 1.1 Overview of the irrigation sub-sector in the country

The Republic of Kenya, with its predominantly rural population, relies heavily on the agricultural sector for achieving a steady economic growth for its people. The sector accounts for 24% of the GDP, over 65% of total Kenya exports, provides 18% of formal employment and more than 70% of informal employment in the rural areas. Over 60% of the national income is also from this sector. During the past several years, the sector has consistently registered the highest contribution to economic growth when compared to other sectors and is expected to continue carrying the burden of ensuring sustainable economic growth in the country for the foreseeable future. This role is demonstrated by the corresponding growth of the Gross Domestic Product (GDP) which has been on a growth path since 2002. The GDP was 5.8% in 2005, 6.1 % in 2006, 7% in 2007 and 5.6% in 2010 (*Source: 2011 Economic Survey Report*). Further, it has been established that there is a strong correlation between growth in the agricultural sector and that in GDP.

The Government of Kenya's policy documents identify over-reliance on rain-fed agriculture as one of the contributors to frequent food shortages and insecurity in the country. Therefore, in order to overcome food shortage and achieve food security, the Government intends to increase funding on irrigation related development activities so as to carry out the following:

- a) Rehabilitate and extend existing large and small scale irrigation projects,
- b) Develop new irrigation projects through optimum utilization of available resources,
- c) Develop water storage facilities so as to harness rain water thereby reducing negative impacts related to floods and conserve runoff.

This commitment has been accentuated in the country's annual development target of 32,000 ha of irrigation per annum up to the year 2030. This is the long term development agenda of the Government of Kenya as espoused in the Vision 2030.

## 1.2 Background

Thuchi Dam is being developed by National Irrigation Board (NIB) as part of Kagaari Kyeni Gaturi Irrigation Project. The project has more than 12,000 farmers and covers a gross area of about 6,600 ha. It falls under the following Wards of Runyenjes/Kyeni Divisions in Embu Sub-County of Embu County.

1. Kagaari South
2. Kagaari Central
3. Gaturi North
4. Kagaari North and
5. Kyeni

. The project has been classified into the following phases:

1. Phase I: Consists of 1,248 acres (already completed)
2. Phase II: Consists of 5,500 acres
3. Phase III: Consists of 6,750 acres

Phase 1 of the irrigation project covering the initial 1,248 acres with 1,921 farmers (each with 0.65 acres) benefiting directly has been completed at cost of Ksh 629 million. The works comprises the following components:

- i. Construction and commissioning of a conveyance pipeline
- ii. Construction and commissioning of mainline pipeline
- iii. Construction and commissioning of sub main pipelines
- iv. Construction and commissioning of distribution system pipelines
- v. Construction and commissioning of infield sprinkler system

From hydrological study the water flow in River Thuchi can hardly sustain irrigation during the dry season and hence the need for a dam.

The proposed Thuchi Dam will conserve water during the river's flood flow and release it for irrigation purposes during the dry months of the year. It will also provide for other demands that the wider community may require after the dam is constructed.

It is also noted that the dam has a potential of also providing the following benefits to the wider community:

1. Domestic Water supply
2. Hydropower
3. Tourism
4. Water related sporting

It is estimated that 23 million cubic metres of water shall suffice to irrigate the 6,600 ha of irrigated land in Kagaari Kyeni Gatari Irrigation project area.

### **1.3 Expected Benefits**

Among other benefits, the community will draw the following benefits from the project:

1. Food security
2. Creation of employment
3. Improving the living standards
4. Source of income
5. Generation of electricity

### **1.4 Objective of the Engineering Service**

The objective of the engineering assignment includes a study of Thuchi River water resources up to the lowest possible water intake for Kagaari Kyeni Gatari Irrigation Project.

Identify the possible dam locations which shall be ranked using the above consideration at feasibility study stage and the report presented to the stakeholders where their views shall be recorded, Collated and incorporated in the final feasibility study report.

A detailed design undertaken incorporating the suggestions and findings obtained during the workshop.

### **1.5 Scope of the work and duties of the consultant**

The scope of the work is listed as:

1. Feasibility study.

2. Detailed hydrological analysis for Thuchi River. This shall including effects of climate change based on National Adaptation Program Action (NAPA) on climate change.
3. Detailed topographical survey at the dam embankment, borrow area and impounding area delineating the areas as well as providing coordinated reference points to be used at construction stage.
4. Detailed geotechnical investigation.
5. Detailed design for embankment abutments draw of woks, diversion works, spillways and other appurtenant structures.
6. Environmental and social impacts assessment.
7. Financial and economic analysis.

#### **1.6 Workshop expectation**

In the workshop, the stakeholders were informed of the progress of the proposed project (study) so that from then they could be part of the project and shall make comments and suggestion on various issues that may directly or indirectly affect them. They were also briefed on the next stage of activities and requested to allow the study team to visit their community accord it assistance in the various studies and investigations.

#### **1.7 Address by the Member of Parliament, Runyenjes Constituency Representative**

Mr Kariuki on behalf of Member of Parliament Hon Cecily Mbarire gave the background of the project from its inception to the current status where phase one of the project was complete and about 2,000 families were benefiting. He requested the people to fully participate and to allow the project attain its full implementation. He mention that politics may derail the project and hence advised members to keep politics away and requested the participant to inform other project stakeholders who could not attend the workshop what transpired in the workshop.

#### **1.8 Address by the Embu County Director Water Land and Environment**

The Chief Officer, Water Land and Irrigation in the Embu County informed the participants that the Governor was committed on other projects of equal importance and that he was representing him. He envisaged various benefits that will be realised from the project after its implementation and requested the stakeholders to fully participate in developing it.

He mentioned the challenge that was there with the Kagaari Kyeni Gaturi Irrigation project, where WRMA had limited the amount of water that could be for abstracting from Thuchi River, hence leading to low volume of water being abstracted.

He wound up by requesting for active participation in the workshop and all the activities involving the project for the success of the project and declared the workshop opened.

#### **1.9 Remarks by National Irrigation Board's Representative**

In line with its mandate to develop, promote and manage all national irrigation schemes in the country, National Irrigation Board representative expressed their intention to design and develop the proposed Thuchi Dam on River Thuchi to conserve water during the rains and release it for irrigation purposes during the dry months of the year. The dam was to support 6600 ha of irrigated land in Kagaari Kyeni Gaturi Irrigation project area.

He informed the workshop that Kiri Consult had been engaged by the Board to conduct studies and designs the Thuchi dam and requested for active participation in the workshop and all other activities on the project as required. He wound up by listing the various benefits of developing the project including the follows:

- Food security
- Creation of employment
- Improving the living standards
- Source of income

He requested the community to fully participate and to offer the necessary support and assistance as requested to see that the project is successful.

#### **1.10 Presentation by Kiri Consult Ltd**

The Project Engineer introduced the consultancy services and explained what they were involved in studies and designs of the dam.

He informed the workshop that the stakeholders were to be informed of the progress of the project study so that they could make their opinions and suggestions listened to, recorded, collated and incorporated in final design.

#### **1.11 Presentation 1 - Workshop 1 Review (By Project Engineer)**

The Engineer took the workshop through the project by making a brief review of workshop 1 and the deliberation agreed then:

##### **1.11.1 Introduction**

The proposed Thuchi dam on River Thuchi was to support 6600ha of irrigated land in Kagaari Kyeni Gatari Irrigation project area.

River Thuchi is at the boulder of Embu and Tharaka Nithi Counties within the Mt. Kenya forest region. It is 15km from Runyenjes Town along Embu-Meru Road. River Thuchi basin is on the eastern side of Mt. Kenya and is part of the bigger Mutonga River catchment of the River Tana catchment.

##### **1.11.2 Background**

The following are the main weather and rainfall stations

- Embu metrological station is the only station that records all weather parameters including temperatures in the region.
- Kerugoya castle station was found suitable to present the forest region.
- Irangi Forest rainfall station to represent tea growing area, the Ena leaf station coffee growing region while Karurumo was found suitable for the cotton growing area.

Below were graphical representations of long term average rainfall of these stations.

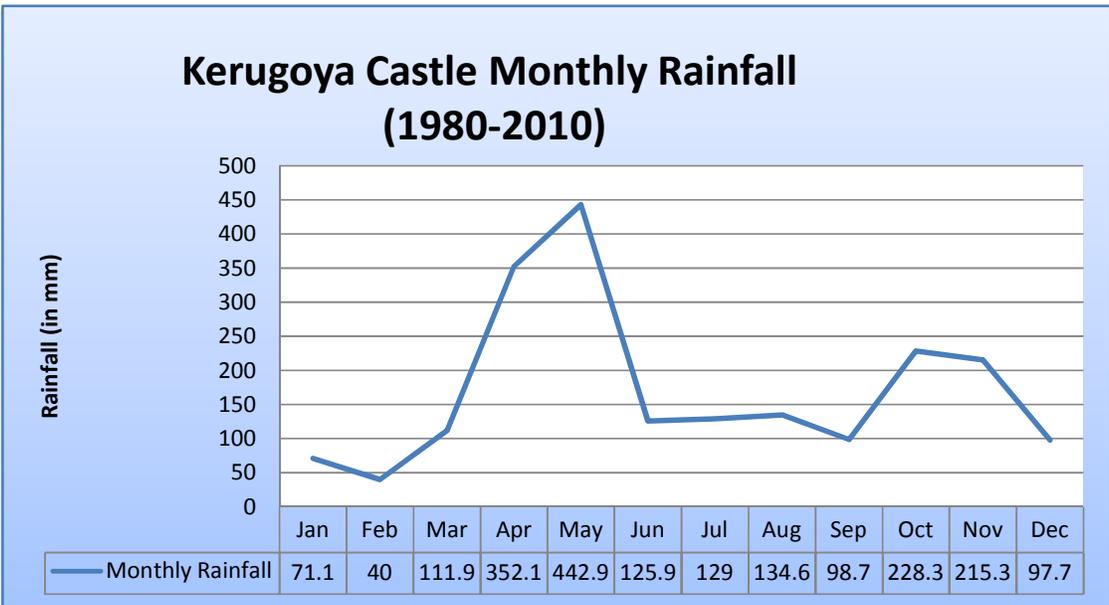


Figure 1: Kerugoya Castle long term trends of rainfall observed

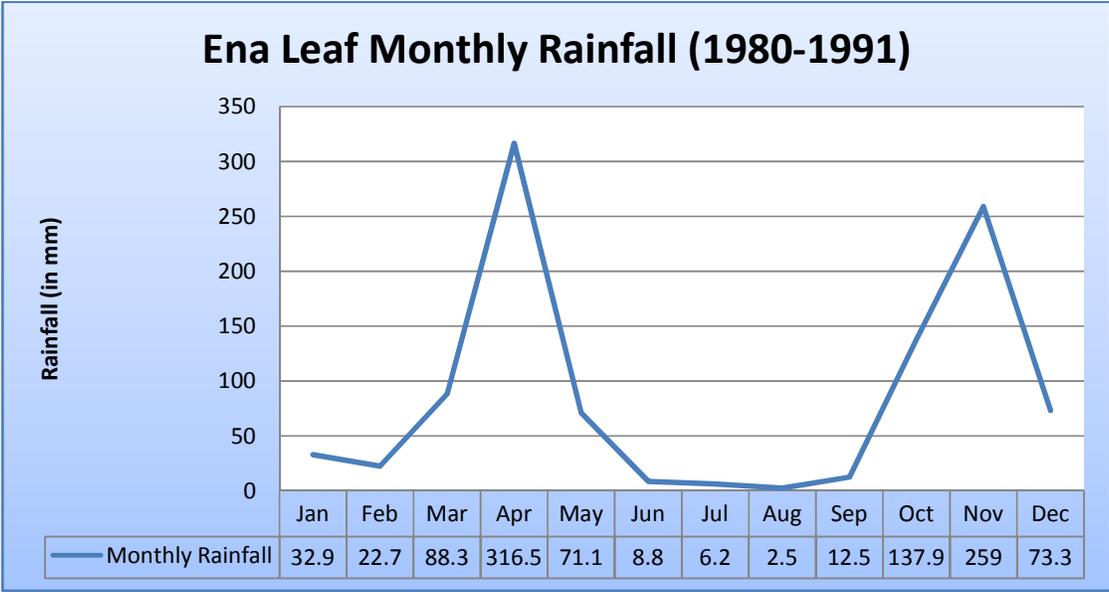


Figure 2: Ena leaf long term trends of rainfall observed

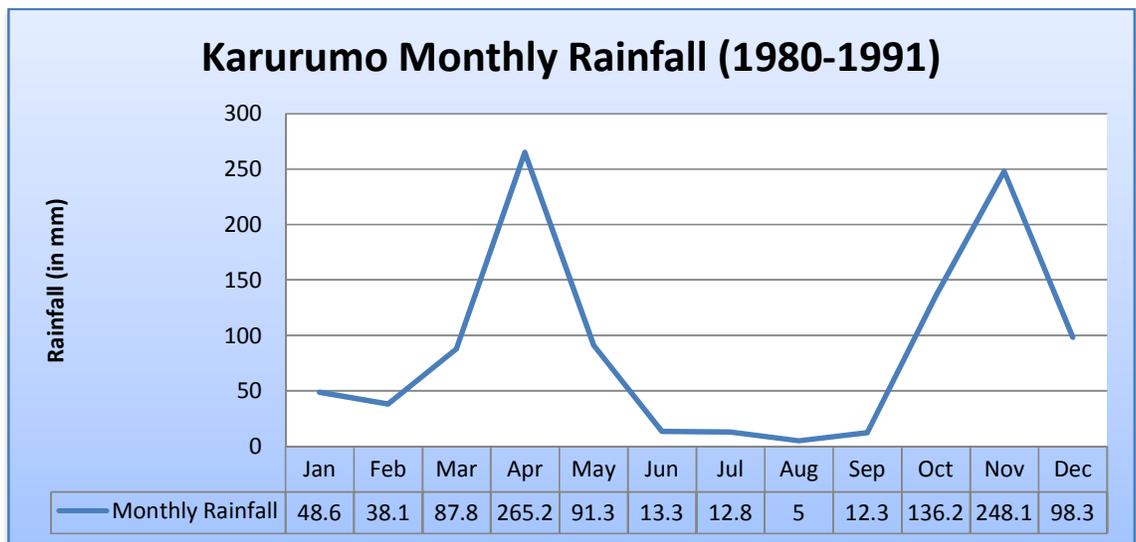


Figure 3: Karurumo long term trends of rainfall observed

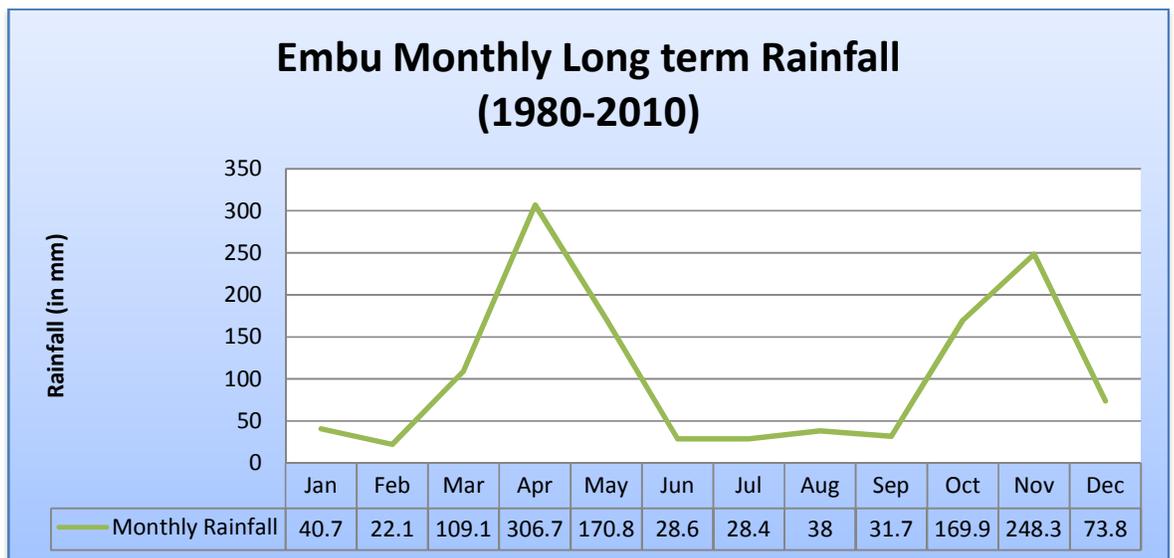


Figure 4: Embu long term trends of rainfall observed

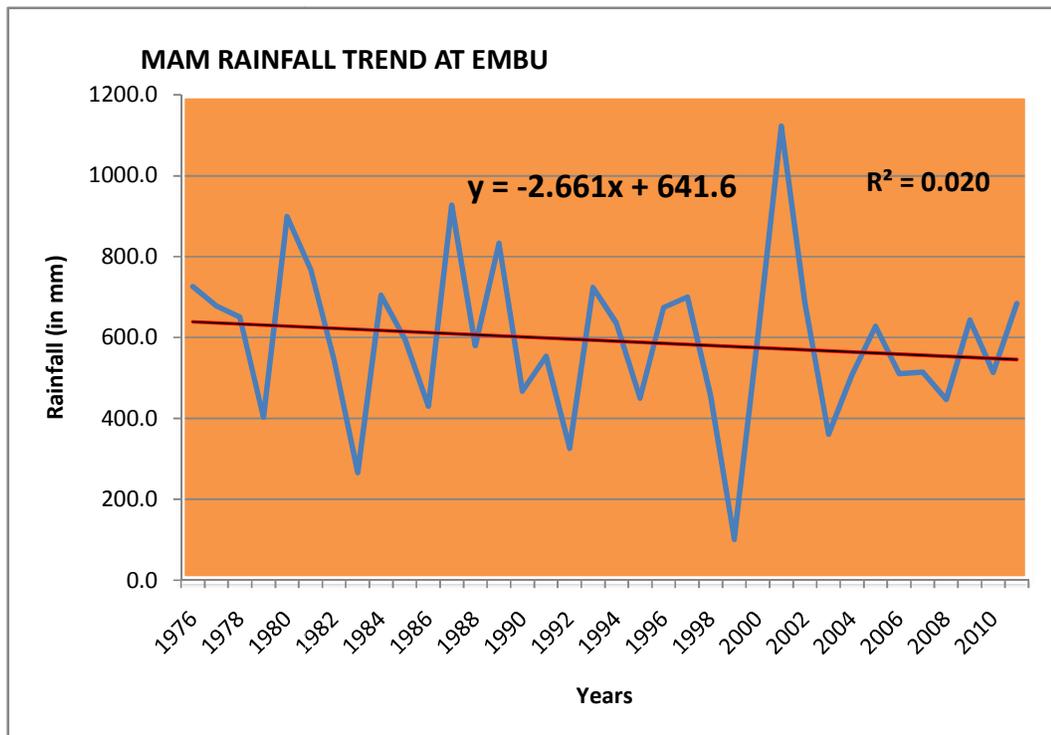


Figure 5: Embu MAM trends of rainfall

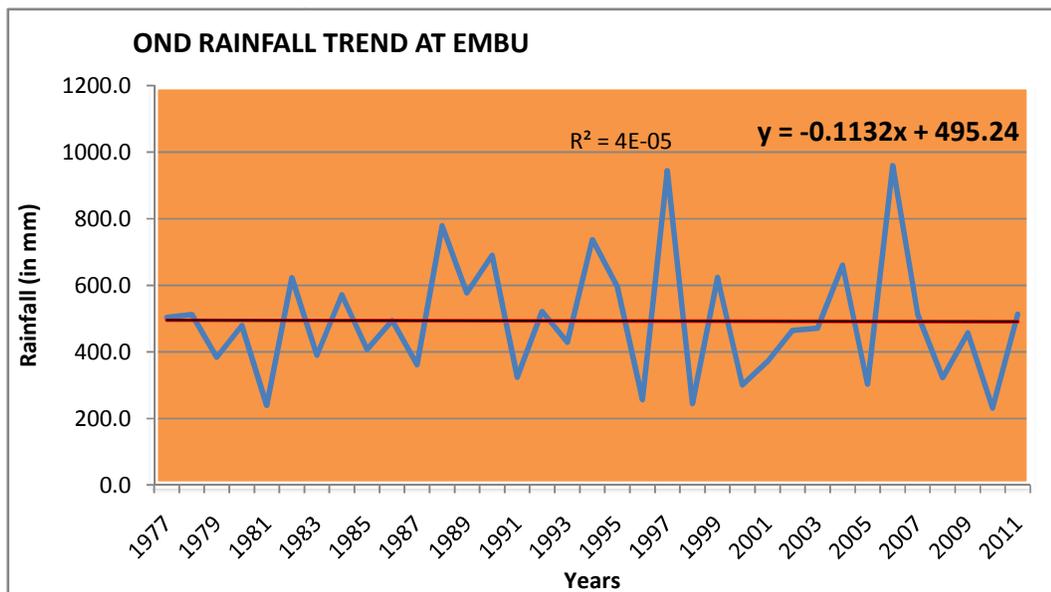


Figure 6: Embu OND trends of rainfall

These graphs shows that there is a slight decline of rainfall in March April May long rains and October November and December short rainfall and the rains starting dates were also found to be shifting.

### 1.11.3 Temperatures,

Temperatures were recorded at Embu metrological station in the region, however, comparison of rainfall trend and amounts of the following metrological stations were found to be fair representatives of tea, coffee and cotton growing areas:

- Kericho for tea growing areas
- Machakos (Katumani) for cotton growing area
- Embu represent coffee growing areas

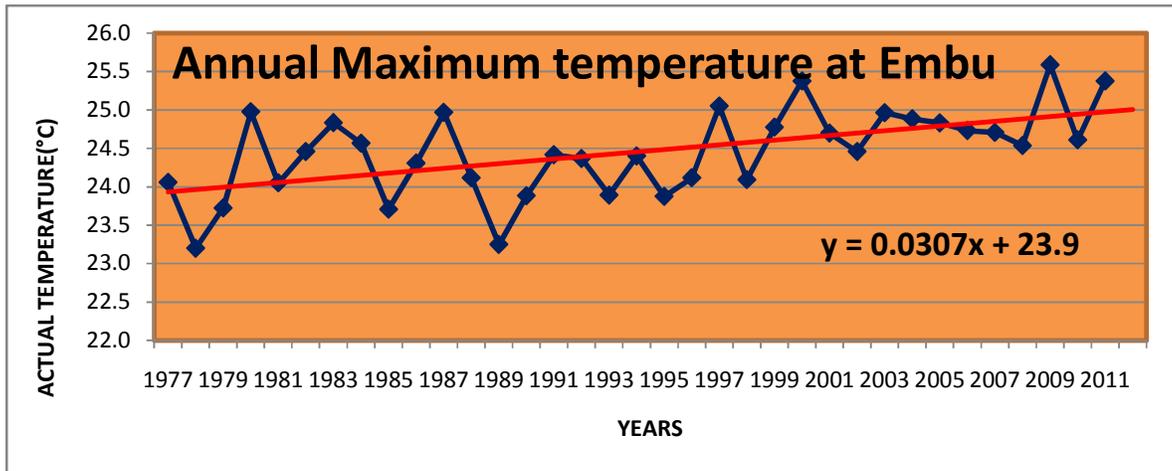


Figure 7: Maximum temperatures for Embu Coffee growing areas

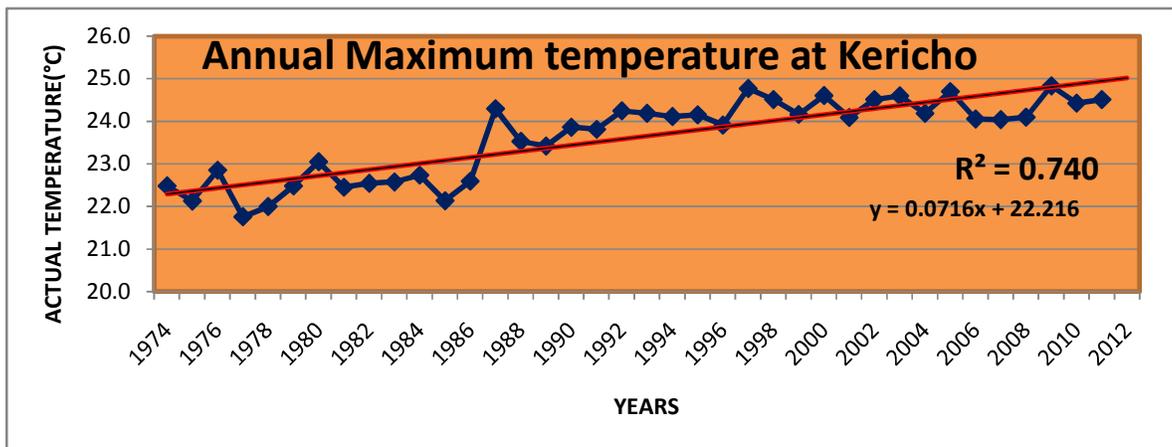


Figure 8: Maximum temperatures for Kericho tea growing areas

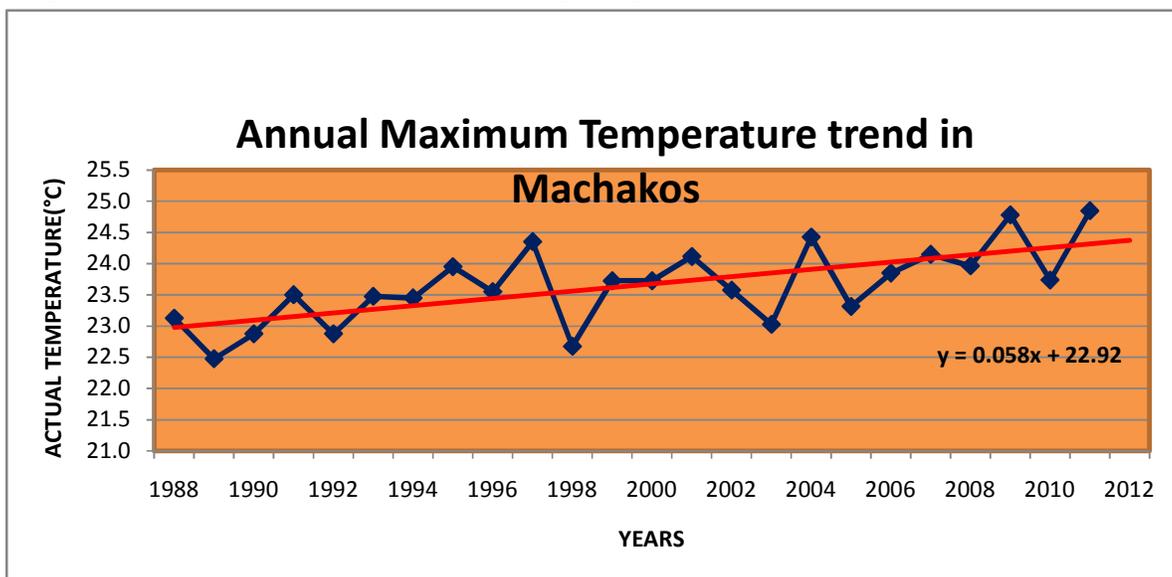
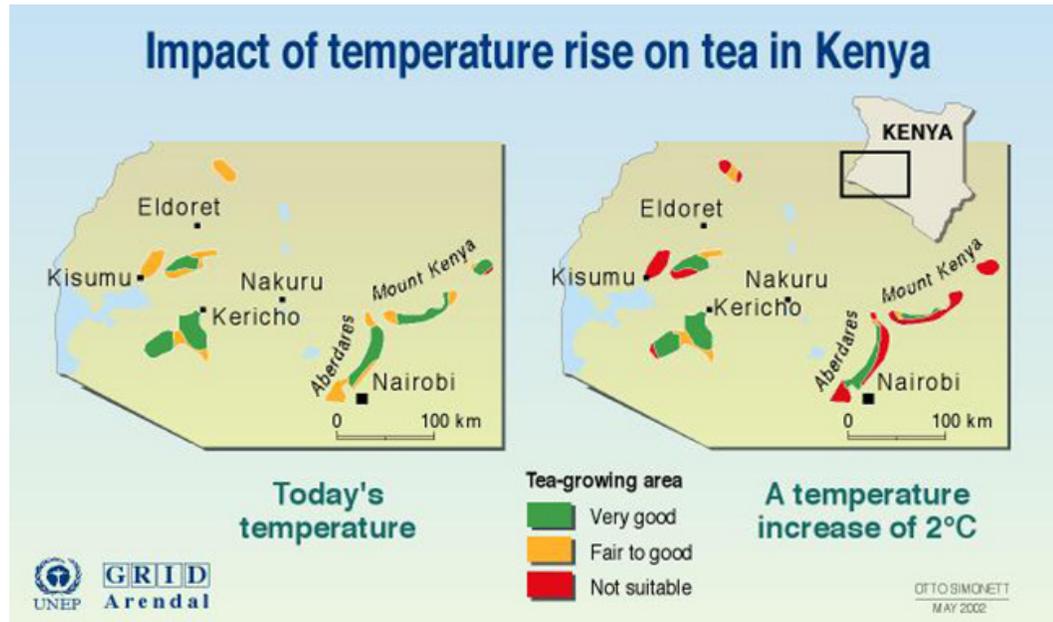


Figure 9: Maximum temperatures for Machakos (Katumani) Cotton growing area

From these long term observation it is clear that in this region the following will happen:

- Rainfall was expected to fall slightly by an average of about 30mm every year,
- Temperatures were expected to rise by 1-1.5degrees in 20 years and 2-3 in 50 years.
- Agricultural potential shall change from what it is today in less than 20 years.

Below is a graphical comparison of tea growing potential in Kenya today and in feature (50yrs) as predicted by Otto Simonett.



Source: Otto Simonett, *Potential impacts of global warming*, GRID-Geneva, case studies on climate change. Geneva, 1989.

Figure 10: Impact of temperature rise on tea in Kenya

From the foregoing, it was clear that climate change/global warming was a reality we have to embrace and plan to live with.

Irrigation was one of the ways proposed for developing resilience in our food production and the proposed Thuchi dam was part of this development proposed by the government and the stakeholders were requested to support it.

#### 1.11.4 Scope of services

The following is the main scope of the service:

- Interim study
- Feasibility study
- Detailed hydrological analysis for River Thuchi
- Detailed topographical survey
- Detailed Geotechnical Investigation
- Detailed design for embankment abutments draw off works, diversion works and spillways, diversions and draw down towers
- Tender documents of the dam
- Environmental and Social Impacts Assessment

### **1.11.5 Planned Activities**

At workshop 1 held in July 2014 the following were the deliberations:

1. Preliminary design that involved the following for each dam possible dam site:
  - Confirmation the location of the possible dam sites on the ground.
  - Carrying out preliminary survey to confirm levels and dimensions.
  - Carrying out geotechnical investigation by Vertical Electrical Sounding
  - Carrying out investigation of possible borrow sites by excavation of trial pits and correcting samples for testing.
2. Feasibility study that involved the following:
  - Establishing the social economic infrastructure in the beneficially area.
  - Establishing the willingness to accommodate the project and cost of doing so.
  - Establishing the benefits that shall be gained by building the dam.

### **1.11.6 Output**

From analysis of all cost and benefits the dams were ranked in order of their effectiveness. In that workshop it was to be agreed on the best dam location to be adopted.

## **1.12 2<sup>nd</sup> Presentation by the team Leader - Progress of the project**

The team leader/dam expert took the workshop through the various activities that had been done since the inception of the project. The following were the extracts:

### **1.12.1 Background**

Kagaari Kyeni Gatari Irrigation Project was 6,600 ha irrigation project that phase 1 was already in place and the other two phases in progress.

Thuchi River that emanated from Mt. Kenya forest was the sources of irrigation water. At the project inception it was noted that the river did not have adequate water flow to sustain irrigation throughout the year and hence construction of a dam was recommended.

The current assignment (project) is to determine the following:

- Location of the dam
- Size
- Material to be used
- Environmental impact
- Social Impact

During the first workshop, the project was introduced and outlined the method and considerations to be undertaken in the study process and develop a feasible, cost effective and efficient dam and associated works.

## Thuchi Dam Benefits

The main benefit is provision of water for irrigation purposes and the other inbuilt benefits are as follows:

- Supply of domestic water
- Generate electricity
- Stabilize river flow hence reducing downstream flooding/low flows
- Create employment

During interim feasibility study, 3 dam sites with a possibility of storing sufficient water (23 million cubic metres) were identified. Studies were conducted on the 3 sites to ascertain their feasibility for dam construction.

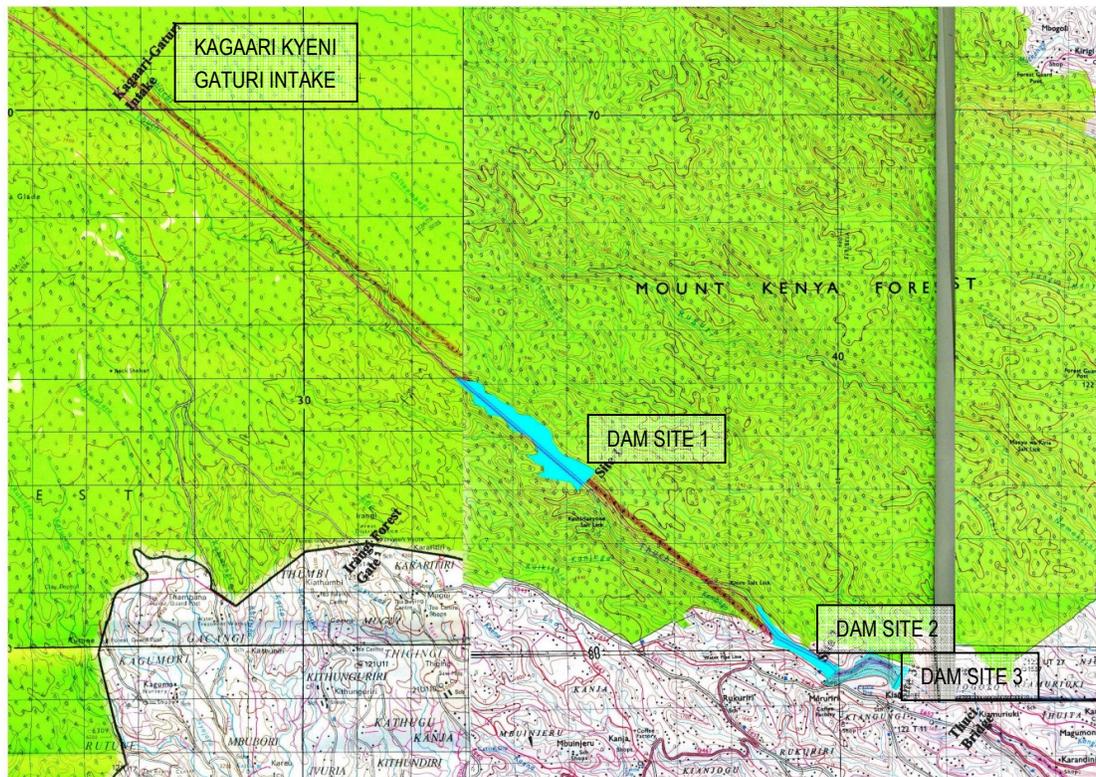


Figure 11: Proposed dam sites

All the 3 dam sites were located downstream of the Kagaari Kyeni Gaturi Irrigation water intake.

Dam site 1 was fully in Mt. Kenya forest, dam site 2 and 3 are within human settlement area with a bit of their reservoirs extending into the forest area.

Dam site 1 was located inside Mount Kenya forest and could only irrigate about 50% of the lower region of phase III and the whole of phase I and II. The other two sites were located off the forest and could only irrigate phase I and II.

It's proposed that the non-irrigable upper area of phase III be supplied with irrigation water from the existing intake and downstream compensation be done by the dam.

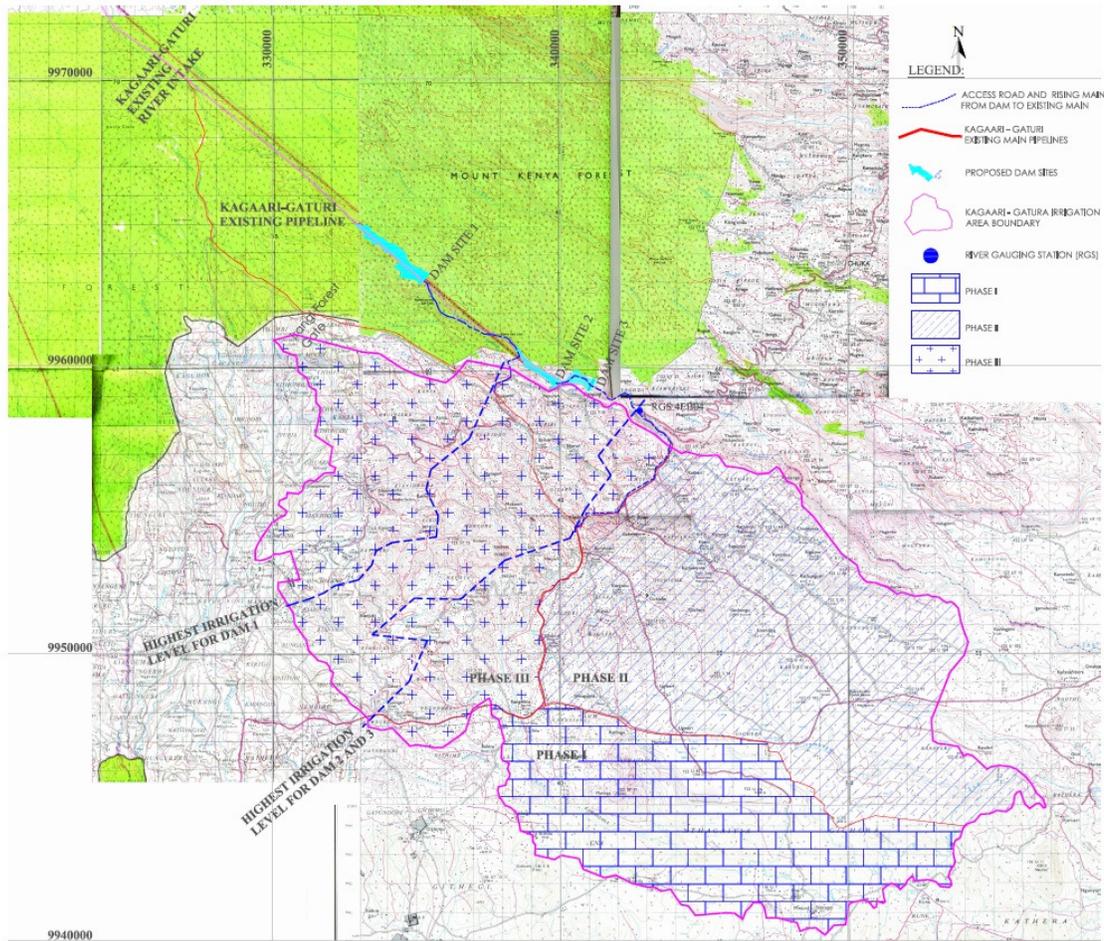


Figure 12: Kagaari Kyeni Gatari proposed Irrigation phases.

### 1.12.2 Water Demand

Water Demand was estimate for both domestic and irrigation requirement.

Taking Thuchi dam design year as 2015 with life expectancy of 50 years, year 2065 shall be the ultimate year, and then population in the project area is expected to be 390,267 people. Commercial and livestock water demand was estimated to be proportional to peoples' population.

- Domestic water demand was estimated to be 43,890 m<sup>3</sup>/day
- Irrigation Water Requirement: was based on a 6,600 ha scheme; adjusting for rains and supply during floods a total of 38,865,000 m<sup>3</sup>/ year of water was required to be stored to irrigate 6,600 ha of land throughout the year.
- Considering further that there were two seasons in a year an Ideal dam capacity was considered to be 23 million cubic metres.

### 1.12.3 River Hydrology

The figure below shows the characteristic of Thuchi river flow at River Gauging station RGS 4EB04 (Thuchi River bridge)

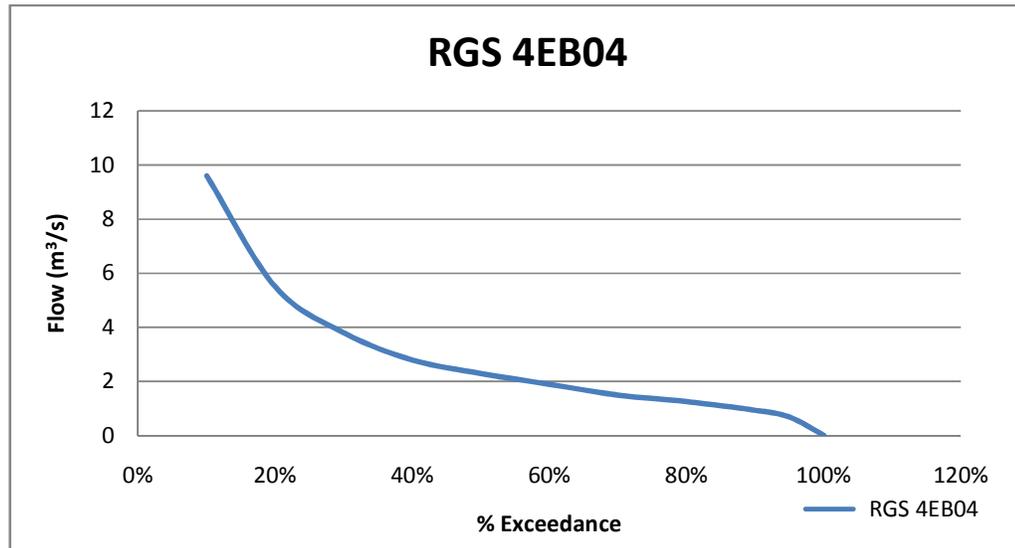


Figure 13: River gauging station 4EB04

Water Resource Management Authority -Tana River Catchment allow commercial water abstraction only when the river flow is more than 80% of the time (Exceedence).

Using this criterion the table below is a summary of the water that must be retained in the river all the time in various dam sites.

Table 1: Dependable flows from studies

Dam Alternative	Catchment Area (Km <sup>2</sup> )	80% Exceedence (m <sup>3</sup> /s)
Dam site 1 (in forest)	67.436	0.8
Dam site 2	80.7	0.9
Dam site 3	83.4	1.0

A comparison was made for the allowed Thuchi river water supply (abstraction) and Kagaari Kyeni Gaturi scheme water demand based on 1 in 5 years drought. The figure below shows this comparison.

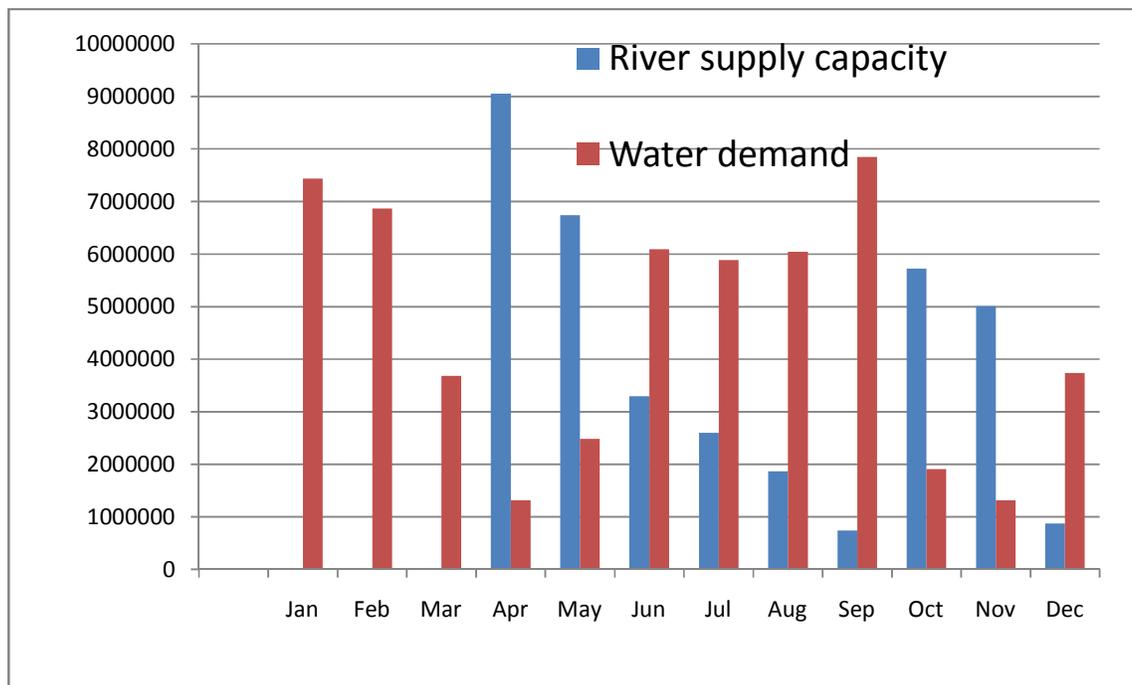


Figure 14: comparison between Thuchi river water supply (abstraction) and Kagaari Kyeni Gatari scheme water demand based on 1 in 5 year's drought.

Based on the figure above, the following issues were noted;

- There were periods of the year when demand outstrip supply and hence storage was required.
- River flow in a 1 in 5 year drought had a capacity to supply 82.5 million cubic metres.
- In a normal year the river can supply more than 300 million cubic metres while demand was 54.6 million cubic metres.
- We conclude that the river had capacity to meet demand most of the time.

#### 1.12.4 Geology

From the general study we conclude that the geology of Thuchi dam sites is composed of a thick complex of Mount Kenya volcanic rocks consisting of interbedded lavas, agglomerates and tuffs whose thickness reaches over 900 m. These rocks overlie a flat surface of the sub-Miocene Peneplain. The structural geology of the area indicates that no major faults are present and any deformational structures are only in the underlying deep seated Basement System rocks. The site is therefore on stable geological foundation.

#### 1.12.5 Geotechnical investigations

Geophysical sounding conducted along the 3 sites concluded the following

- The foundation is composed of weathered and slightly fractured volcanic rocks.
- The foundation rocks are laid in form of discontinuous blocks that are differently weathered.

- There are blocks of fresh and compact rocks, especially on the higher flanks of the river valley.
- The weathered lavas are separated by discontinuous layers of OLS deposits that are clayey in nature and sometimes have bands of sands and detritus from earlier weathering.
- No faulting was observed and foundation is stable in all the three sites
- The weathering and fracturing are not very deep except at the riverbed area which seems to be underlain by palaeo-deposits which are likely to be quite permeable.
- In comparison, the foundation conditions are better in the lowest proposed site as there the weathering seems less there than the other two sites investigated.
- Treatment by grouting will be necessary due to the weathered nature of the foundation rocks.

The figure shows a typical geophysical investigation results for dam site 2.

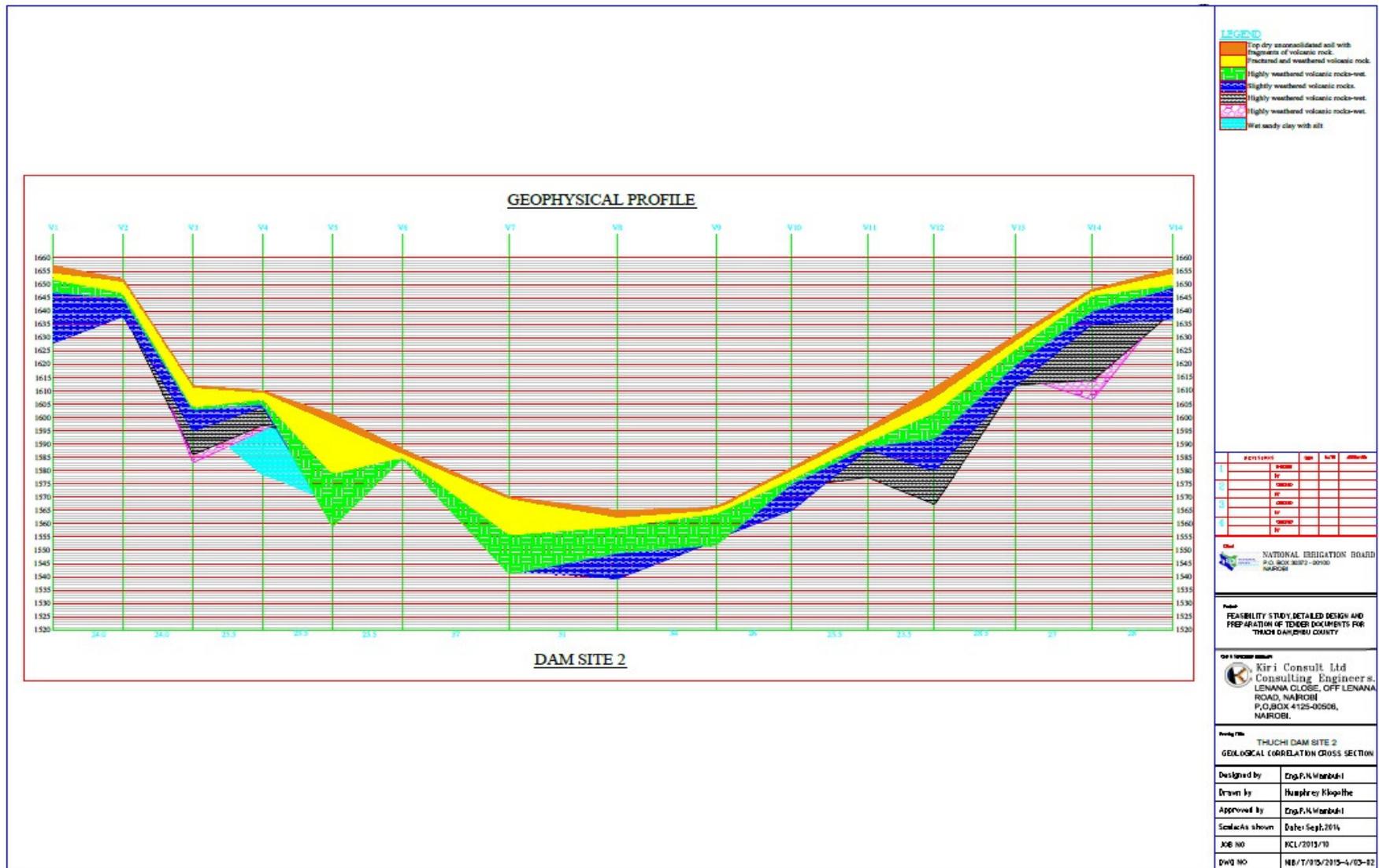


Figure 15: Typical geophysical investigation profile for dam site 2.

### 1.12.6 Material sources

Samples obtained from trial pits around the dam sites were analysed, the test results from all the 3 sites had material with dry density of about 1200 kg/m<sup>3</sup> and internal angle of friction 21 ° which is good for embankment construction.

The clay content was in the region of 12%, not suitable for dam core construction. In the next phase of the assignment clay core shall have to be searched further and different types of construction shall be investigated.

The materials for rip rap will be obtained by quarrying from the impounding area while aggregate for construction and filters will be obtained from crushing the rocks from dam reservoir area.

### 1.12.7 Environmental and social considerations

The environmental and social scoping exercise was done between 12<sup>th</sup> and 25<sup>th</sup> August 2014, Integrated Participatory Approach was used.

Both positive and negative impacts were identified.

#### Social-Economic and institutional Data

At dam sites 1 and 2, some people will be displaced to pave way for the proposed dam. The table below is a Summary of the expected displacements anticipated.

*Table 2: Summary of the expected displacements anticipated*

	Upper site	Lower site
Homesteads	57	53
Area under tea (Ha.)	33.7	39.1
Area under other crops (Ha.)	23.4	51.0
Mt. Kenya Forest Area (Ha.)	30.1	none

The following are the aerial imagery for the 3 dam sites.

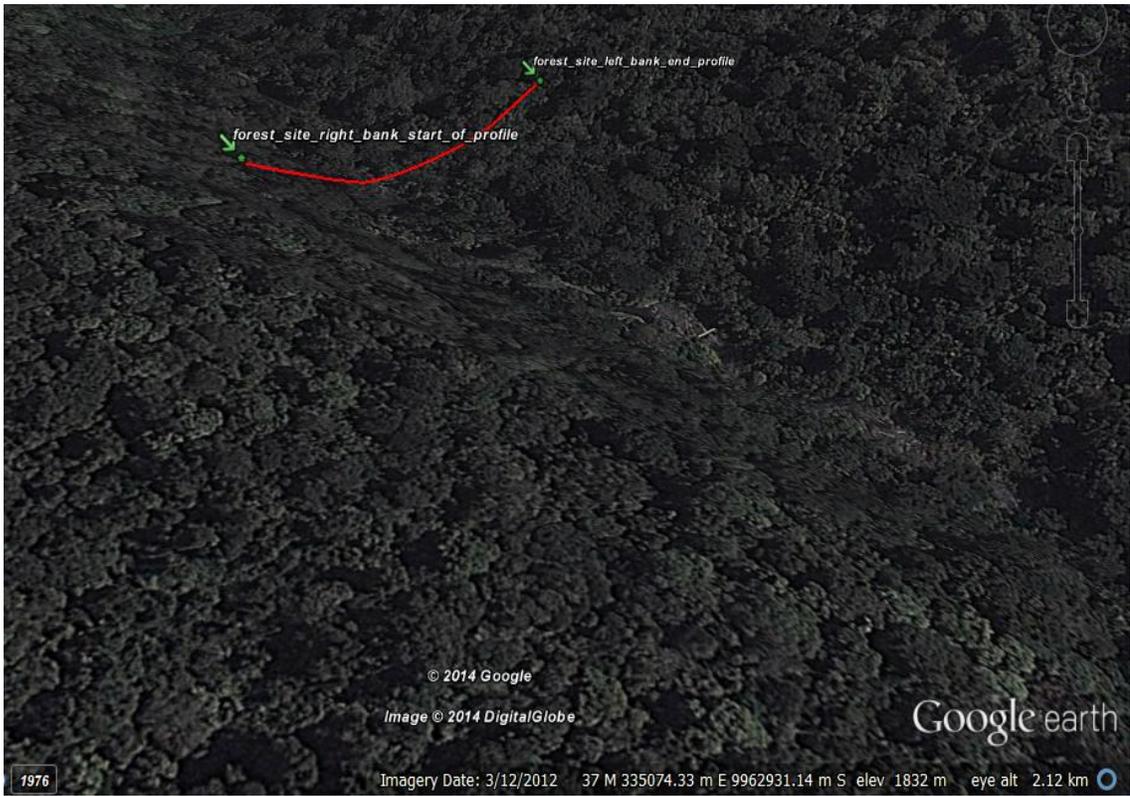


Figure 16: Dam site 1 (Inside forest)

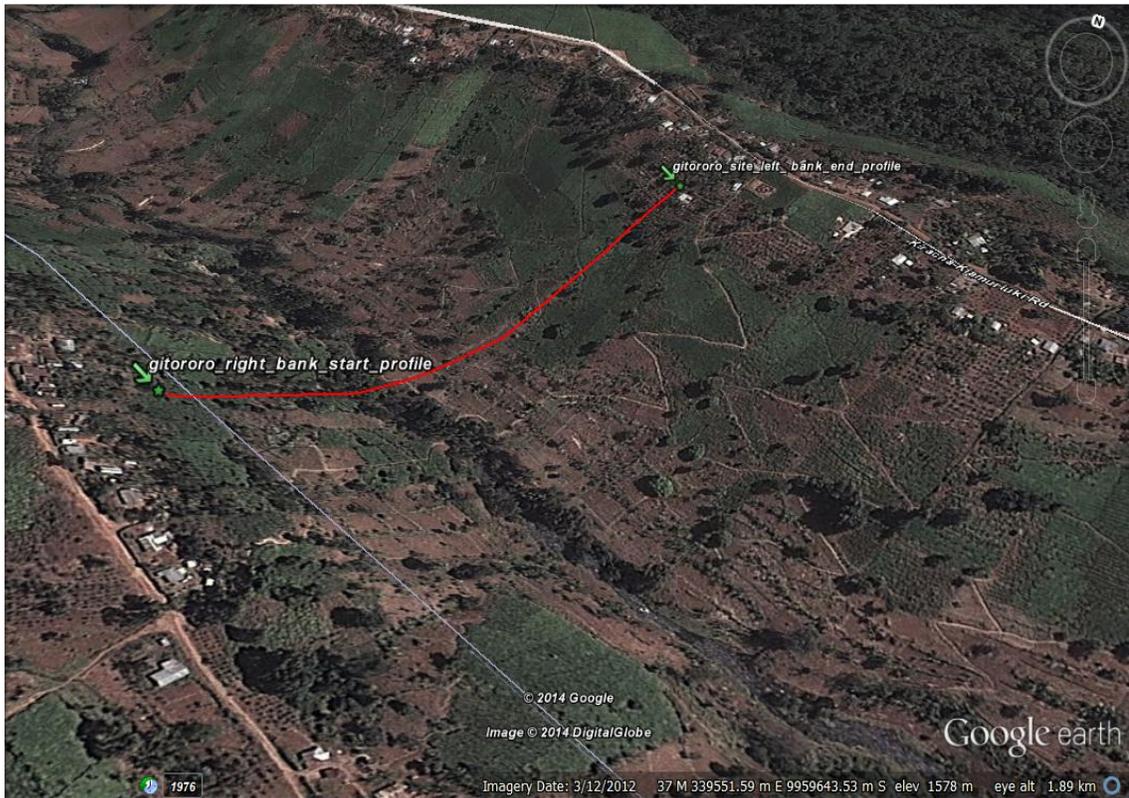


Figure 17: Dam site 2

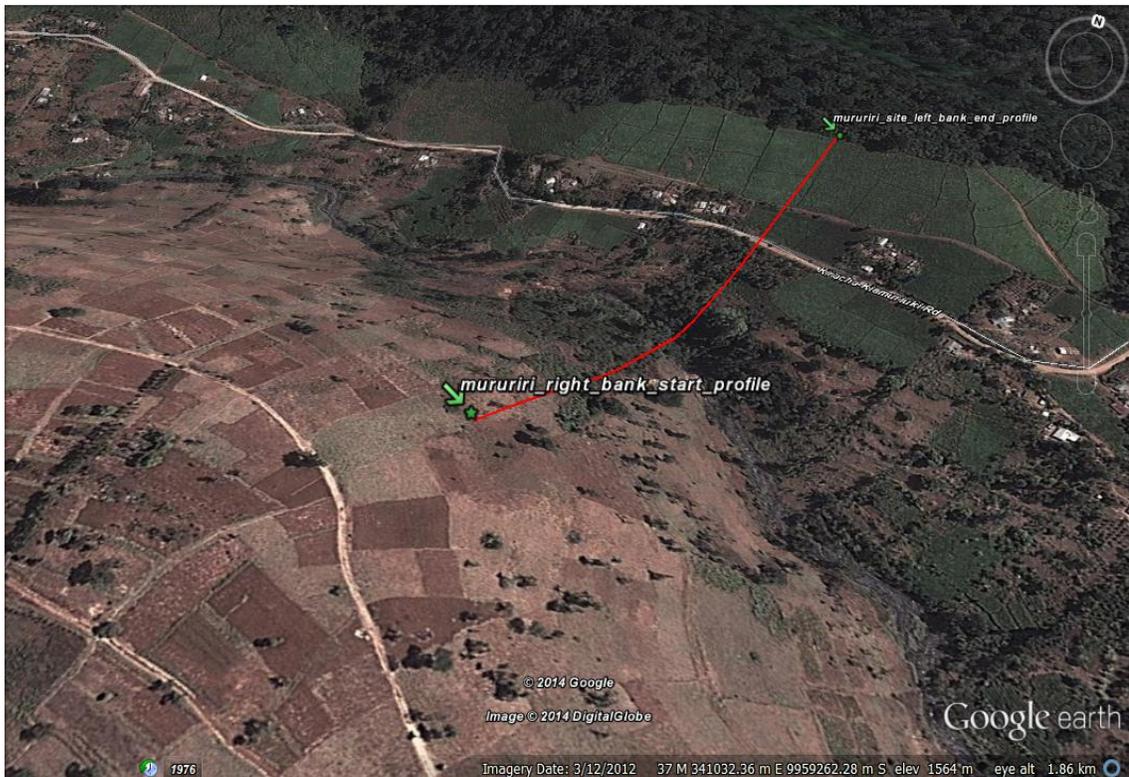


Figure 18: Dam site 3

### Environmental and social impacts

There were basically two alternatives

- Construct the dam in the forest area which has huge environmental impact.
- Construct the dam outside the forest area with huge relocation of human settlement, estimated to be about 60 families and 47 ha. of tea and other crops.

### 1.12.8 Summary of characteristics of proposed dam sites

Characteristics of the proposed 3 dam site that can provide the storage required (23 million m<sup>3</sup>)

Table 3: Characteristic of proposed dam sites

Dam alternative	Location	Dam height	Dam volume (million m <sup>3</sup> )	Area Water impoundment (Ha)	Embankment length (m)	Embankment volume (million m <sup>3</sup> )
1	Impound area within forest	77.5	23	72.5	490	4.7
2	Impound area at inhabited & partly within forest	72.5	23	74	280	2.7
3	Impound area at inhabited	95	23	115.5	480	3.6

## 1.12.9 Proposed Dam Structure and Associated Works

### 1.12.9.1 Dam Embankment

Earth fill dam with slopes ranging from 1:3 upstream and 1: 4 downstream

### 1.12.9.2 Spillway

Proposal for morning glory or side spillway

### 1.12.9.3 Diversion culvert

2 no of 4m wide and 4m high or use in diverting river flow during construction and for compensation, reservoir flushing and draw off passage for outlet pipes.

### 1.12.9.4 Cofferdam

To safeguard construction of structures from flooding during initial construction.

## 1.12.10 Estimated Cost

Table 4: Cost Estimates

Item no.	Item Description	Estimated cost in Kenya Shillings		
		Dam site 1	Dam site 2	Dam site 3
1	General Items	600,000,000	600,000,000	600,000,000
2	Geotechnical Investigations & ground treatment	400,000,000	400,000,000	400,000,000
3	Demolition and Site Clearance	170,000,000	61,000,000	73,000,000
4	Earthworks	2,800,000,000	1,400,000,000	2,300,000,000
5	Concrete Works	600,000,000	400,000,000	700,000,000
6	Pipe work & Drainage	1,500,000,000	1,360,000,000	1,400,000,000
7	Miscellaneous Works	80,000,000	54,000,000	42,000,000
	<b>SUB TOTAL</b>	<b>6,150,000,000</b>	<b>4,275,000,000</b>	<b>5,515,000,000</b>
	<b>10% Contingencies</b>	<b>615,000,000</b>	<b>427,500,000</b>	<b>551,500,000</b>
	<b>10% Price Adjustment</b>	<b>615,000,000</b>	<b>427,500,000</b>	<b>551,500,000</b>
	<b>SUB TOTAL</b>	<b>6,765,000,000</b>	<b>4,702,500,000</b>	<b>6,066,500,000</b>
	<b>Add 16% VAT</b>	<b>7,847,400,000</b>	<b>5,454,900,000</b>	<b>7,037,140,000</b>
	<b>Grand Total Billion Ksh</b>	<b>7.8474</b>	<b>5.4549</b>	<b>7.03714</b>
	<b>Other Costs</b>			
1	Land compensation	0	283,000,000	463,000,000
2	Families relocation	0	437,000,000	463,000,000
	Totals	7.85	6.17	7.96

## 1.12.11 Other Benefits

### 1.12.11.1 Hydropower potential

Main purpose for the dam is for irrigation, however there is possibility of hydro-power generation by utilizing the 35% or 50% exceedance flow, the tail water is then used for irrigation purposes.

Table 5: Summary of the three dams hydropower capacity

Dam	Generation potential (Gwh) at flow exceedence		Income based Ksh. Millions at flow exceedence	
	50%	35%	50%	35%
Dam site 1	11,265	14,420	85	107
Dam site 2	11,329	14,483	85	109
Dam site 3	13,817	17,801	104	134

### 1.12.11.2 Domestic water supply

The dam will provide domestic water for the entire communities in the irrigation scheme. This component is not part of this assignment.

## 1.12.12 Ranking matrix

Dam ranking in terms of various aspects that may determine the desirability of the project the best is ranked 1 and worst 3.

Table 6: Desirability ranking on 10 aspects of the sites

Item no.	Aspect description	Ranking			Remarks
		Dam site 1	Dam site 2	Dam site 3	
1	Topology	2	1	3	Marginally different
2	Access	3	1	2	Dam site 1 is very difficult to access
3	Geological	3	2	1	Marginally different
4	Hydrological	3	2	1	
5	Hydropower	3	2	1	
6	Irrigation coverage	1	2	3	Dam site 1 is very good
7	Hydro power	3	2	1	Marginally different
8	Social impact (disruption)	1	3	2	Dam site 1 and to are Marginally different
9	Environmental	3	2	1	Dam site 1 has a major impact
10	Start of construction	2	1	1	Dam site 1 shall take a lot of persuasion

### 1.12.13 Conclusions

#### 1.12.13.1 Cost of Construction

Dam site 2 had the lowest cost of construction at Ksh 6.2 billion, dam site 1 and 3 were comparable at Ksh 7.8 billion and Ksh 8.0 billion.

#### 1.12.13.2 Social costs

Due to water impounding at the inhabited area, Dam site 2 and 3 has very high social cost that could be effectively costed.

#### 1.12.13.3 Environmental impact

Dam site 1 was wholly located in the forest while dam site 2 displaces about 30 ha of forest land. Mt Kenya Forest being a UNESCO protected site, it may take high level intervention for a dam construction permit.

### 1.12.14 Recommendation

Dam site 1 is almost impossible to proceed with from this stage though it has no social cost implication.

Dam site 3 has high construction cost.

Dam site 2 is recommended to proceed to final design stage.

The following aerial photo shows the proposed location for dam site 2



Figure 19: Dam site 2 aerial photo showing the extent boundary

1.12.15 Work plan

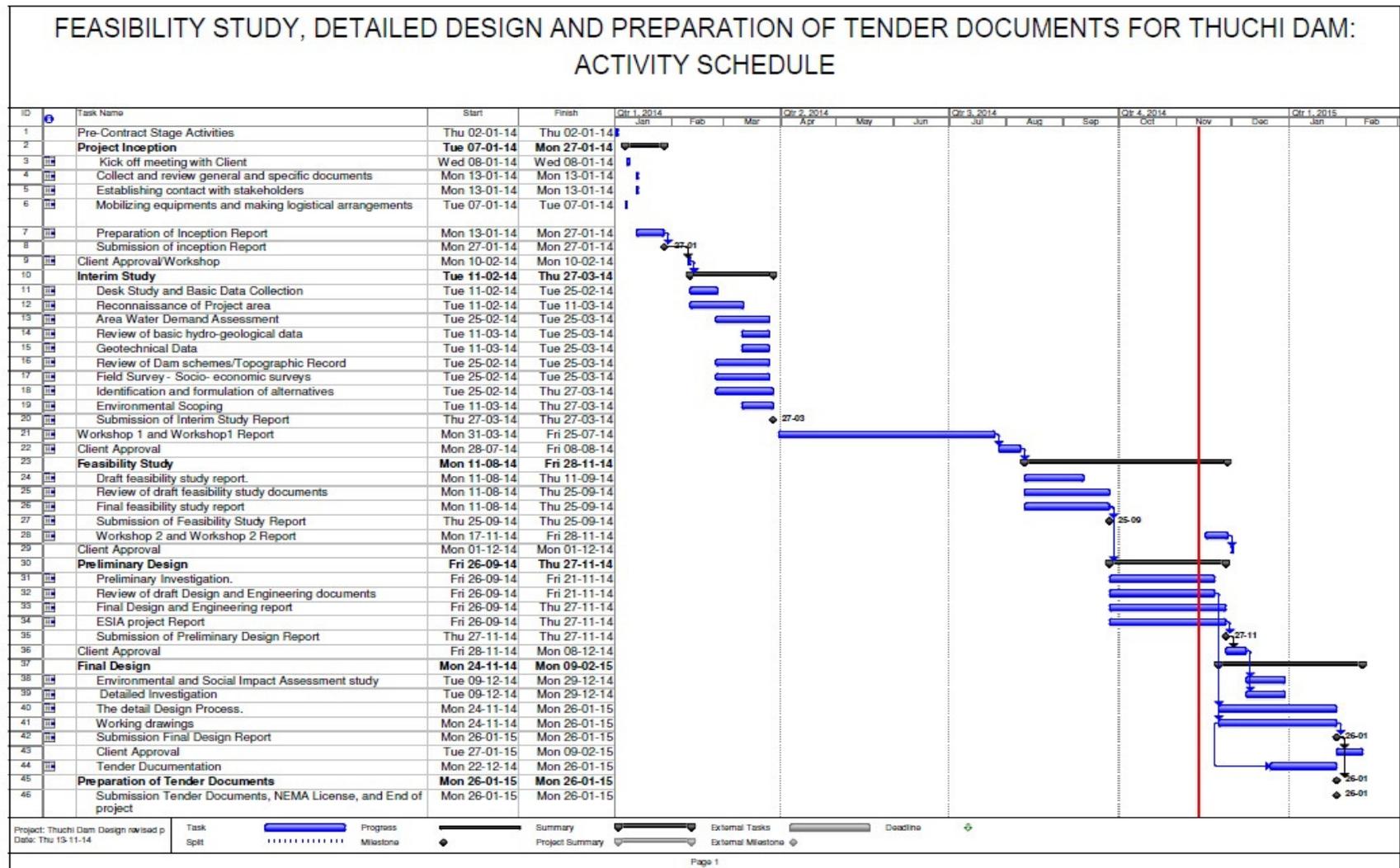


Figure 20: Work plan

### 1.13 3<sup>rd</sup> Presentation - Stake holder participation (by project sociologist)

The sociologist explained that Kagaari Kyeni Gatari Irrigation project was at advanced stage of completion and the area is benefitting, however he pointed out that the water is not sufficient and more people may not benefit without the dam. Hence the Kagaari Kyeni Gatari owners must see that the dam project proceed to a logical conclusion for the scheme to bear fruits.

Water resources management Authority shall also benefit greatly from the revenue expected from supply of water and downstream flow stabilisation.

Hence Kagaari Kyeni Gatari Irrigation scheme members must own the dam project. Each and every member of this community shall benefit from employment, increased disposable income and or steady supply of food and industrial material.

Hence all of us must own and support the project from employment, income, or steady and cost effective food supply and hence each of the community leaders should own the project and assistance in bring the remaining parts to their completion by doing the following:

- Allow the study team access to various sites while caring out survey and investigations
- Give the consultant information regarding agriculture production, expectation and their preferences
- Participate fully in barazas
- Be willing to accommodate other people's opinion in order that we can reach a consensus.

### 1.14 4<sup>th</sup> Presentation by team leader - Work plan in 3<sup>rd</sup> stage

The team leader/dam expert explained to the workshop that various activities to be conducted in the third stage. The following are the main activities highlighted and explained after.

- Conduct a detailed geotechnical investigation on the proposed dam site.
- Conduct a detailed topographical survey at the proposed dam embankment site and within the reservoir.
- Develop a detailed design, tender documents, and cost estimates for entire project.
- Conduct a full Environmental and Social Impact Assessment (ESIA) study and reporting to NEMA for licensing.

#### 1.14.1 Detailed Geotechnical Investigation

The activities to be involved in these tasks will include.

1. Borehole drilling and core recovery and sampling - Drilled cores will be sampled and taken to laboratory for testing

2. Standard Penetration Test - Conducted on the overburden soil to determine its bearing capacity.
3. Water pressure test - Conducted on each borehole to determine permeability of the ground.
4. Trial grouting test (Grout take) - Conducted on each borehole to determine the amount of grout required to seal the ground.

#### **1.14.2 Detailed Topographical Survey**

Detailed topographical survey will be carried out at the dam location and within the reservoir.

Details of topographic maps will be prepared as follows:

- Dam site area and hydraulic structures mapped to scale of 1:500 and contour intervals of 1 m
- Reservoir and buffer areas mapped to scale of 1:1000 and contour intervals of 5 m
- Map to include physical features in the area

#### **1.14.3 Detailed Design and Tender Documents**

Based on the detailed geotechnical investigation results, dam design will be finalized and a final design report is prepared.

Tender documents will include.

- Bid document
- Work and material specification
- Bills of quantities
- Drawings

The client will receive a comprehensive cost estimate for the project.

#### **1.14.4 Environmental and Social Impact Assessment**

As required by the law, a full ESIA study was to be conducted identifying all the possible impacts and mitigations. A comprehensive report detailing the outcome of the study will be submitted to NEMA for approval and licensing.

## 1.15 Discussions and Comments

### Participant 1, Johnson Mbogo (KYEWASCO Director - Kyeni)

**Q:** On the 6,600 ha of proposed irrigation land whether Kyeni was included

**A:** Kyeni was part of Kagaari Gatari irrigation project in the proposed project area.

### Participant 2, Alex Ndwiga (Kawanjara village)

**Q:** Based on the three dam sites, which site was the dam be constructed?

**A:** The consultant had recommended dam site 2, based on his studies, but was to be agreed with all the stakeholders involved.

### Participant 3, Mr. John Njeru, (Kyeni Water)

**C:** Suggested dam site 1 (inside the forest) reason being that it would not interfere with people's life and property. It would be able to command water to nearly all the three phases.

### Participant 4, Mr. Kibe:

**Q:** Based on the layout presented, he sought to know if Kyeni was not covered.

**A:** The Consultant explained that Kagaari-Gatari Irrigation project is just a name referring to the Kagaari Kyeni Gatari irrigation project. Kyeni was included in the project as one of the beneficiaries and they will include the name Kyeni, hence the project was to be referred to as "Kagaari Kyeni Gatari" Irrigation Project.

### Participant 5, Alex Ndwiga (Kawanjara Village)

**Q:** Wanted to know the possible areas that could be irrigated by the dam.

**A:** The consultant indicated the area and indicated the limit up to which the 3 possible dam sites could irrigate. He displayed Figure 12: Kagaari Kyeni Gatari proposed Irrigation phases.

### Participant 7, Mrs. Sarah Wawira (Nyagari Village)

**Q:** She wanted an elaboration on what was to happen because half of the dam would be located on Tharaka Nithi county.

**A:** The consultant responded by indicating that water is a natural resource that does not belong to any administrative county in Kenya. For the sake of development there will be no hindrance. Thuchi River marks the boundary of the two counties hence none of the three sites will be fully in Embu county.

### Participant 8, Johnston Njue (Kyeni South)

**C:** Expressed support for the project and dam site 2, and as a teacher, he expressed the benefit of such infrastructure close to the human settlement for students and local people to learn from it

**C:** The dam infrastructure touching on Tharaka Nithi County was not an issue due to the fact that, it was there to benefit all the people irrespective of their location.

**A:** Comments appreciated

**Participant 9**, Johnson. Mbogo (KYEWASCO Director - Kyeni)

**C:** Expressed concern that the issue of compensation will be a difficult task, and hence he proposed the dam site 1 inside the forest.

**A:** The Consultant explained to the workshop how difficult sometime it is, to obtaining a permit allowing one to construct a dam inside the forest. However, the permission could be granted only after a high level intervention.

**Participant 10**, John Waiganjo (County Director of Water Land and Environment)

**C:** Wanted to know whether there was a provision for downstream release after impounding.

**A:** The consultant explained that there was a provision for retaining a flow from the river for downstream users. However if more water was required, another dam could be constructed to provide more storage.

**Participant 11**, Mrs. Mercy Wanja (Mbiruri Village)

**C:** She proposed dam site 1 (Inside the forest) explaining that it will not affect human settlement.

**Q:** Also wanted to know whether hydropower was a proposal or it was part of the Thuchi dam project.

**A:** Hydro power was not part of the project, but it was a proposal that could be implemented.

**Participant 12**, Mrs. Monica Wambura (Mukuuri Village)

**C:** Expressed suggestion for site 1 (inside the forest) which will not interfere with people's life.

**A:** Suggestion appreciated

**Participant 13**, Mrs. Miriam Njeru (Kigumo Village)

**C:** Suggested that Kyeni be included in the irrigation project and the full name to be Kagaari Kyeni Gaturi Irrigation Project.

**A:** It was agreed.

**Participant 14**, Lydia Muthoni Kariuki (Kigumo Upper, WRUA))

**Q:** Wanted to know the areas covered by irrigation.

**A:** The layout was displayed and the areas covered shown.

**Participant 15**, Mr. Elijah Njiru (Kyeni)

**C:** Expressed support for the project, the location of the project was not important as compared to the benefits that were going to be realized from the project.

**Q:** He requested for employment of the locals during the project implementation stage.

**A:** Comments appreciated and the consultant assured him that the locals will be considered for employment, but for labor that will require special skill, qualified people irrespective of their origin were to be employed.

**Participant 16:** Alex Muriithi (Kyeni South)

C: Advised workshop to follow professional advice. He expressed concern that if there was no any good reason to disagree on the dam location, the ultimate thing was for irrigation water.

A; Comments appreciated.

**Participant 17:** Johnson. Mbogo (KYEASCO Director - Kyeni)

Q: Expressed concern that about 75% of the participants were in favor on dam site 1 and any issue with the forest could be addressed later at the county or national level.

A: The consultant suggested by show of hands for those in favor of dam site 1, those in favor of dam site 2 and those in who primary interest was water irrespective of the dam location.

The votes were as follows

*Table 7: Results*

<b>Voting options</b>	<b>Votes (% fraction of population)</b>
In favor of dam site 1 (inside the forest)	<b>75%</b>
In favor of dam site 2 (inside the forest)	<b>15%</b>
Main concern is water irrespective of the dam site.	<b>10%</b>

The consultant responded that the result will be communicated to National Irrigation Board.

#### **1.16 Closing Remarks by the County Director of Water, Land and Environment.**

The County Director of Water thanked the organizers and the participants for their participation and cooperation toward the success of the workshop.

He proposed that other dams be implemented for future water storage due to the fact that the population was still growing and more water for irrigation will be required.

#### **1.17 Closing remarks by Runyenjes Sub - County Administrator on behalf of County Commissioner**

On behalf of the County Commissioner and the entire Embu County officials, the Runyenjes Sub - County Administrator thanked the organizers and the participants for their participation and cooperation toward the success of the workshop.

He mentioned that the county was in the process of improving the forest cover within their county, this is a major thing in conservation of water.

He argued the people to respect the governor office and not to bring any politic in the project if they want it to be successful.

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## 2. APPENDICES

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## 2.1 APPENDIX 1: WORKSHOP PROGRAMME

## 2.2 APPENDIX 3: STAKEHOLDERS ATTENDANCE LIST

**2.3 APPENDIX 4: KIRI CONSULT LTD 1<sup>ST</sup> PRESENTATION  
1<sup>ST</sup> WORKSHOP PRESENTATION REVIEW (TEAM LEADER'S PRESENTATION)**

**2.4 APPENDIX 5: KIRI CONSULT LTD 2<sup>ST</sup> PRESENTATION  
PROGRESS OF THE PROJECT (TEAM LEADER'S PRESENTATION)**

**2.5 APPENDIX 6: KIRI CONSULT LTD 3<sup>RD</sup> PRESENTATION  
STAKEHOLDERS PARTICIPATION (SOCIOLOGIST'S PRESENTATION)**

**2.6 APPENDIX 7: KIRI CONSULT LTD 4<sup>TH</sup> PRESENTATION  
WORK PLAN IN 3<sup>RD</sup> STAGE (TEAM LEADER'S PRESENTATION)**

2.7 APPENDIX 8: WORKSHOP PHOTOS



Figure 21: Participants introducing themselves



Figure 22: Presentation and discussions underway



Figure 23: Presentation and discussions underway



Figure 24: Workshop underway, 3rd presentation



Figure 25: Workshop underway, Participant raising comments



Figure 26: Workshop underway, voting exercise

**ANNEX 1C**

**PUBLIC CONSULTATIONS**

**REPORT**

**(SPECIAL WORKSHOP)**

# FEASIBILITY STUDY, DETAILED DESIGN AND PREPARATION OF TENDER DOCUMENTS FOR THUCHI DAM, EMBU COUNTY

Contract No. NIB/T/015/2013-2014



## SPECIAL WORKSHOPS REPORT

JULY 2015



NATIONAL IRRIGATION BOARD  
P.O. BOX 30372-00100  
NAIROBI



KIRI CONSULT LIMITED  
P. O. BOX 4125 - 00506  
NAIROBI

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## 1 INTRODUCTION

Thuchi Dam is being developed by National Irrigation Board (NIB) as part of Kagaari Kyeni Gaturi Irrigation Project. The project has more than 12,000 farmers and covers a gross area of about 6,600 ha. It falls under the following administrative locations:

- Runyenjes/Kyeni Divisions in Runyenjes Sub-county of Embu County and
- Gitogoto village of Meru South /Chuka/IgambaNg'ombe sub-county of Tharaka Nithi County

National Irrigation Board has appointed Kiri Consult Limited to carry out a feasibility study, detailed investigations and Engineering design for the development of Thuchi dam on River Thuchi. This also includes a study of River Thuchi Water Resources, review of Kagaari Kyeni Gaturi Irrigation project and related subjects. The assignment is at Preliminary design stage

Among the benefits the community will draw the following from the project include the following:

1. Food security
2. Creation of employment
3. Improving the living standards
4. Source of income
5. Generation of electricity

The consultancy services Term of Reference among other things required Kiri Consult Limited in collaboration with the National Irrigation Board to organise two consultative workshops for stakeholders in the course of the assignment and the following have been conducted so far:

- Workshop no. 1 during interim study stage to inform the stakeholder of the project its requirement and their involvement
- Workshop no. 2 to inform the stakeholders of the findings, record and incorporate their opinions in the final design report.

## 2 SPECIAL WORKSHOPS

In the course of preliminary design and out of experience with the social issues on the ground it was found necessary to hold workshops with the project affected person as a way of sensitising and entry point to the community. The workshops were agreed to be held at the proposed dam site 2, that was found most feasible as per studies conducted, and also recommended by the client. This proposed site is located in the following villages:

- Gitogoto village of Meru South, Tharaka Nithi County.
- Mutuangima Village, Iriari location, Embu County.

### 2.1 Special workshop expectation

Special workshops were agreed to be conducted, with the aim of obtaining permission, from the landowners, to access parcels and properties lying within the limit of the dam embankment, spillway and other abutments.

The target group were the land owners and opinion leaders that included area Member of Parliament and County assembly members and witnessed by County Commissioner's officers.

The two workshops were held as follows:

- 3<sup>th</sup> July 2015 at Gitogoto Primary school grounds for Gitogoto village in Meru South sub-county, Tharaka Nithi County
- 13<sup>th</sup> July 2015 at Iriari Primary school grounds for Mutuangima Village, Iriari location Embu County.

### 2.2 Tharaka Nithi County Workshop

The workshop was held on on 3<sup>th</sup> July 2015 at Gitogoto primary school grounds. It was attended by the following:

1. The Member of Parliament Hon. Muthomi Njuki
2. The Meru South Sub-county commissioner staff led by Mr. C. Otieno, the Sub-county Commissioner.
3. The County Assembly staff led by Mr Gichiko, the area ward county assembly representative.
4. The Constituently Development Fund Chairman Mr. Patrick Munene
5. National Irrigation Board Representative
6. Kiri Consultant representatives.
7. Land owners.

Those who attended the meeting addressed the gathering and the following is a brief of what transpired:

### 2.2.1 Meru south/Chuka/Igembengombe sub-county commissioner

He informed the meeting that the County Commissioner office was aware that the Central Government was carrying out a study on possibility of a dam being built at the site and it was expected that the consultant shall carry out the study within the community without disrupting the current social economic status.

He requested the Consultant to always inform his office every time they are on the ground and give him a programme of the study components.

### 2.2.2 The County assembly representative

He informed the Community that he was happy with the Government for bringing development to the community and requested that should any labour be required they should be sourced from within.

He requested the community to co-operate with the Consultants at this stage, which involves a study and nothing shall be destroyed or taken away from them. He elaborated on the benefits that shall accrue to the community from the dam as follows:

- Employment during construction
- Market for their farm produce during construction and after the dam is built
- Trade as a result of the tourism it shall attract.
- The village name shall be known all over Kenya.

### 2.2.3 Kiri Consultant representatives

Kiri Consult representative introduced the consultancy and explained what they were involved in. He gave the background of the project with the following key points:

- Irrigation project completion status,
- Expected benefits of the proposed Thuchi dam,
- Objective of the Engineering Service
- Scope of the work and duties of the Consultant
- Workshop expectations

He requested the land owners to allow the study team in their community and assist them in understanding the project better.

He further informed the participant the activities to be done in the subsequent stages of the assignment.

### 2.2.4 Area member of parliament

Hon. Muthomi Njuki, the area Member of Parliament, informed the meeting that the project is a vision 2030 flagship project and as such it is intended to improve welfare and livelihood of the Kenyan citizen.

He informed the participants that even if the project intends to supply irrigation water to Embu County, their Constituency and Tharaka Nithi County will also benefit indirectly from the project.

He further requested that Tharaka Nithi be considered for irrigation and water supply from the dam.

He requested NIB to conduct a fair valuation and compensation of the properties to be affected.

#### 2.2.5 Workshop discussion and comments

##### Participant 1

Q: Will the project provide domestic water supply,

A: The scope by this project is limited to making allowance for an off-take for abstraction of domestic water from the dam. However, the surrounding community can be provided with domestic water from a different source.

##### Participant 2

Q: He sought to know how the compensation will be conducted

A: This is a study to establish suitability or not of the dam. A study for compensation will be done after this stage if the site proves favourable for the dam construction. At that study each item shall be valued at the market value and shall include a percentage for disturbance and each item shall be agreed between the valuer and the affected person, before this is represented for payment.

##### Participant 3

Q: shall the local youths be employed during investigation and construction.

A: At both stages the local youths and persons with necessary skills shall be given first priority.

##### Participant 4

Q: Requested honesty and fairness during compensation

A: Amicable agreement involving all affected people and within the law will be done.

##### Participant 5

Q: He sought to know how the negative impacts will be handled.

A: An ESIA study is underway to establish all the negative impacts that can arise and possible mitigation. A perimeter fence around the dam may eliminate human animal conflict.

#### 2.2.6 Closing remarks and way forward by NIB representative.

The NIB representative thanked the land owners for allowing the study team access their land and concluded by stating the following.

- The affected farms, if necessary, will be compensated for any interference with their crops or livestock pasture during investigations.
- The investigation to consider employing local youth on untrained manual jobs.
- If investigation yields positive results, there will be fresh negotiation within the law that set out team of engagement with landowners.

## 2.3 Embu County Workshop

The workshop was held on 13<sup>th</sup> July 2015 at Iriari primary school grounds and attended by the following:

1. The Member of Parliament Hon. Cecily Mberire
2. The Runyenje's Sub-county commissioner staff led by Mr. Muchelule the Sub-county Commissioner.
3. National Irrigation Board Representative
4. Kiri Consultant representatives.
5. Land owners.

### 2.3.1 Runyenje's Sub-county commissioner

He informed the meeting that, Thuchi dam is a central Government project which aims at improving agriculture in the area and beyond. He requested the landowners not to have negative perception and he will ensure that the study is conducted with dignity and there shall be no intimidation. He further said that nothing in this exercise shall hinder the community from continuing with their daily life.

He wound up by requesting for active participation in the workshop and all the activities involving the project for the success of the project and declared the workshop opened.

### 2.3.2 NIB representatives

In line with the mandate to develop, promote and manage all national irrigation schemes in the country, NIB representative expressed their intention to design and develop the proposed Thuchi dam on River Thuchi to conserve water during the rains and release it for irrigation purposes during the dry months of the year. The dam shall support 6,600 ha of irrigation land in Kagaari - Gaturi Irrigation project area.

He informed the workshop that Kiri Consult has been engaged by the Board to conduct studies and design the dam. He listed the various benefits of developing the project as follows:

- Food security
- Creation of employment,
- Improving the living standards
- Source of income and

- Generation of electricity

The NIB representative wound up by making a request to the land owners to permit the study team access their land for investigation and survey purposes.

### 2.3.3 Kiri Consult representative

The Kiri Consult representative introduced the consultancy and explained what they were involved in. He gave the background of the project with the following key points:

- Irrigation project completion status,
- Expected benefits of the proposed Thuchi dam,
- Objective of the Engineering Service
- Scope of the work and duties of the Consultant
- Workshop expectations

He requested the land owners to allow the study team in their community and assist them in understanding the project better.

He further informed the participant the activities to be done in the subsequent stages of the project design.

### 2.3.4 Area member of parliament

Hon. Cecil Mbarire, the area Member of Parliament, gave the background of the project from its inception using CDF money, to the current status where phase one of the project was completed and about 2000 families are benefiting. She informed the meeting that the project is a vision 2030 flagship project and as such she had invited the president to participate in the inauguration of phase 1 of the project.

She informed the participants that the current engineering assignment shall solve their water problem being experienced currently in phase 1 and that shall enable completion of the remaining phases.

Hon. Cecily Mbarire explained to the meeting the importance of the project to the people. She informed the meeting of her request to the President to finance the project once the study has been finalized. She acknowledged the challenges involved in siting the dam in the forest and requested the land owners to accept the project for the benefit of the community. She informed them that valuation for their properties will be done fairly.

### 2.3.5 Workshop discussion and comments

#### Participant 1

Q: He sought to know how the compensation will be conducted

A: This is a study to establish suitability or not of the dam. A study for compensation will be done after this stage if the site proves favourable for the dam construction. At that study each item shall be valued at the market value when it is new and shall include a percentage for disturbance and each item shall be agreed between the valuer and the affected person, before this is represented for payment.

#### Participant 2

Q: What if one is not for the project?

A: If one is not for the project then he or she should give the reasons as to why he/she is not for the project. This shall form the basis for consideration compared with reasons given by the ones who are for the project

#### Participant 3

Q: Wanted to know which kind of properties will be paid and which one will not.

A: It was stressed that the study is not for compensation but for suitability of the dam. However, if the location is suitable for the project then all properties shall be considered for payment as per agreement before anything is affected.

#### Participant 4

Q: He expressed concern that, he is used to the area and displacing him and his family to a different place may be difficult for him.

A: During the study for compensation, he may request to be compensated with land within the area, and modalities for this kind of compensation shall be considered

#### Participant 5

Q: Requested honesty and fairness during compensation

A: Amicable agreement involving all affected teams and within the law will be done.

#### Participant 6

Q: The area youths to obtain employment from the investigation to be conducted.

A: Jobs will be given to the available youths and persons with necessary skills apart from those jobs that require experts from outside.

#### Participant 7

Q: He sought to know the value of the land around the area

A: No compensation is being done at this stage, and the study team does not have experts on land or property valuation.

Participant 8

Q: She sought to know where irrigation water for the surrounding farms shall be sourced from.

A: Irrigation water for the farms upstream of the dam will be sourced from the existing intake, while the one on the dam will be supplied to the downstream users.

Participant 9

Q: He sought to know how the negative impacts like crocodile and hippopotamus manifestation will be handled.

A: An ESIA study is underway to establish all the negative impacts that can arise and possible mitigation. A perimeter fence around the dam may eliminate human animal conflict.

Participant 10:

C: Expressed support for the dam and elaborated on its benefits and reasons for the consultant to propose the dam location to be within their lands.

A: Comments appreciated

### 2.3.6 Closing remarks and way forward by NIB representative.

The NIB representative thanked the land owners for allowing the study team access their land and concluded by stating the following.

- The affected farms, if necessary, will be compensated for any interference with their crops or livestock pasture during investigations.
- The investigation to consider employing local youths on untrained manual jobs.
- If investigation yields positive results, there will be fresh negotiation within the law that set out team of engagement with landowners.

### 3 CONCLUSION

It was noted that the land owners in both counties hand no problem with the study and hence the Consultants' staff have access to the community and their land for preliminary design investigation and survey purposes.

4 APPENDICES

4.1 APPENDIX 1: Special workshop photographs - Gitogoto primary school grounds



Workshop underway with the MP address the meeting



Workshop underway



Workshop underway: The area chief recording concerns.



Workshop underway, address by the area Member of National Assembly



Workshop underway, address by the area Sub-County Commissioner



Landowners raising comments

4.2 APPENDIX 2: Special workshop photographs - Iriari primary school grounds



Workshop underway



Workshop underway



Workshop underway: Landowners



Workshop underway address by the area Member of National Assembly



Workshop underway address by the area Sub-County Commissioner



Landowners raising comments

# **ANNEX 2**

# **ATTENDANCE LIST**

**ANNEX 2A**

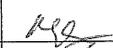
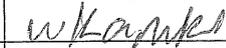
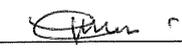
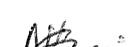
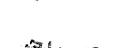
**WORKSHOP 2**

**ATTENDANCE LIST**

# STAKEHOLDERS CONSULTATIVE WORKSHOP 2 ON THUCHI DAM PROJECT, EMBU COUNTY

## SIGN-IN SHEET

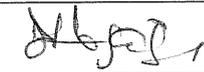
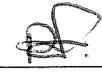
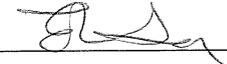
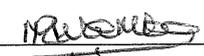
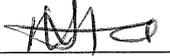
Venue: ST. MARY'S WOMEN TRAINING CENTRE Date: 28/11/2014 Time: \_\_\_\_\_

	NAME	ORGANIZATION & DESIGNATION	PHONE/EMAIL	SIGNATURE
1	ERIC MUTWIRI KARIUKI	ISUFU	0700 7955 644	
2	DOROTHY WAMWARA	MUKUURI	07 10 712 597	
3	MONICA WAMBUA	MUKUURI	0128253965	
4	LYDIAH KARIUKI	KIGUMO (WRUA)	07	
5	MAURUS NJOKI	KIGUMO (WRUA)	0725924145	
6	MARY NJOKI NJERU	KATHARI WRUA	0726-683722	
7	Lydiah W. Karimani	KIGUMO UPPER WRUA	0725134143	
8	ELIAS GACINGO	KIGUMO UPPER WRUA	0717 701809	
9	CHRISTOPHERE NJERU	CMW C.D.F.	0722 6 45382	
10	ESTHER N. NYAGA	UWEZO FUND CHAIR	0724406063	
11	NANCY IRIMBA	MAENDELEO YAKANAWAKLE SUB COUNTY	0702545680	
12	Isacah Njoru	Kenote	0726318532	
13	ALICE GICUISU	UWEZO COMMITTEE	0710 493 789	

## STAKEHOLDERS CONSULTATIVE WORKSHOP 2 ON THUCHI DAM PROJECT, EMBU COUNTY

### SIGN-IN SHEET

Venue: ST. MARY'S WOMEN TRAINING CENTRE Date: 28/11/2014 Time: \_\_\_\_\_

	NAME	ORGANIZATION & DESIGNATION	PHONE/EMAIL	SIGNATURE
14	SILAS M NJAGI	UPPER THUCHI WAOA	0926370141	
15	NANCY MAREGA	RUKKAGAARI SOUTH	0726064186	
16	David Gikonyo	Kiaraigana	0710502381	
17	Phinaim Kivungu	KASABARI	0725349514	
18	AGOSTA WAMBURA	KARURUMO	0723488602	
19	ESTHER RWAMBA	KINTHITHE	0728915926	
20	BONFACE NYAGA	Kiaraigana	0714419661	
21	JANIE KARIMI KIBACIO	UWESO Fund	0727425605	
22	Stella Rwamba	Kiaraigana	0729668803	STELLA
23	CHARLES E-K. NJERU	UPPER THUCHI WAOA / WAOA <sup>UC</sup>	0725866643	
24	MIRIAM R. NJERU	KIGUMU	0718431542	
25	MERCY WANJA	MBURU	0710378361	
26	ALEXIS NYAMBO	WIMWOTO	0720799120	

# STAKEHOLDERS CONSULTATIVE WORKSHOP 2 ON THUCHI DAM PROJECT, EMBU COUNTY

## SIGN-IN SHEET

Venue: ST. MARY'S WOMEN TRAINING CENTRE Date: 28/11/2014 Time: \_\_\_\_\_

	NAME	ORGANIZATION & DESIGNATION	PHONE/EMAIL	SIGNATURE
27	EVDICUS MWAMUKI	CDP REP KIGUMU	0704937085	
28	KENNETH MTHICTA	CDP REP MUKURIA	0789719290	
29	Andrew Kingua	Director Mkwesaka	0724801304	
30	Njaji Njue	" Ngawaso	0722117947	
31	SCHOLASTICA M. NJERU	CDP REP	0729943684	
32	ANGILO RUTERE	CDP REP RUKURUKI	0700781011	
33	MICHAEL GICIKUMU	SUP-AREA MIFU	0720584019	
34	JOHN NZERU NGARI	K.K.G.I.P V/CHAIRMAN	0727226640	
35	PERMINVS KINYUA	KIGUMU	0721658772	
36	ANTONY MUMITHI	KIARAUAHA	0727320200	
37	MR JUSTIN GIDOMA	<del>CDP</del> DUNYEMBE'S	0728152784	
38	DANCA KIVUA NJERU	CDP REP MUKURIA	0712993908	
39	SARLES MUMITHI	KIARAUAHA	0714355244	

# STAKEHOLDERS CONSULTATIVE WORKSHOP 2 ON THUCHI DAM PROJECT, EMBU COUNTY

## SIGN-IN SHEET

Venue: ST MARY'S WOMEN TRAINING CENTRE Date: 28/11/2014 Time: \_\_\_\_\_

	NAME	ORGANIZATION & DESIGNATION	PHONE/EMAIL	SIGNATURE
40	Gerald K. Njauki	Chairman_CDF KATHARI	0725645849	<i>[Signature]</i>
41	Gibson MBOGO	KYEWASCO-AIRLIFT	0721346804	<i>[Signature]</i>
42	Gibson Njue Kitewa	EAPC Pastel MEMBER	07124051283	<i>[Signature]</i>
43	FEZISIO NYAGA	Constituency office	0727785147	<i>[Signature]</i>
44	AGNES MUMBU MWANGI	MEMBER KAGAARI	0710813208	<i>[Signature]</i>
45	COSILIA GICUKU	MEMBER KAGAARI	0727864965	<i>[Signature]</i>
46	ELISABETH NJUE	KKG IRR. W. PRO. CHAIRMAN	0713391002	<i>[Signature]</i>
47	ELIZABETH KAMATHA	KKG IRR DEV. PRO CHAIRMAN	0721649719	<i>[Signature]</i>
48	JANISIA NYAGA	KKG IRR-DEV. PRO. SECRETARY	0720828655	<i>[Signature]</i>
49	MERCY KARIMI NTERU	VICHAIR C.D.F. NIAURU	0717116491	<i>[Signature]</i>
50	ALEX KIBOI NTHIGA	FARMER KARIARU	0729801572	<i>[Signature]</i>
51	HELLEN MATHONI	FARMER KARIARU	0700044037	<i>[Signature]</i>
52	HENRY KARIUKI	GATURI NORTH WARD	0732312174	<i>[Signature]</i>

# STAKEHOLDERS CONSULTATIVE WORKSHOP 2 ON THUCHI DAM PROJECT, EMBU COUNTY

## SIGN-IN SHEET

Venue: ST. MARY'S WOMEN TRAINING CENTRE Date: 28/11/2014 Time: \_\_\_\_\_

	NAME	ORGANIZATION & DESIGNATION	PHONE/EMAIL	SIGNATURE
53	Alex NDIWA KARARI	Olman Kawanya	0725686378	
54	SUSAN MUTHONI	KAGAARI	0723065269	
55	ELIUD K. MUTWANGA	CHAIRMAN KAGAARI	0735281171	
56	NJERI KARANJI	M/ Mute CDF	0721842909	
57	Jane Muthoni	Chw Lady Gichiche sb	0723832524	
58	Peter Njue Mungu	Kigaa	0725789433	
59	PETER K. MARI	GATURI	0712885326	
60	ZACHARY KARIKI	GATURI	0726607737	
61	JAVANSON N. NGARI	Nyagari	0716070068	
62	DAMARIS NDEKE	MCA'S REP. (KIENI N. WARD)	0722295663	
63	SITEM MUGENDO M.	CIW KAJI NRIH STCA	0726246572	
64	ROBERT NDWIGA	Gikuri Member	0710684005	
65	ELIAS IRENI NYAGA	CHAIRMAN KIANGUNI	0715812898	



## STAKEHOLDERS CONSULTATIVE WORKSHOP 2 ON THUCHI DAM PROJECT, EMBU COUNTY

## SIGN-IN SHEET

Venue: ST MARY'S WOMEN TRAINING CENTRE Date: 28/11/2014 Time: \_\_\_\_\_

	NAME	ORGANIZATION & DESIGNATION	PHONE/EMAIL	SIGNATURE
66	PETER MAEMA	C/M CMA	0720252241	
67	EMMASTUS NJUE NATHAN	C/M KALLA ACIS KIARAGAYA	0719689775	
68	AMOS MUCEMI KIBOI	KYENI SOUTH	0726157451	
69	ALEX MURITHI NJERU	KYENI SOUTH	0718432809	
70	ALFRED GIKOHEGA	KYENI SOUTH	0728868425	
71	ELINJA MWANIKI	ILWANI	0727412198	
72	JOHNSTONE NJUE	KYENI SOUTH	0724148069	
73	MANTIN MUMIGA	SECRETARY MCA OFFICE	0702030660	
74	STEPHEN MUGENDI	K/KAMANIYI BUSINESS	0713570555	
75	SARAH WAWINA	NGAGANI	0715164882	
76	FRANCIS NGANGA	MEMBER ONE	0727517701	
77	JERRY MURITHI	C.D.K MEMBER	0714598369	
78	ELINJA MWANIKI	GICHECHE	0727000222	

# STAKEHOLDERS CONSULTATIVE WORKSHOP 2 ON THUCHI DAM PROJECT, EMBU COUNTY

## SIGN-IN SHEET

Venue: ST. MARY'S WOMEN TRAINING CENTRE Date: 28/11/2014 Time: \_\_\_\_\_

	NAME	ORGANIZATION & DESIGNATION	PHONE/EMAIL	SIGNATURE
77	NICHOLAS KINYAMUNGI	C.D.F.C	0720798134	
80	SILAS MWANGI	MOWA TECH	0721712720	
81	JAMES HANU	KAGGARI SOUTH/EMBU	0711602637	
82	ROSEMARY MAIN MARIANI	C.D.F. PRESIDENT	0713923020	
83	EUNICE NJOKI MADARA	C.D.F. CHAIR KIGAA	0724740760	
84	VERA MURUGU	MEMBER MURUGU	0727109163	
85	ALBERT MANITHI	REPRESENTING M.C.A KENIA	0716273000	
86	RUFUS MURUTHI	WATER	0726216087	
87	ROBERT WANGI	NATIONAL IRRIGATION BOARD	0722165571	
88	ELIC GITUNGA	C.D.F. PRESIDENT	0714152587	
89	ARTHUR N KITHAKA	COUNTY	0726225825	
90	BONFACE NJIRU	KIANJUNI	0725442955	
91	JOSEPH KINYAMUNGI	EMBU C.D.F. CHAIR	0727296966	

9

# STAKEHOLDERS CONSULTATIVE WORKSHOP 2 ON THUCHI DAM PROJECT, EMBU COUNTY

## SIGN-IN SHEET

Venue: ST MARY'S WOMEN TRAINING CENTRE Date: 28/11/2014 Time: \_\_\_\_\_

	NAME	ORGANIZATION & DESIGNATION	PHONE/EMAIL	SIGNATURE
92	DAVID MUCHANGI	CHAIRMAN <del>Chairman for</del>	0712783291	<del>DM</del>
93	Nyaga wakarua	Treasurer	0724269009	<del>NY</del>
94	BENARD NJAS MBO	Secretary	0716411560	<del>B</del>
95	MALICK MUCHANGI	Yantra	0725170899	MY
96	Kherogitha Njeru	MB'urum	0722550	<del>K</del>
97	MICHAEL KOKHARI	Greener	0701427486	<del>M</del>
98	PURITY H NJERU	Secretary	0125696286	<del>P</del>
99	Sammy Kava	Kyeni South	0719776228	<del>S</del>
100	JULIA R. NJAU	RUNYENSIS	0707636221	<del>J</del>
101	EMILY WANJIRI	RUNYENSIS	0721100586	<del>E</del>
102	DENNIS MUGENDI	RUNYENSIS	0725631244	<del>D</del>
103	Catherine Nyagal	Runyensis Office	0724052176	<del>C</del>

**ANNEX 2B**

**SPECIAL WORKSHOP  
ATTENDANCE LIST**

# CONSULTATIVE SPECIAL WORKSHOP ON THUCHI DAM PROJECT, EMBU COUNTY

## SIGN IN SHEET

Venue: IRIARI PRIMARY SCHOOL

Date: 13 JULY 2015 Time: \_\_\_\_\_

	NAME	ORGANISATION/DESIGNATION	PHONE/EMAIL	SIGNATURE	Amount
14	ROBERT KINYUA MAWIGA	IRIARI Sub-Location	0725636218		1,000
15	MERCY MUTITHANJE NTAGA	IRIARI Sub-Location	0703217989		1,000
16	MARGRET MURUGI MBUI	IRIARI SUB-LOCATION	0725509771		1,000
17	Jane NJURA	IRIARI SUBLOCATION	0719468505		1,000
18	NAZARIA WANTIRU	IRIARI SUBLOCATION (PAP)	0723-303324 <del>0720 23</del>		1,000
19	MOSES NYRONA NGOROI	IRIARI S/LOC. (PAP)	0723-325599		1,000
<u>20</u>	ALUCIA WANJA	IRIARI S/LOC. (PAP)	0724-458741		1,000
3 1	LUCIA KIDRA	IRIARI S/LOC (PAP)	3512786		1,000
2	MERCY JOY MURUGI	IRIARI S/LOC (PAP)	0718 911 437		1,000
3	ROSE NANCY RWAMBA K.	IRIARI /Sub Location	0718280555		1,000
4	JAMES MUGENDO	IRIARI S/LOC.	0736-909624		1,000
5	PATRIK NJERU MWANIKI	IRIARI S/LOC.	0716-590 308		1,000
*	<del>IRENE MUTHANJE</del>	<del>IRIARI S/Location</del>			
8	NDWIGA MBOGO	IRIARI /S location	35.10855 (ID.)		1,000

\*1 Entered wrongly. NOT affected by project.  
\*2 Also signed Panel 4 for illustrate neighbor.

# CONSULTATIVE SPECIAL WORKSHOP ON THUCHI DAM PROJECT, EMBU COUNTY

SIGN IN SHEET

Venue: IRIARI PRIMARY SCHOOL

Date: 13-July-2015 Time: \_\_\_\_\_

	NAME	ORGANISATION/DESIGNATION	PHONE/EMAIL	SIGNATURE	AMOUNT
37	HARRISSON MURITHI	IRIARI SUBLOCATION (PAP)	0726-578532		1,000
8	ANTHONY GITONGA NYAGA	IRIARI SUBLOCATION (PAP)	0729-093156	Anthony	1,000
9	ESTHER NGAJI	IRIARI SUBLOCATION (PAP)	0735-299165	Esther	1,000
40	JOSEPH NDWIGA NYAGA	IRIARI SUBLOCATION	0712326890		1,000
41	GRACE KARIMI	IRIARI SUBLOCATION (PAP)	0701-167222		1,000
42	JULIUS MURITHI MWIGA	IRIARI SUBLOCATION	0726636279		1,000
43	JUSTO RUTERE	IRIARI SUBLOCATION	0714-569754	Justo	1,000
* 43	JOSEPH NJAGA	IRIARI SUBLOCATION (PAP)	0712-779432	Joseph	1,000
44	SABINA KINYA	IRIARI SUBLOCATION (PAP)*	0717 775228	<del>SABINA</del>	1,000
45	NANCY WANJA	IRIARI SUBLOCATION (PAP)	0702884042	NK	1,000
46	ENOS KINYUA	IRIARI SUBLOCATION (PAP)	0725-862727		1,000
47	SAMUEL MURITHI NYAGA	IRIARI SUBLOCATION (PAP)	0714988438		1,000
48	JAMES NJAGI NYAGA	IRIARI SUBLOCATION (PAP)	0719689401	JAMES	1,000
49	NJUE KITHIURURU	IRIARI SUBLOCATION (PAP)	0724152163		1,000

# CONSULTATIVE SPECIAL WORKSHOP ON THUCHI DAM PROJECT, EMBU COUNTY

SIGN IN SHEET

Venue: IRIARI PRIMARY SCHOOL Date: 13/07/2015 Time: \_\_\_\_\_

	NAME	ORGANISATION/DESIGNATION	PHONE/EMAIL	SIGNATURE	AMOUNT
50	KENNEDY MUCHANGI	IRIARI S.L (PAP)	0712 377150		1,000
51	PETER NJERU NAAWAN	IRIARI S.L (PAP)	1299 588 (ID)		1,000
52	STANLEY NUAGA GACOGO	IRIARI S/Location (PAP)	8601616 (ID)		1,000
53	SALESIO IREPI KAINI	IRIARI S/Location (PAP)	0721 414624		1,000
54	SIMON NJACHU NGESE	IRIARI S/Location (PAP)	0704 553926		1,000
55	Obedian NJIRU	IRIARI Location (PAP)	0710 593206		1,000
56	LUCIA KISUKU	IRIARI S/Loc. (PAP)	0711 863018		1,000
57	EMILY WAWIRA NGORO	IRIARI S/LOCATION (PAP)	0705-901299		1,000
58*	CHARLES GACUWO GATHUITA	IRIARI S/Location (PAP)	35 11 589 (ID)		1,000
59	DAVID MURIKU MUTHEE	IRIARI S/Location (PAP)	0715-812842		1,000
60	JAMLECK GITONGA	IRIARI S/Loc. (PAP)	0726 384388		1,000
61	LYDIA TGA IGANDU	IRIARI S/Loc (PAP)	0711 365598		1,000
X	NATALI NYAGA EZERIE	IRIARI S/Loc (PAP)	0733 487202		1,000
62	ELIPHAZ GITONGA	IRIARI S/Loc PAP			1,000

# CONSULTATIVE SPECIAL WORKSHOP ON THUCHI DAM PROJECT, EMBU COUNTY

SIGN IN SHEET

Value: \_\_\_\_\_ Date: \_\_\_\_\_ Time \_\_\_\_\_

	NAME	ORGANISATION/DESIGNATION	PHONE/EMAIL	SIG
63	PATRICK KIRIUKI	IRIARI S/LOC. PAP	0708 <sup>579996</sup> <del>444</del>	PK
64	NEBERT KANI NYAGA	IRIARI S/LOC PAP	0717150478	NK
65	PETER MUTHEE NAMAN	IRIARI S/LOC PAP	0712011581	PO
66	DAVID MUGENDI NDWIGA	IRIARI S/LOC PAP	0721712567	<del>DM</del>
67	STANLEY IRENI NDEKE	IRIARI S/LOC PAP	12879204	IN
68	DANSON MUSAHIKI	IRIARI S/LOC PAP	0716352746	DM
69	DEHNIC MUGENDI MUNE	IRIARI S/LOC PAP	0737421283	<del>DM</del>
70	JOHN M. BENSON	IRIARI S/LOC PAP	0724305954	JB
71	Samuel Nyaga	IRIARI S/LOC PAP	0724019016	Sam
72	LAWRENCE MURIMI	IRIARI S/LOC PAP	0715888499	LM
73	Richard Njiru Ndeke	IRIARI S/LOC PAP	3512829	RN
74	Mbogo Nyaga	IRIARI S/LOC	16114262	Mbogo
75	Patrick Njiru	IRIARI S/LOC PAP	0702223751	PK
76	NDEKE GATUARWARE	IRIARI S/LOC PAP	3513720	ND

# CONSULTATIVE SPECIAL WORKSHOP ON THUCHI DAM PROJECT, EMBU COUNTY

## SIGN IN SHEET

Venue: IRIARI PRIMARY SCHOOL Date: 13/07/2015 Time: \_\_\_\_\_

	NAME	ORGANISATION/DESIGNATION	PHONE / EMAIL	SIGNATURE	AMOUNT
77	ESHER WANJA	IRIARI Sub-Location	072549442		1,000
78	FLORA NJOKI	IRIARI Sub-Location	05773169		1,000
79	ELEENIA GICHUKU MUNE	IRIARI SUB-LOCATION	0703988922		1,000
80	NJOGU NJIRU	IRIARI SUB-LOCATION	<del>076364</del> 3515963	N.N. Iwangi	1,000
81	DAGLUS KARANJA	IRIARI SUB-LOCATION	3510176		1,000
82	Herbert Nyaga	IRIARI Sub-loc	3510637	Herbert	1,000
83	MARY MUTHONI	IRIARI Sub-Loc	0714342450	MARY	1,000
84	MARTIN NJUE NDWIGA	IRIARI Sub-Loc	0710985284		1,000
*	MARTIN H. NJUE	IRIARI SUB-LOC.	0723917268		1,000
85	Elijah Njiruh	IRIARI	3306043		1,000
86	John Nyaga		35-12838	J	1,000
87	LENDU Nyagi		0706189963		1,000
88	PHILIP MUGENDI	IRIARI	3213400		1,000
89	MILICENT MUKEMI	IRIARI	074689270	MM	1,000

# CONSULTATIVE SPECIAL WORKSHOP ON THUCHI DAM PROJECT, EMBU COUNTY

SIGN IN SHEET

Venue: IRIARI PRIMARY SCHOOL

Date: 13/07/2015

Time: \_\_\_\_\_

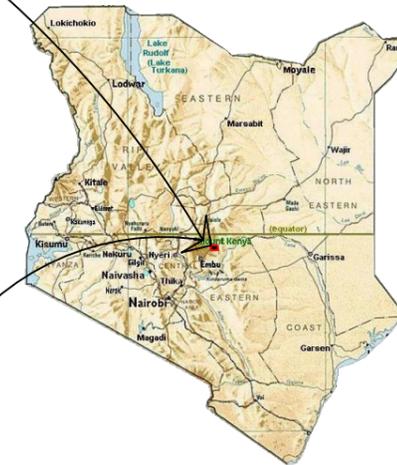
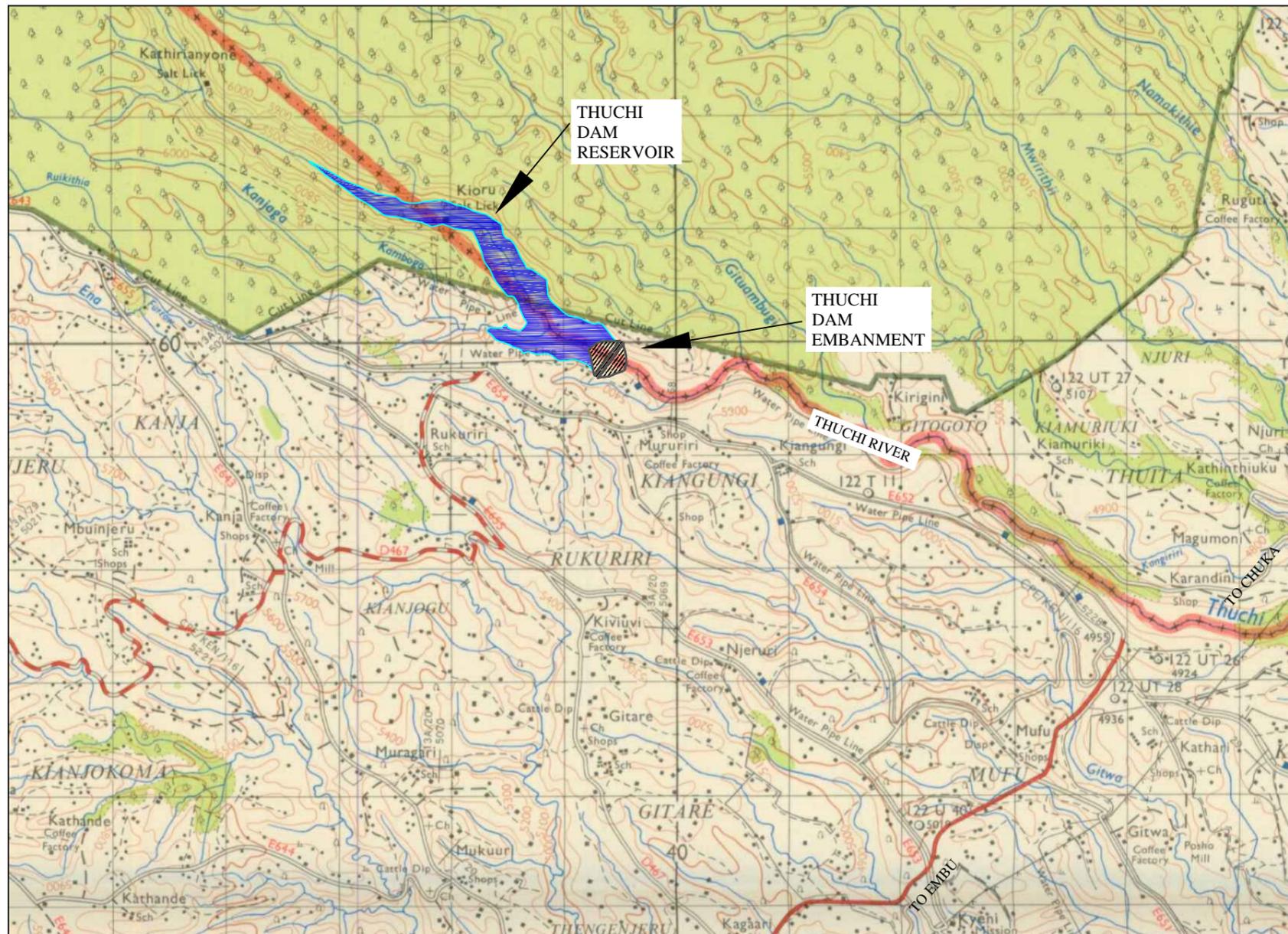
	NAME	ORGANISATION/DESIGNATION	PHONE/EMAIL	SIGNATURE	Amount
1	JOSEPH NDIRU	IRIARI S.L (PAB)	0718089285		1,000
2	JOSHUA DAVID	IRIARI S.L (PAB)	0725478185		1,000
3	ROBERT MURUTHI	IRIARI SUB-LOCATION	07066981	Robert	1,000
4	EUSEPIA NJERI	IRIARI S.L (PAB)	0729422995	Njeri	1,000
5	JOSPHINE WANJA MURUKU	IRIARI S.L (PAB)	0710514822	Josphine Wj	1,000
6	Monica Muthoni	IRIARI S.L (PAB)	0706330478		1,000
*	EMILIAH M. K. NAGGA	IRIARI S.L (PAB)	0716202870		1,000
7	JULIUS NJERU	IRIARI S.L (PAB)	0723129342		1,000
8	LINUS NYAGA PITIMBI	IRIARI Sub Location (PAB)	0727932445	Linus	1,000
9	JOSEPH KINYUA NJAGI	IRIARI S.L (PAB)	0727296966		1,000
10	DORIS GESTICO	IRIARI S.L (PAB)	0714293268	Doris	1,000
11	Jason Kamwana	IRIARI S.L (PAB)	0718737574	Jason	1,000
12	Ernest Njue	IRIARI S.L (PAB)	0701428054	Ernest	1,000
13	Samuel Nyaga	IRIARI S.L (PAB)	0712307052	Samuel	1,000





# **ANNEX 3**

# **DAM DESIGN OUTLINE**



REVISIONS	CHECKED	SIGN	DATE	APPROVED
1	CHECKED			
	BY			
2	CHECKED			
	BY			
3	CHECKED			
	BY			
4	CHECKED			
	BY			

Client  
 NATIONAL IRRIGATION BOARD  
 P.O. BOX 30372 - 00100  
 NAIROBI

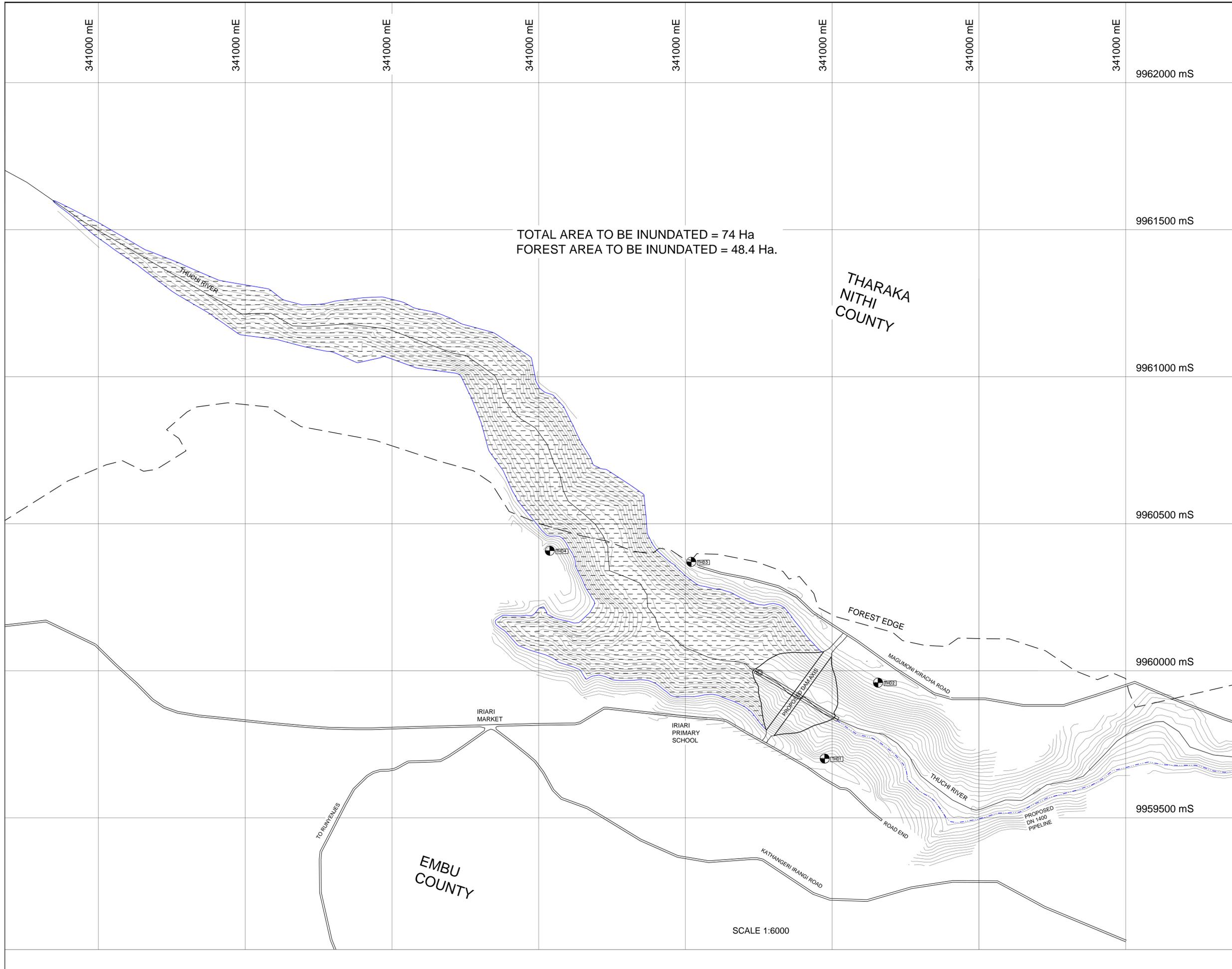
Project  
 FEASIBILITY STUDY, DETAILED DESIGN AND  
 PREPARATION OF TENDER DOCUMENTS FOR  
 THUCHI DAM, EMBU COUNTY

Civil & Structural Engineers  
 Kiri Consult Ltd  
 Consulting Engineers.  
 LENANA CLOSE, OFF LENANA  
 ROAD, NAIROBI  
 P.O. BOX 4125-00506,  
 NAIROBI.

Drawing Title  
 THUCHI DAM LOCATION MAP

Designed by	Eng.P.N.Wambuki
Drawn by	Humphrey Kiogothe
Approved by	Eng.P.N.Wambuki
Scale: As shown	DECEMBER 2016
JOB NO	KCL/2013/10
DWG NO	NIB/T/015/2013-4/01-01





TOTAL AREA TO BE INUNDATED = 74 Ha  
 FOREST AREA TO BE INUNDATED = 48.4 Ha.

NOTES:  
 1. ALL DIMENSIONS ARE IN METERS  
 2. ELEVATIONS ARE IN METERS ABOVE MEAN SEA LEVEL

LEGEND:

-  RESERVOIR BOUNDARY
-  FOREST EDGE
-  PIPELINE
-  BENCHMARK

THD1 -	339474.69mE 9959701.01mS 1617.40 MASL
THD2 -	339656.34mE 9959959.69mS 1640.91 MASL
THD3 -	339474.69mE 9959701.01mS 1662.77 MASL
THD4 -	339656.34mE 9959959.69mS 1671.95 MASL

REVISIONS	CHECKED	SIGN	DATE	APPROVED

Client  
 NATIONAL IRRIGATION BOARD  
 P.O. BOX 30372 - 00100  
 NAIROBI

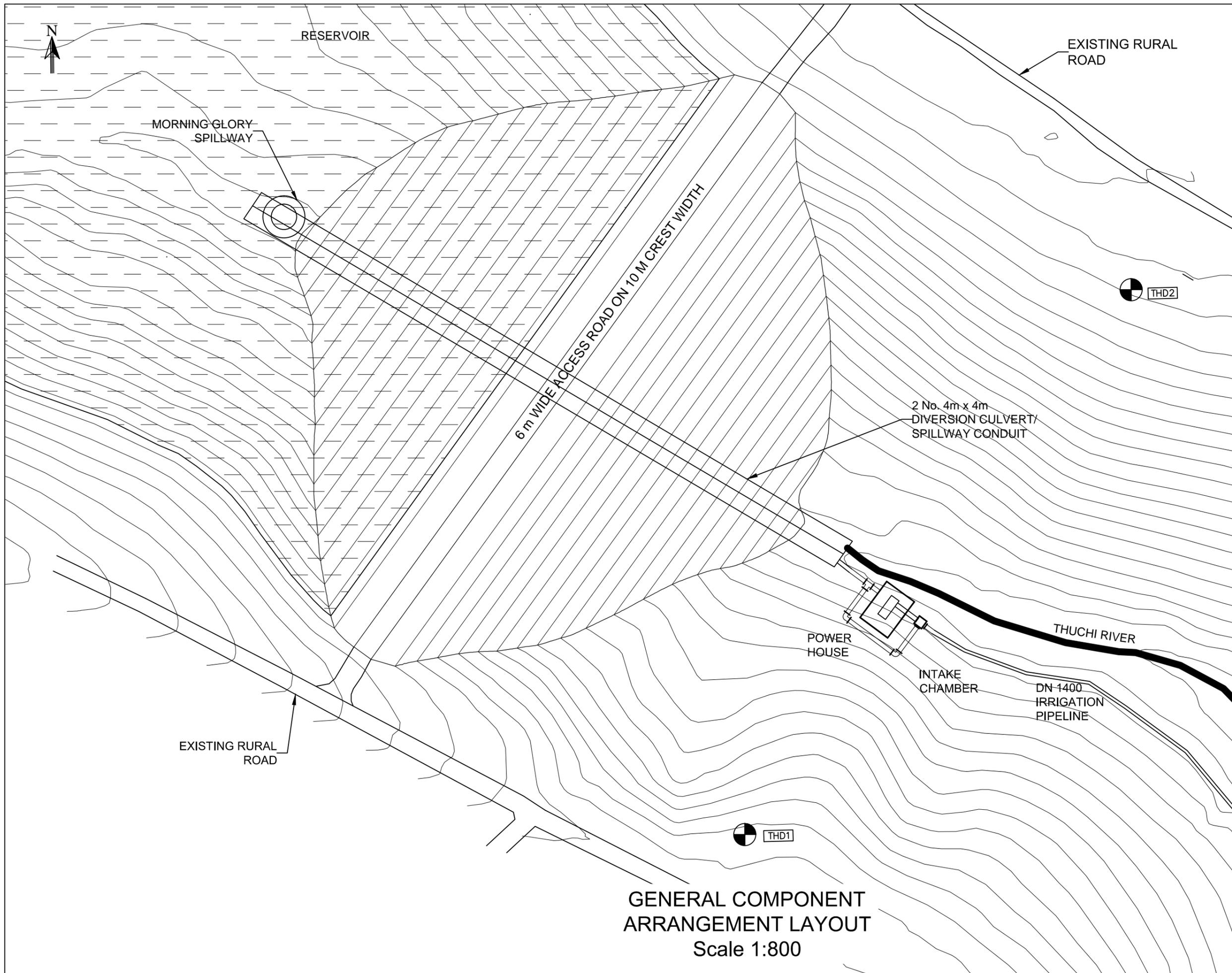
Project  
 FEASIBILITY STUDY, DETAILED DESIGN AND  
 PREPARATION OF TENDER DOCUMENTS FOR  
 THUCHI DAM, EMBU COUNTY

Civil & Structural Engineers  
 Kiri Consult Ltd  
 Consulting Engineers.  
 LENANA CLOSE, OFF LENANA  
 ROAD, NAIROBI  
 P.O. BOX 4125-00506,  
 NAIROBI.

Drawing Title

Designed by	Eng.P.N.Wambuki
Drawn by	H. Kiogothe
Approved by	Eng.P.N.Wambuki
Scale: As shown	DECEMBER 2016
JOB NO	KCL/2013/10
DWG NO	NIB/T/015/2013-14/01-03

SCALE 1:6000



**GENERAL COMPONENT  
ARRANGEMENT LAYOUT**  
Scale 1:800

**NOTES:**  
 1. THE DESIGN SHOWN ON THIS DRAWING IS TENTATIVE ONLY AND SUBJECT TO MODIFICATION WHEN SITE INVESTIGATION DATA ARE AVAILABLE.  
 2. ALL DIMENSIONS ARE IN mm UNLESS OTHERWISE STATED

**LEGEND:**  
 BENCH MARK  
 THD1 - 339474.69mE, 9959701.01mS  
 THD2 - 339656.34mE, 9959959.69mS

REVISIONS	CHECKED	SIGN	DATE	APPROVED
1	CHECKED			
	BY			
2	CHECKED			
	BY			
3	CHECKED			
	BY			
4	CHECKED			
	BY			

**Client**  
 NATIONAL IRRIGATION BOARD  
 P.O. BOX 30372 - 00100  
 NAIROBI

**Project**  
 FEASIBILITY STUDY, DETAILED DESIGN AND PREPARATION OF TENDER DOCUMENTS FOR THUCHI DAM, EMBU COUNTY

**Civil & Structural Engineers**  
 Kiri Consult Ltd  
 Consulting Engineers s.  
 LENANA CLOSE, OFF LENANA ROAD, NAIROBI  
 P.O. BOX 4125-00506, NAIROBI.

**Drawing Title**  
 GENERAL ARRANGEMENT LAYOUT MAP

Designed by	Eng.P.N.Wambuki
Drawn by	H. Kiogotho
Approved by	Eng.P.N.Wambuki
Scale:1:800	DECEMBER 2016
JOB NO	KCL/2013/10
DWG NO	NIB/T/015/2013-4/02-01